British Journal of Oral and Maxillofacial Surgery (2004) **xxx**, xxx–xxx

ELSEVIER

BRITISH Journal of Oral and Maxillofacial Surgery
www.bjoms.com

REVIEW

Current management of damage to the inferior alveolar and lingual nerves as a result of removal of third molars

Peter P. Robinson*, **Alison R. Loescher**, **Julian M. Yates**, **Keith G. Smith**

Department of Oral & Maxillofacial Surgery, School of Clinical Dentistry, University of Sheffield, Claremont Crescent, Sheffield S10 2TA, UK

Accepted 28 February 2004

KEYWORDS
Inferior alveolar nerve;
Lingual nerve;
Nerve injury;
Nerve repair;
Sensory testing

Introduction

Confusion and uncertainty still exists over the optimal management of patients who sustain nerve damage during extraction of lower third molars. This brief review is designed to clarify the management by presenting simple protocols to aid decision-making. These protocols are based on experience gained from managing patients referred to our unit, and so are particularly relevant to the secondary care service in the UK. Complementary guidance to the primary care sector in the UK has been published recently.[1]

We aim to identify those patients who may benefit from some form of intervention, from within the substantial number of patients with some form of nerve injury. Patients who are ultimately left with a minor degree of hypoaesthesia (reduced sensation) or mild paraesthesia (abnormal sensation) cope well with the sensory deficit, are unlikely to benefit from intervention, and are probably best left untreated. In contrast, patients who have either a substantial sensory deficit or the painful sensory disorder of dysaesthesia (unpleasant abnormal sensation) may benefit from intervention, and so must be identified and managed in a manner that will optimise the outcome.

We will deal purely with clinical issues. Reviews of the pathophysiological changes that follow injury to the trigeminal nerve have been published elsewhere,[2,3] as has a review of the aetiology of injury-induced trigeminal dysaesthesia.[4]

We will consider the management of injuries to the inferior alveolar and lingual nerves individually.

Management of damage to the inferior alveolar nerve

At the time of third molar removal

While attempts can be made to predict the likelihood of damage to the inferior alveolar nerve dur-

*Corresponding author. Tel.: +44-114-2717849; fax: +44-114-2717863.
E-mail address: p.robinson@sheffield.ac.uk (P.P. Robinson).

0266-4356/$ — see front matter
doi:10.1016/j.bjoms.2004.02.024

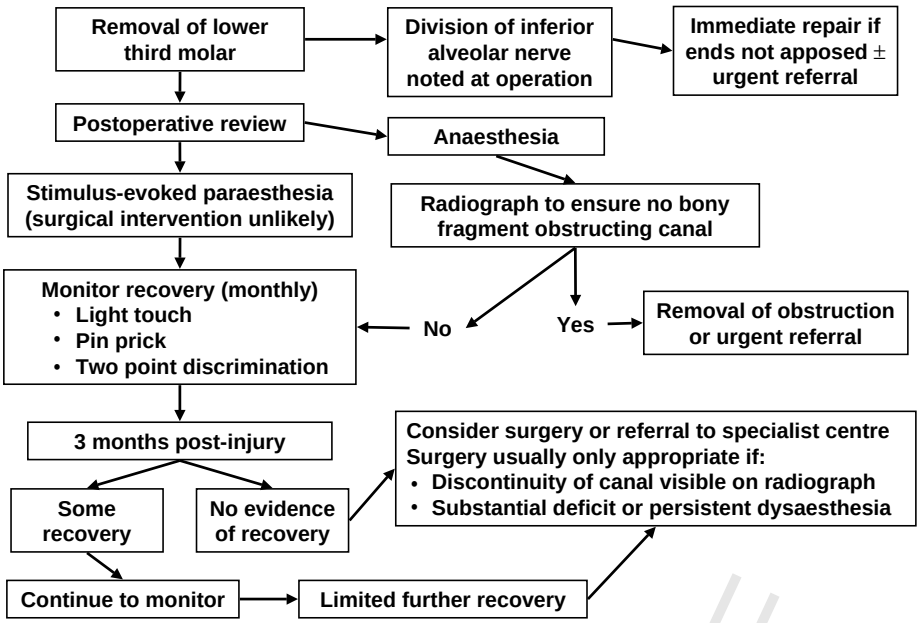

Figure 1 Algorithm showing the management of injuries to the inferior alveolar nerve after removal of a third molar.

ing removal of third molars on the basis of radiological appearance,[5] there is little evidence that any change in surgical technique that results from this information affects the outcome. About 4% of patients sustain injury during removal of lower third molars.[3] An algorithm to guide management decisions for such patients is shown in Fig. 1. In a small proportion of patients, damage to the inferior alveolar nerve is noted at the time of operation. As the neurovascular bundle is well supported within the mandibular canal, and even after section the ends do not retract, primary repair of the nerve is not normally required. Bleeding from the bundle should be controlled by gentle temporary packing with gauze (which is removed before the wound is closed), and diathermy should not be used. Medicaments or haemostatic agents such as Whitehead's varnish or 'Surgicel' should also be avoided as they can cause a chemical injury to the nerve.[6] In the rare event that the two ends of the nerve become displaced and separated within the tooth socket, an attempt should be made to reapproximate them with epineurial sutures (using an 8/0 monofilament polyamide suture, Ethilon, Ethicon Ltd., UK), inserted with the aid of loupes or an operating microscope. This is only possible if the procedure is being undertaken under general anaesthesia, and access and visibility at this stage can be difficult.

At the postoperative review

The clinician usually becomes aware of the nerve injury only at the time of a postoperative review, approximately 1 week after the operation. At this stage, patients may have profound anaesthesia, or varying degrees of paraesthesia or dysaesthesia. If some sensation is evoked by mechanical stimulation of the lip and chin in the mental distribution, it suggests that at least part of the nerve remains intact and functioning and full recovery is likely. This should be distinguished from the spontaneous paraesthesia (reported by the patient as 'tingling' from the affected area) that can result from neural activity initiated at the site of nerve injury,[7,8] and which does not predict spontaneous recovery. If there is complete anaesthesia, an appropriate radiograph (such as a segmental dental panoramic tomograph) should be obtained to show the mandibular canal at the site of the socket of the third molar. If this shows that a fragment of the cortical bone from the roof of the canal has been displaced and is obstructing the canal, then it seems appropriate to remove it, using the approach described below. In most cases an obstruction will not be identified, however, and recovery should be monitored for a time before any intervention. Of course, a full explanation for the occurrence of the nerve injury should be given to the patient, together with a description of the events that may follow.

Monitoring recovery

Various methods for monitoring recovery of sensation have been described[9] but only a simple assessment is required for routine clinical use.[2] Light touch stimuli (ideally with a von Frey hair), pin-

prick stimuli, and the measurement of two-point discrimination thresholds, is adequate to detect evidence of early sensory recovery. The method of construction of the simple equipment required for these tests has been described.[10] These tests can be repeated at approximately monthly intervals, and most patients will gradually recover normal sensation. In the few patients in whom there is *no evidence* of recovery by 3 months, surgical intervention should be considered and discussed with the patient. The patient should be referred at this stage to a unit with a special interest in the management of injuries to the trigeminal nerve. Gregg has outlined the case for this delay before intervention, and the restriction of an operation to those patients with either anaesthesia or a significant sensory disturbance such as dysaesthesia.[11] If there is some evidence of sensory recovery by 3 months, monitoring should be continued until there is no progressive improvement (up to 12 months).[12] At this stage, an operation should again be restricted to patients with either a substantial deficit or persistent dysaesthesia.

Surgical procedures

Patients referred with either very little recovery or significant dysaesthesia should have a radiograph of the mandibular canal, if this is not available. If there is obvious deviation or disruption of the canal (Fig. 2), then 'decompression' of the affected area is indicated, a procedure first advocated by Merrill.[13] This is done by an intraoral approach and the canal is reached by removing a segment of buccal plate: the anterior and posterior limits are defined by cuts through the cortex with a bur, a groove 'scored' at the level of the canal, and the segment removed with a chisel and discarded. This approach is similar to that described by Miloro.[14] More bone is carefully removed with a large round diamond bur, together with dental excavators, until the neurovascular bundle can be eased gently laterally from the canal for examination (Fig. 3). Under the operating microscope, any lateral neuroma is excised and constricting scar tissue at the site of injury is released by longitudinal incisions through the epineurium (neurolysis). The mandibular canal restricts mobilisation of the central and distal stumps, and so a long segment of damaged nerve cannot be excised. A limited degree of reapproximation is, however, sometimes possible.

The outcome of this is variable[15,16] and there is a surprising paucity of published data on the efficacy of any form of exploration or repair of the inferior alveolar nerve.[17] Rather remarkably, Mozsary and Syers reported 'complete recovery' in 20 of 23 patients who had had some form of decompression or reanastomosis, but they used no form of objective

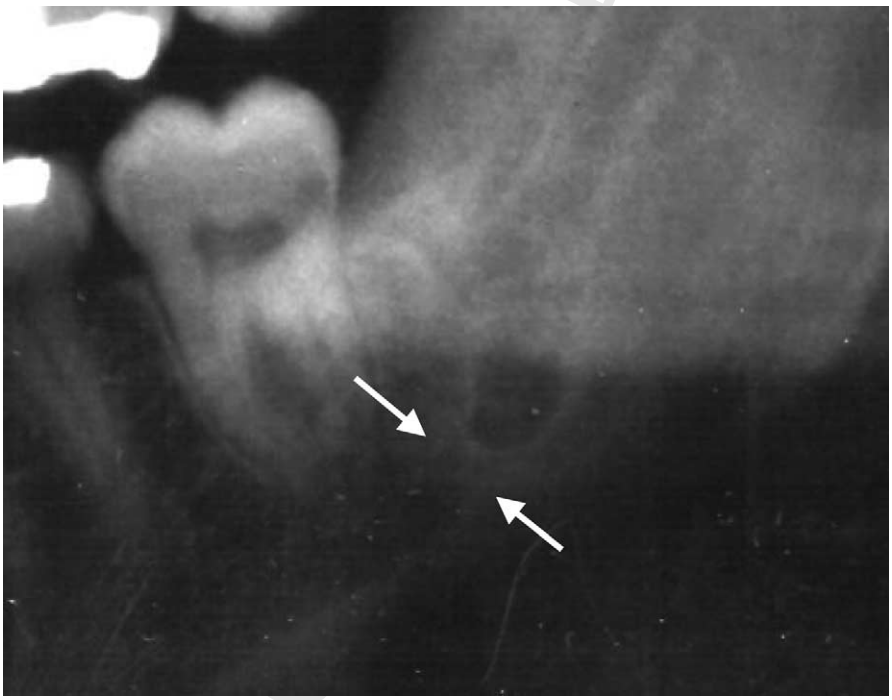

Figure 2 Radiograph taken 23 months after removal of a third molar. The mandibular canal is disrupted with little evidence of continuity either radiographically or at the time of subsequent exploration. The white arrows indicate an area of bone formation across the site of the original canal with a cortical outline to the proximal section.

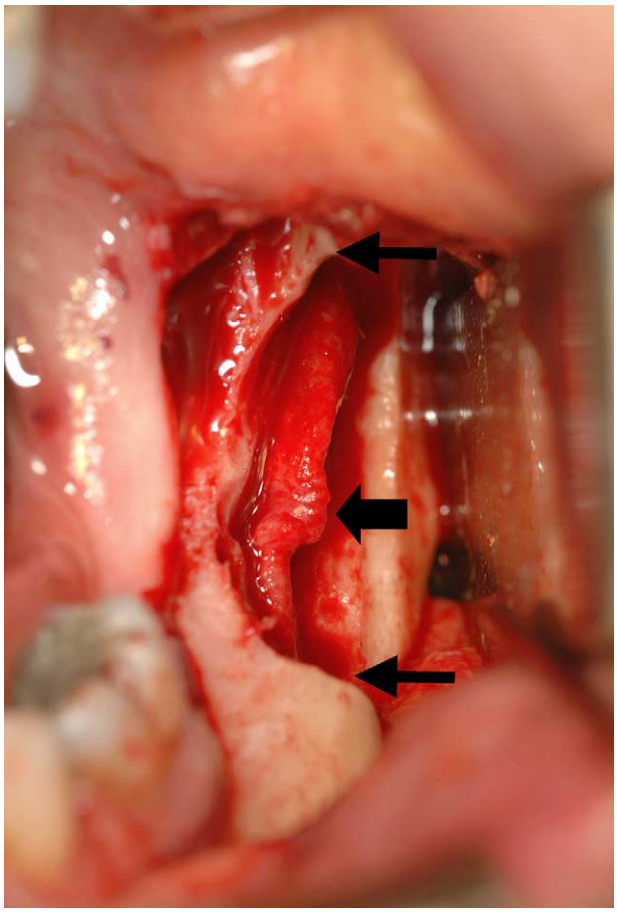

Figure 3 Exploration and decompression of the left inferior alveolar nerve. The small arrows indicate the site of the cortical cuts made before a segment of the buccal plate was removed. The large arrow indicates a neuroma that extended laterally and towards the alveolar crest from the neurovascular bundle, and the bundle narrows distal to this point.

testing.[18] The largest report is an appraisal using retrospective postal questionnaires of 316 operations on the inferior alveolar nerve at seven units in the USA.[19] This included a range of procedures and the authors reported an overall success rate of 74%. We have found that some patients gain a significant degree of recovery, but a reduction in dysaesthesia may only be transient in others.

Various approaches to the inferior alveolar nerve have been described, together with a 'cascade' of options for managing the site of injury.[20] Various forms of nerve grafting,[21,22] entubulation,[23–25] or nerve sharing[26,27] operations have been reported but usually with few cases or as single case reports, so their value remains uncertain and indeed some procedures may do more harm than good.

Management of damage to the lingual nerve

At the time of removal of the third molar

The surgical technique used for removal of the tooth does affect the incidence of damage to the nerve and our primary concern should be the reduction of any form of iatrogenic injury. There is good and increasing evidence that lingual flap retraction should be avoided for most cases,[28–31] but this issue has been extensively debated elsewhere and will not be pursued here. The mean incidence of damage to the lingual nerve in a series of reported studies is approximately 7% of operations,[3] and an algorithm to guide management decisions for these patients is shown in Fig. 4. In a few patients, damage to the lingual nerve is noted at the time of removal of the third molar. In such circumstances, if the operation is being undertaken under general anaesthesia, immediate microsurgical repair should be undertaken. We recommend the use of an operating microscope and insertion of 6 to 8, 8/0 monofilament polyamide epineurial sutures. If for practical reasons this is not possible, the patient should be referred urgently to a unit with a special interest in trigeminal nerve repair.

At the postoperative review

As described for injuries to the inferior alveolar nerve, it is usually only at this time that the clinician becomes aware of the injury. Once again, the extent of sensory disturbance at this early stage is a guide to the likely extent of recovery. If some sensation is evoked by mechanical stimulation of the tongue, it suggests that at least part of the nerve remains intact and functioning, and full recovery is likely. Mason showed that recovery was most rapid when only the tip of the tongue was involved and slowest when the entire distribution was affected.[32] Spontaneous paraesthesia ('tingling' from the affected area) can again result from neural activity initiated at the site of nerve injury,[33] and should be distinguished from sensations evoked by mechanical stimulation of the tongue. Whatever the outcome of this test, however, a short period of review is recommended and a full explanation for the occurrence of the injury and likely sequel should be given to the patient. This review period helps to distinguish between anaesthesia caused by a crushed nerve (in which case signs of recovery begin within 3 months and intervention is not usually required) and a sectioned nerve (when recovery is slow and an operation is usually indicated). This is particularly impor-

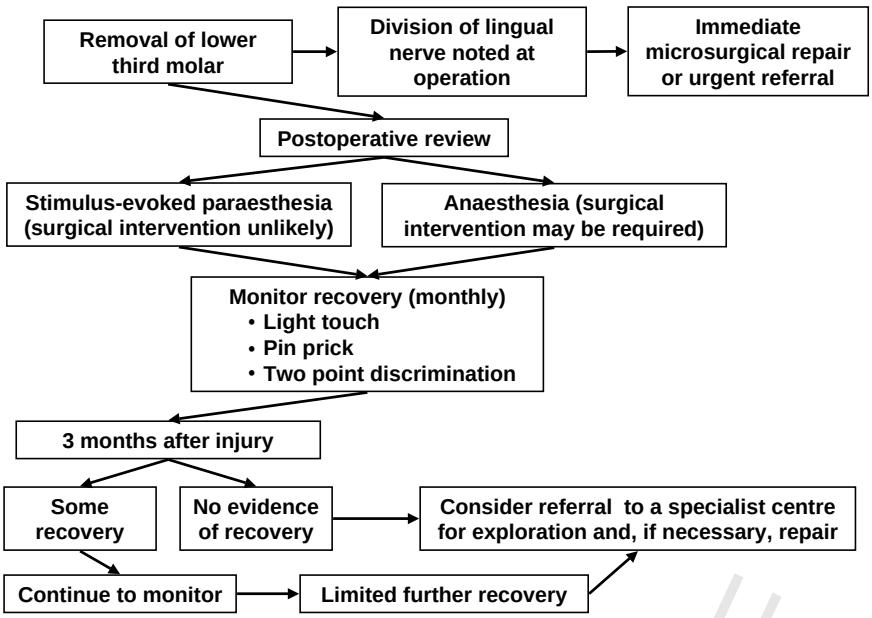

Figure 4 Algorithm showing the management of injuries to the lingual nerve after removal of a third molar.

tant in the UK where substantial crush injuries can still occur as a result of attempts at lingual retraction.

Monitoring recovery

Sensory testing should be undertaken at approximately monthly intervals using light touch and pin prick stimuli, and two-point discrimination thresholds should be recorded, as described above. The lack of any evidence of recovery by 3 months is recommended as an indication for surgical intervention[34] and laboratory studies suggest that this delay has little detrimental effect on the outcome.[35,36] If there is some evidence of sensory recovery by 3 months, monitoring should be continued for a further 3–6 months, until there is no further improvement. At this stage, an operation is considered if there is either poor recovery or dysaesthesia. The potential value of surgery can be assessed by comparing the patient's sensory deficit with reported postoperative results (see below).

Surgical procedures

The optimal surgical management of patients who sustain lingual nerve injuries is clearer, as the outcome of surgical intervention is better understood. The use of microsurgical techniques to repair damaged lingual nerves was first described about 25 years ago, but early reports included little information about outcome[13,37,38] or about the methods used to assess a successful result.[39] The first published reports on outcome evaluated by sensory testing appeared mainly in the 1990s[15,40–44] and, while some results were encouraging, the number of patients assessed was small or they were treated by many different surgical procedures. The largest report was from an appraisal by retrospective postal questionnaire of 205 repairs of lingual nerves at seven units in the USA.[19] The operations included direct suture or grafting, and although the authors reported an 80% success rate, their main conclusion was ''it is apparent that there is need for a detailed prospective study of specific injury conditions and their response to standardised microneurosurgical interventions''.

In this journal we have reported the outcome of a prospective, quantitative study of lingual nerve repair in 53 patients, and this is the largest single-centre study ever published to our knowledge.[45] The protocol we used was based on the results of an extensive series of laboratory investigations[46,47] and led us to excise the damaged segment of nerve, including any neuroma, mobilise the central and distal stumps, and repair with epineurial sutures, without a nerve graft (Fig. 5). Postoperatively, most patients regained some sensation, fewer tended to bite the tongue by accident, and there were highly significant improvements in the results of sensory tests. Most importantly, the operation was considered by the patients to be worthwhile. However, the level of success was variable; some patients did not improve, speech and taste sensation sometimes remained affected, and recov-

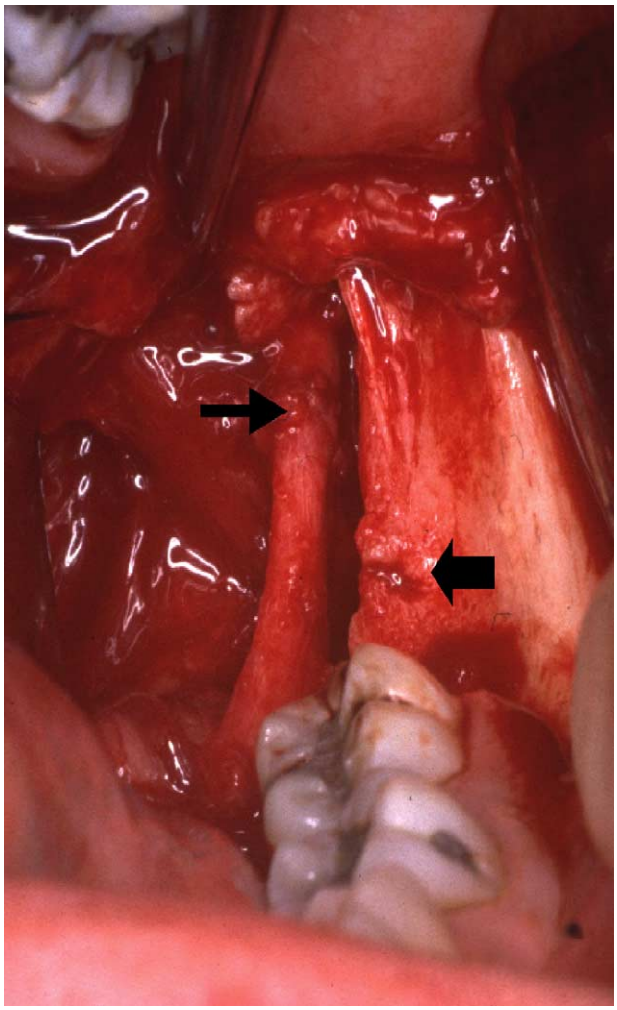

Figure 5 A repaired left lingual nerve. The small arrow shows the site of suture to the proximal stump after the damaged segment has been excised. The large arrow indicates the probable site of the initial injury where a bur has penetrated the lingual plate during removal of the third molar.

ery was never complete. In addition, surgery did not reduce the number of patients with dysaesthesia.

Our results from direct reapposition of the lingual nerve by epineurial sutures seem to be better than those reported after other methods of repair such as nerve grafting,[15,43,48] artificial conduits,[24] or some reports of external neurolysis.[40] However, in a small proportion of patients, exploration of the damaged nerve shows it to be intact but involved in scar tissue, or only partially divided. Such injuries could be the result of vigorous lingual retraction or damage from the cutting needle at the time the wound is closed. In this small group of patients it seems appropriate to free the scar tissue or repair only the area of partial section. Analysis of a series of such patients may explain the good recovery sometimes reported after neurolysis.[49]

Timing of repair

Several papers have suggested that late repair is followed by a poorer outcome than early repair[39,48] and Riediger et al.[15] were sceptical about repair undertaken more than 12 months after the injury. Meyer[50] reported 90% success if the repair was undertaken within three months, reducing to 10% success by 12 months, although the nature of his analysis is unclear. The timing of the repair in our study[45] ranged from 4 to 47 (mean 15) months after the initial injury and we found no significant correlation between delay and any measures of outcome. We concluded that the method we described was worthwhile for both early and late repair of lingual nerves. Nevertheless, we advocate early referral after the 3-month monitoring period, as shown in our protocol. Inevitable delays in both clinic and operation appointments mean that surgery is not commonly undertaken less than 5—6 months after the injury.

The management of persistent dysaesthesia

It is surprising that some patients who sustain a nerve injury may be left with profound anaesthesia but no dysaesthesia, while others complain bitterly of chronic pain and tingling, often exacerbated by moving or touching the affected area. The explanation for these two widely differing outcomes is not known, but the nature of the initial injury is likely to be important. In this context it is of note that patients in whom the inferior alveolar nerve is damaged as a result of mandibular fractures or orthognathic surgery rarely complain of dysaesthesia, whereas some patients in whom the inferior alveolar nerve is damaged during removal of third molars develop this disorder.

Despite our observation that lingual nerve repair did not reduce the *number* of patients with dysaesthesia, it seemed that the severity of these symptoms was often reduced.[45] This is consistent with other reports of a reduction in pain scores after repairs of both inferior alveolar and lingual nerves.[19] For this reason, our first line of management for patients with inferior alveolar or lingual nerve dysaesthesia is surgical, using the methods described above. However, even after operation, some patients are left with severe symptoms that cause great distress and disruption of daily life. For

this group a pharmacological approach is appropriate. Unfortunately, the drugs currently available are not universally effective, and at best produce only partial relief of symptoms. Gregg[51] showed that tricyclic antidepressants were helpful in some patients. Carbamazepine, while also giving some relief of symptoms, is associated with side-effects in many patients. The more recently developed anticonvulsant drugs may also be of benefit[52] but their efficacy after injuries to the trigeminal nerve has yet to be shown. Clinical and laboratory studies to determine the value of these drugs in trigeminal dysaesthesia are ongoing in our unit.

References

1. Loescher AR, Smith KG, Robinson PP. Nerve damage and third molar removal. *Dental Update*, in press.
2. Robinson PP. Nerve injuries resulting from the removal of impacted teeth. In: Andreason JO, editor. *Diagnosis and treatment of tooth impactions*. Copenhagen: Munksgaard; 1997. p. 469–90.
3. Holland GR, Robinson PP. Peripheral nerve damage and repair. In: Harris M, Edgar M, Meghji S, editors. *Clinical oral science*. Oxford: Butterworth-Heinemann; 1998. p. 274–89.
4. Fried K, Bongenhielm U, Boissonade FM, Robinson PP. Nerve injury-induced pain in the trigeminal system. *Neuroscientist* 2001;**7**:155–65.
5. Rood JP, Shehab BAAN. The radiological prediction of inferior alveolar nerve injury during third molar surgery. *Br J Oral Maxillofac Surg* 1990;**28**:20–5.
6. Loescher AR, Robinson PP. The effect of surgical medicaments on peripheral nerve function. *Br J Oral Maxillofac Surg* 1998;**36**:327–32.
7. Bongenhielm U, Robinson PP. Spontaneous and mechanically evoked afferent activity originating from myelinated fibres in ferret inferior alveolar nerve neuromas. *Pain* 1996;**67**:399–406.
8. Bongenhielm U, Robinson PP. Afferent activity from myelinated inferior alveolar nerve fibres in ferrets after constriction or section and regeneration. *Pain* 1998;**74**:123–32.
9. Essick GK. Comprehensive clinical evaluation of perioral sensory function. In: LaBanc JP, Gregg JM, editors. *Oral and maxillofacial surgery clinics of North America: trigeminal nerve injury: diagnosis and management*, vol. 4. Philadelphia: W.B. Saunders; 1992. p. 503–26.
10. Robinson PP, Smith KG, Johnson FP, Coppins DA. Equipment and methods for simple sensory testing. *Br J Oral Maxillofac Surg* 1992;**30**:387–9.
11. Gregg JM. Surgical management of inferior alveolar nerve injuries (Part 11): the case for delayed management. *J Oral Maxillofac Surg* 1995;**53**:1330–3.
12. Robinson PP. Observations on the recovery of sensation following inferior alveolar nerve injuries. *Br J Oral Maxillofac Surg* 1988;**26**:177–89.
13. Merrill RG. Prevention, treatment, and prognosis for nerve injury related to the difficult impaction. *Dent Clin N Am* 1979;**23**:471–88.
14. Miloro M. Surgical access for inferior alveolar nerve repair. *J Oral Maxillofac Surg* 1995;**53**:1224–5.
15. Riediger D, Ehrenfeld M, Cornelius CP. Micronerve surgery on the inferior alveolar and lingual nerve with special consideration for nerve replacement. In: Riediger D, Ehrenfeld M, editors. *Microsurgical tissue transplantation*. San Francisco: Quintessence Publishing; 1989. p. 189–94.
16. Pogrel MA. The results of microneurosurgery of the inferior alveolar and lingual nerve. *J Oral Maxillofac Surg* 2002;**60**:485–9.
17. Dodson TB, Kaban LB. Recommendations for management of trigeminal nerve defects based on a critical appraisal of the literature. *J Oral Maxillofac Surg* 1997;**55**:1380–6.
18. Mozsary PG, Syers CS. Microsurgical correction of the injured inferior alveolar nerve. *J Oral Maxillofac Surg* 1985;**43**:353–8.
19. LaBanc JP, Gregg JM. Trigeminal nerve injuries. Basic problems, historical perspectives, early successes and remaining challenges. In: LaBanc JP, Gregg JM, editors. *Oral and maxillofacial surgery clinics of North America: trigeminal nerve injury: diagnosis and management*, vol. 4. Philadelphia: W.B. Saunders; 1992. p. 277–83.
20. LaBanc JP, Van Boven RW. Surgical management of inferior alveolar nerve injuries. In: LaBanc JP, Gregg JM, editors. *Oral and maxillofacial surgery clinics of North America: trigeminal nerve injury: diagnosis and management*, vol. 4. Philadelphia: W.B. Saunders; 1992. p. 425–37.
21. Maghen A. The use of autologous vein grafts for inferior alveolar and lingual nerve reconstruction. *J Oral Maxillofac Surg* 2001;**59**:985–8.
22. Rath EM. Skeletal muscle autograft for repair of human inferior alveolar nerve: a case report. *J Oral Maxillofac Surg* 2002;**60**:330–4.
23. Crawley WA, Dellon AL. Inferior alveolar nerve reconstruction with a polyglycolic acid bioresorbable nerve conduit. *Plast Reconstr Surg* 1992;**90**:300–2.
24. Pogrel MA, McDonald AR, Kaban LB. Gore-Tex tubing as a conduit for repair of lingual and inferior alveolar nerve continuity defects: a preliminary report. *J Oral Maxillofac Surg* 1998;**56**:319–21.
25. Pitta MC, Wolford LM, Mehra P, Hopkin J. Use of Goretex tubing as a conduit for inferior alveolar and lingual nerve repair: experience with 6 cases. *J Oral Maxillofac Surg* 2001;**59**:493–6.
26. Haschemi A. Partial anastomosis between the lingual and mandibular nerves for restoration of sensibility in the mental area after injury to the mandibular nerve. *J Maxillofac Surg* 1981;**9**:225–7.
27. Kaban LB, Upton J. Cross mental nerve graft for restoration of lip sensation after inferior alveolar nerve damage: report of a case. *J Oral Maxillofac Surg* 1986;**44**:649–51.
28. Robinson PP, Smith KG. Lingual nerve damage during lower third molar removal: a comparison of two surgical methods. *Br Dent J* 1996;**180**:456–61.
29. Gargallo-Albiol J, Buenechea-Imaz R, Gay-Escoda C. Lingual nerve protection during surgical removal of lower third molars: a prospective randomised study. *Int J Oral Maxillofac Surg* 2000;**29**:268–71.
30. Valmaseda-Castellon E, Berini-Aytes L, Gay-Escoad C. Lingual nerve damage after lower third molar surgical extraction. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2000;**90**:567–73.
31. Pichler JW, Beirne OR. Lingual flap retraction and prevention of lingual nerve damage associated with third molar surgery: a systematic review of the literature. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2001;**91**:395–401.
32. Mason DA. Lingual nerve damage following lower third molar surgery. *Int J Oral Maxillofac Surg* 1988;**17**:290–4.
33. Yates JM, Smith KG, Robinson PP. Ectopic neural activity from myelinated afferent fibres in the lingual nerve

of the ferret following three types of injury. *Brain Res* 2000;**874**:37–47.
34. Blackburn CW. A method of assessment in cases of lingual nerve injury. *Br J Oral Maxillofac Surg* 1990;**28**:238–45.
35. Smith KG, Robinson PP. An experimental study on the recovery of the lingual nerve after injury with or without repair. *Int J Oral Maxillofac Surg* 1995;**24**:372–9.
36. Smith KG, Robinson PP. The effect of delayed nerve repair on the properties of regenerated afferent fibres in the chorda tympani. *Brain Res* 1995;**691**:142–52.
37. Hausamen JE. Principles and clinical application of micronerve surgery and nerve transplantation in the maxillofacial area. *Ann Plast Surg* 1981;**7**:428–33.
38. Donoff RB, Guralnick W. The application of microneurosurgery to oral-neurological problems. *J Oral Maxillofac Surg* 1982;**40**:156–9.
39. Mozsary PG, Middleton RA. Microsurgical reconstruction of the lingual nerve. *J Oral Maxillofac Surg* 1984;**42**:415–20.
40. Blackburn CW. Experiences in lingual nerve repair. *Br J Oral Maxillofac Surg* 1992;**30**:72–7.
41. Hillerup S, Hjørting-Hansen E, Reumert T. Repair of the lingual nerve after iatrogenic injury. *J Oral Maxillofac Surg* 1994;**52**:1028–31.
42. Robinson PP, Smith KG. A study on the efficacy of late lingual nerve repair. *Br J Oral Maxillofac Surg* 1996;**34**:96–103.
43. Hausamen J-E, Schmelzeisen R. Current principles in microsurgical nerve repair. *Br J Oral Maxillofacial Surg* 1996; **34**:143–57.
44. Zuniga JR, Chen N, Phillips CL. Chemosensory and somatosensory regeneration after lingual nerve repair in humans. *J Oral Maxillofac Surg* 1997;**55**:2–13.
45. Robinson PP, Loescher AR, Smith KG. A prospective, quantitative study on the clinical outcome of lingual nerve repair. *Br J Oral Maxillofac Surg* 2000;**38**:255–63.
46. Smith KG, Robinson PP. An experimental study of lingual nerve repair using epineurial suture or entubulation. *Br J Oral Maxillofac Surg* 1995;**33**:211–9.
47. Smith KG, Robinson PP. The reinnervation of the tongue and salivary glands after lingual nerve repair by stretch, sural nerve graft or frozen muscle graft. *J Dent Res* 1995;**74**:1850–60.
48. Pogrel MA, Kaban LB. Injuries to the inferior alveolar and lingual nerves. *J Calif Dent Assoc* 1993;**21**:50–4.
49. Joshi A, Rood JP. External neurolysis of the lingual nerve. *Int J Oral Maxillofac Surg* 2002;**31**:40–3.
50. Meyer RA. Applications of microneurosurgery to the repair of trigeminal nerve injuries. In: LaBanc JP, Gregg JM, editors. *Oral and maxillofacial surgery clinics of North America: trigeminal nerve injury: diagnosis and management*, vol. 4. Philadelphia: W.B. Saunders; 1992. p. 405–16.
51. Gregg JM. Post-traumatic trigeminal neuralgia: response to physiological, surgical and pharmacological therapies. *Int Dent J* 1978;**28**:43–51.
52. Backonja MM. Use of anticonvulsants for treatment of neuropathic pain. *Neurology* 2002;**59(5 Suppl 2)**:S14–7.