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Experiences in lingual nerve repair

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SUMMARY. **An account is given of the experience gained through the exploration of 23 lingual nerves injured during third molar surgery, including a description of the findings in each case and the repair methods used. Details are given of the results of the preoperative and postoperative assessment. The outcome on the whole has been disappointing, and possible reasons for this are discussed. The discussion includes an evaluation of the use of somatosensory evoked potentials as part of the diagnostic method.**

INTRODUCTION

Permanent alteration of lingual sensation following third molar surgery is not an infrequent occurrence. Recently reported studies (Mason, 1988; Blackburn & Bramley, 1989) indicate that permanent lingual nerve damage may result from as many as one in 200 procedures. In these cases consideration might be given to exploration and repair of the nerve lesion. However for several reasons the decision may not be an easy one to make.

Firstly, many of these patients exhibit partial recovery, and there is as a consequence the concern of making the situation worse by attempting repair. Added to this there is a paucity of information in the literature regarding surgical technique, or the outcome following repair. The most informative accounts available are those by Donoff and Guralnick (1982) and Mozsary and Middleton (1984) who reported that overall a satisfactory outcome may be achieved in most cases.

Secondly, there is a need for early identification of those patients unlikely to make full recovery, as the experience gained with nerve repair in general is that the best results are obtained when the surgery is performed soon after injury (Seddon, 1975a; Merle *et al.*, 1986). This problem of the need for early diagnosis has already been addressed (Blackburn, 1990).

An account of the various suturing techniques used for direct anastomosis and grafting of nerves was given by Emerson (1981). He, like many other authors, stressed the need to avoid tension across the suture line. To this end attention has focused on vascularised nerve grafts, for which superior results have been claimed. These were reviewed by Breidenback and Terzis (1984).

Neurolysis is the term for the release of a nerve from scar in the surrounding tissues (external neurolysis) or in the epineurium (internal neurolysis). Such scar may cause a conduction block, or prevent the regeneration of injured fibres, as a result of compression. While these forms of lesion may be amenable to surgery, it is not possible to remedy scarring of the perineurium or within the fascicle using such technique (Seddon, 1975b).

The problem of the nerve lesion in continuity was discussed by Sunderland (1978). He described two situations where it may be necessary to excise the damaged segment and perform an anastomosis. The first is where a hard irregular nerve is found, with dense peripheral scar, and internal neurolysis reveals disrupted fascicles. The second is where a neuroma is present. This by itself does not indicate a need for resection. Rather the neuroma should be explored and any intact fascicles preserved. If only dense scar is found, resection and subsequent suture is indicated. He described important aspects of the technique for neurolysis, foremost being the preservation of the blood supply to the nerve trunk, and the effective control of bleeding to prevent the reformation of scar tissue.

MATERIALS AND METHODS

The series reported here comprised 21 patients who had sustained lingual nerve injury as a consequence of third molar surgery. There were two bilateral cases. Diagnosis was by patient subjective report, sensory testing using moving two-point discrimination and touch, and the recording of somatosensory evoked potentials (SEP's) following lingual stimulation. These methods have been described elsewhere (Blackburn, 1988; Blackburn, 1990; Altenmuller *et al.*, 1990). The results of the preoperative assessment, together with the period of time that had elapsed between injury and attempted repair for each case, are shown in Table 1. In Tables 1 and 3, 'touch' refers to the area of the dorsum of the tongue sensitive to the touch stimulus as represented by a distance measured backward from the tip. The bending strength of the filament used was 4.5 G. Under 'M2PD' (moving two-point discrimination) the figures refer to the difference in threshold

Table 1 – Preoperative assessment of the 23 cases of lingual nerve damage

Patient	Problem	Sensory testing		
		Touch	M2PD	SEP
1	anaesthesia	nil	nil	no response
2	anaesthesia	nil	nil	no response
3	dysaesthesia	nil	nil	no response
4	anaesthesia	nil	3	low amplitude
5	anaesthesia & paraesthesia	tip	5→nil	low amplitude
6	anaesthesia	patchy	nil	delay–9 ms
7	anaesthesia & paraesthesia	tip	nil	delay & low amp
8	anaesthesia & paraesthesia	tip	3	delay–8 ms
9	anaesthesia	1.5 cm	nil	delay–4 ms
10	anaesthesia & dysaesthesia	?tip	nil	no response
11	anaesthesia	nil	7	equip. failure
12	dysaesthesia & paraesthesia	?tip	8	delay–5 ms
13	anaesthesia	nil	6	delay–12 ms
14	anaesthesia & paraesthesia	tip	6	normal response
15	anaesthesia	nil	nil	delay- 4 ms
16R	paraesthesia	nil	6	normal response
16L	paraesthesia	nil	4	normal response
17	anaesthesia & paraesthesia	tip	nil	delay–6.5 ms
18	anaesthesia & dysaesthesia	tip	5	normal response
19	anaesthesia	nil	3→5	delay 5 ms
20R	anaesthesia & dysaesthesia	tip	1	normal response
20L	anaesthesia & dysaesthesia	tip	9	normal response
21	paraesthesia	3 cm	1	equip. failure

between affected and normal sides, except in bilateral cases where the actual threshold is given; 'nil' signifies no threshold, that is, the patient was unable to discriminate one point from two even at 10 mm separation of the points; '0' signifies no difference in threshold between sides. Under 'SEP' the response obtained following numb side stimulation is described, compared to the responses following normal side stimulation; in the bilateral cases the responses are compared to those previously obtained from normal subjects. The patient's main complaint is listed under 'Problem' as anaesthesia indicating numbness, paraesthesia indicating abnormal sensation such as tingling, and dysaesthesia indicating unpleasant and distressing sensations such as pain or burning.

The procedures were performed under general anaesthesia, and in most cases an operating microscope was used for final dissection and the repair. Two surgical approaches were used. The first was by means of a standard wisdom tooth incision and the raising of a buccal flap. The incision was carried forward in the gingival crevice on the lingual aspect of the first and second lower molars to allow greater reflection of the lingual flap. Further access was obtained by performing a 'lingual split', with removal of the lingual plate of bone.

The second approach was along the floor of the mouth, by means of an incision over the submandibular duct. To avoid further lingual nerve injury this was started anterior to the second premolar, because it is known that on occasions the lingual nerve may cross the duct at this point (Castelli *et al.*, 1969). It was sometimes necessary to remove the sublingual gland, before tracing the submandibular duct backwards to the point where the lingual nerve could be identified crossing the duct. The nerve was then followed proximally to the site of injury.

The methods used for repair in each case are described below. Care was taken to achieve haemostasis at the end of each procedure, in an attempt to minimise the formation of additional scar tissue. Wounds were closed using a minimum of sutures.

Patients were reviewed for as long as possible. It was not possible to review three patients (nos. 5, 6 & 9), because their place of residence was too far distant. Three patients living locally failed to return for follow-up (nos. 4, 10 & 14), although patient no. 10 gave a report by telephone.

RESULTS

Overall experience and problems encountered

In general, the access provided by these two surgical approaches was good. Used together they provide visualisation of the nerve from where it emerges between medial pterygoid and the mandible, to the point where it crosses the submandibular duct. Care should be taken when making the distal relieving incision in the buccal approach, not to carry it across the retromolar pad. It had been recognised that the lingual nerve may take an aberrant course, and may on occasions cross the retromolar pad, and yet despite this precaution having been taken, in one case the distal incision passed immediately alongside the nerve.

Finding the nerve at the site of injury using the buccal approach alone was frequently a problem, although in several cases, where scarring was not severe, it could be clearly seen through the periosteum of the lingual flap. In situations where the nerve is not immediately apparent, it would be wise to first find it in normal tissue, before tracing it to the site of injury.

Two problems proved difficult to overcome. The first was that of obtaining adequate retraction of the tongue and mucosal flaps. Skin-hooks proved useful, but most valuable were silk stay sutures, which were repeatedly inserted as the dissection advanced in the floor of the mouth. The most awkward part of the dissection was the final part where the two surgical wounds were joined. Here the difficulty lay in obtaining adequate tension in the tissues surrounding the nerve to facilitate dissection. The posterior extent of the wound was retracted using a pair of heavy artery forceps clamped to the ascending ramus.

The second problem was that of haemorrhage. A constant oozing of blood persisted in most cases despite various measures, which included preoperative infiltration of local anaesthetic solution with adrenaline into all areas of dissection, the use of topical adrenaline on linteen gauze, and bipolar

diathermy. It was necessary to frequently irrigate the wound with saline to remove the film of coagulated blood, and for this a microsurgical suction-irrigation system proved most useful.

With regard to instrumentation, an operating microscope was used in most cases. In addition to providing magnification for neurolysis and nerve suture, it gave good illumination. The microscope was also useful in the final stages of dissection of the nerve alluded to above, where visualisation was particularly difficult. Dissection of the nerve was performed using a scalpel and iris scissors. Microsurgical instruments were used for the repair, and it was found that these should be long, ideally with bayonet handles, such as those manufactured by Stille which are 18.5 cm long (cat.nos. 117–C30, A20 & A30).

Surgical findings and repair

In broad terms there were three types of lesion found, and these are illustrated in the Figure.

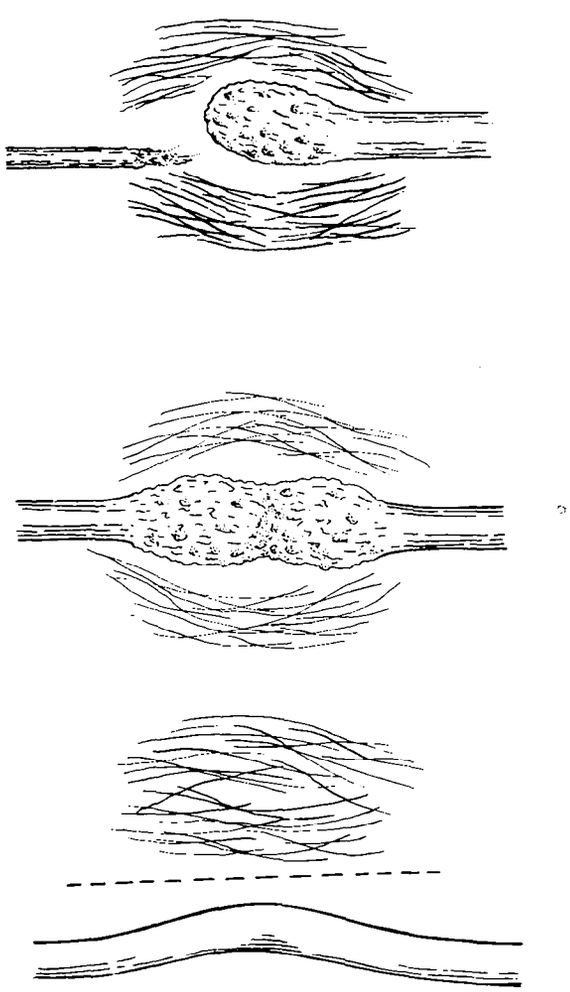

Fig. – Representing the three categories of surgical findings referred to. In the upper drawing, which represents nerve division, note the disparity in size of the segments which was found at stages later than 6 months following injury. The central drawing represents a scarred nerve surrounded by scar, and the lower drawing is of a nerve of normal appearance 'tented up' by scarring in the soft tissues.

Details of the findings in each case are given in Table 2.

The first was that of nerve division. There were at least two such cases. In other cases (for example no. 10), the nerve may well have been divided, yet appeared continuous at the time of exploration as a result of proliferation of the proximal stump and formation of scar. The two cases where the nerve was clearly divided were explored at 6 and 8 months following injury. In both cases the nerve was considered to be situated high in relation to the alveolar crest. There was considerable scarring in the adjacent soft tissues, particularly around the proximal stump, which was also scarred and swollen. The distal stump was found in a deeper plane, and was not only very much reduced in width, but was also extremely friable. It was not possible to identify any fasciculi in the distal segment, nor were there any landmarks such as vascular markings, to give any indication for alignment of the stumps.

Repair was attempted following mobilisation of the stumps. Minimal resection of the distal stump was performed, but the proximal stump was resected until unscarred fasciculi were encountered. An 8/0

Table 2 – Details of the surgical findings and repair of 23 injured lingual nerves. The lines drawn across the table divide the cases into the categories referred to in the text. Patient numbers correspond to those used in tables 1 & 3. Time represents the time following injury in months

Patient	Time	Findings	Repair
1	6	nerve divided	sutured
2	8	nerve divided	sutured
3	192	proximal stump ended in scar	stump divided & diathermied
4	8	dense scar	external neurolysis
5	14	neuroma	neuroma excised, 2 fascicles intact
6	24	disrupted nerve	external neurolysis
7	90	narrowed in scar, bone spur	external neurolysis
8	55	narrowed in scar, bone spur	external neurolysis
9	27	narrowed as passed under spur of bone	external neurolysis
10	14	neuroma	resected & nerve anastomosed
11	8	partial division	divided portion anastomosed
12	10	?neuroma	external neurolysis
13	24	neuroma involving one fascicle	neuroma resected & fascicle anastomosed
14	10	localised soft swelling	internal neurolysis
15a	14	localised soft swelling	internal neurolysis
15b	26	ditto & scar++	resected & nerve anastomosed
16R	37	neuroma	partial resection
16L	37	dense scar	external neurolysis
17	9	disrupted nerve	external neurolysis
18	23	localised soft swelling	internal neurolysis-normal fascicles
19	15	tented up by scar	incision above nerve
20R	23	tented up by scar	incision above nerve
20L	23	tented up by scar	incision above nerve
21	24	tented up by scar	incision above nerve

monofilament nylon suture was used for repair. A stay suture was initially passed through both stumps to approximate the ends. This was not easily achieved due to the extreme friability of the distal segment. It was only possible to place two sutures for repair, due to the reduced size of the distal segment. The result could not be considered a nerve anastomosis, but rather a nerve alignment.

Further difficulties encountered during nerve suture resulted from the fact that the repair was being performed in the depths of a deep hole. This meant that much of the field of vision under the microscope was out of focus, so that it was difficult to see the end of the suture to pick it up with the needle holders, and there was little space in which to 'park' the needle when knot tying.

The second group of findings was basically that of a scarred nerve lying in a bed of scar tissue. This represents the commonest finding; 16 of the 23 nerves explored falling into this category.

There were often changes in the diameter of the nerve. In four cases in this group the nerve was narrowed distal to the site of injury, but in two cases the distal segment was wider. Eight cases had a localised swelling at the site of injury, which was considered to represent neuroma formation. Exploration of these lesions was difficult, for reasons already outlined. In two such cases, performed early in the series, only an external neurolysis was performed. Of the remaining six neuromas, four could be considered to have had an internal neurolysis performed, in that the outer scar/epineurium was incised, although no satisfactory dissection of the contents ensued. Two neuromas were adequately dissected. In one of these cases (no. 5) only two fascicles were found to be intact, following resection of the neuroma. In the second (no. 13), only one fascicle was found to be divided, the remaining fascicles appearing normal. The stumps of this fascicle were resected and an anastomosis was performed using 10/0 Ethilon[R].

Among associated findings, in seven cases a sharp crest of bone was found, which in position was considered to correspond to the distal wall of the third molar socket. In six of these the nerve crossed the crest of bone. In the seventh (no. 9) the tendon of temporalis was partly inserted into the spur of bone, which on the lingual aspect of the mandible formed an incomplete circle through which the lingual nerve passed; the nerve was narrowed for a short distance as it passed through this virtual foramen. In two other cases (nos. 7 & 8) there was a localised narrowing of the nerve for a distance of 5 mm where it passed over the sharp crest of

Table 3 – Outcome following repair of 23 injured lingual nerves. Here time refers to the time in months of the last review following nerve exploration

Patient	Time	Sensory testing			Subjectively
		Touch	M2PD	SEP	
1	26	nil	nil	no response	failed repair
2	17	nil	nil	no response	failed repair
3	27	nil	nil		free of pain for only 6 months
4	5	tip	5	delay 4 msec low amplitude	failed repair
	13	failed review–reported no improvement			
5	12	2 cm	2	low amplitude	
	20	review by others–reported considerable improvement			
6	14	review by others–reported no change			
7	15	1.5 cm	1	normal response	anaesthesia resolved paraesthesia remain
8	30	2.5 cm	1	delay 4 msec	paraesthesia resolved 'feels thick'
9	42	reported no improvement			
10	3	tip	5	low amplitude	dysaesthesia resolved
	46	reported free of dysaesthesia. & 60% recovery			
11	27	2 cm	2	normal response	50% recovery, no longer notices it
12	24	3 cm	2	3 msec delay	dysaesthesia & paraesthesia persist
13	13	small deficit	3	normal response	described as 50% recovery
14	<1	considerable initial improvement			
15a	10	nil	nil	normal response	failed repair
15b	<1	nil	nil	absent response	numbness more profound
16R	6	tip	8	no response before 35 msec	failed repair
16L	6	tip	6	no response before 35 msec	failed repair
17	5	3 cm	2	normal response	50% improved
18	4	intact	1	normal response	70% improved dysaesthesia persist
19	17	3.5 cm	1	normal response	normal at tip 'thick' elsewhere
20R	33	normal	0	not	dysaesthesia persist
20L	33	normal	0	performed	discrimination improved
21	4	normal	0	normal response	feels completely normal

bone. In an attempt to remedy matters in these cases, the bone was smoothed and the nerve dissected from the surrounding scarred tissues.

In two cases (nos. 6 & 17) the nerve although intact appeared considerably disrupted following dissection, the fascicles splaying out into a plexus arrangement. Little was performed here other than dissection of fascicles from scar.

A further associated feature was a perforation the size of a small surgical bur in the lingual plate of the mandible, to which adjacent periosteum and underlying nerve were attached.

In the third category of lesion the injury did not appear to have been directly to the nerve itself, but rather to the soft tissue above the nerve. In these four cases the nerve appeared perfectly normal in texture, colour and dimension. However, above the nerve there was an area of scarring in the periosteum, to which the nerve was attached, such that it was tented upwards. On making a horizontal incision in the periosteum immediately above the nerve, the nerve spontaneously repositioned itself. No attempt was made at further dissection or neurolysis in these cases.

Outcome following repair

The two cases of nerve division repaired by suture to align the stumps showed no recovery. Of the remaining cases only one had 100% recovery, one considered she had recovered by 70%, one by 60%, and three by 50%. This is detailed for each case in Table 3.

For five patients dysaesthesiae described simply as pain, or as constant burning or pulling sensations were a major problem. No success was achieved in attempting to relieve these symptoms for four of these patients. Nerve division, diathermy and ligation in case 3 resulted in only short term relief. External neurolysis produced no benefit in case 12, and neither did internal neurolysis in case 18. In the fifth case (no. 10), who was effectively totally anaesthetic, the damaged segment was resected and an anastomosis performed with three 8/0 monofilament sutures. This relieved the dysaesthesia. In addition she reported a 60% return of sensation, describing her tongue sensation as 'a first thing in the morning furry feeling'.

In one case (no. 15) there was no improvement subjectively or on sensory testing following internal neurolysis, although improvement was seen in the SEP responses recorded postoperatively. After discussion further surgery was undertaken, when dense scarring was encountered from the earlier procedure. The swelling previously found was resected. Histology confirmed this to be a neuroma, with nerve fibres in a completely disorganised arrangement. Both in this and case no. 10 the stumps were anastomosed more readily than in the nerve division cases (nos. 1 & 2), because the distal segment was in a reasonable condition. A 1.5 cm gap had been created, but following mobilisation of the distal stump as far forward as the submandibular duct, there appeared to be no tension across the suture line.

DISCUSSION

The series of cases reported here is small, and the outcome in seven of the cases is not known with certainty. The conclusions that can be reached from this limited experience are therefore restricted.

The outcome has on the whole been disappointing. Only 12 of the procedures were judged to have a worthwhile result, and of these only one regained normal sensation. However, with the exception of the second procedure for patient no. 15 where the nerve was electively divided, and who has not yet been adequately reviewed, none of the procedures resulted in a worsening of sensation.

The two cases of nerve division (nos. 1 & 2) made no recovery whatsoever. Failure was probably due to the disparity in size between proximal and distal stumps; the distal stump being very much reduced in size, and extremely friable. To overcome this problem exploration at an earlier stage would be necessary. The period of 3 months following injury has been suggested as a reasonable interval to attempt to achieve for surgical intervention (Blackburn, 1990).

Of the five patients who suffered dysaesthesia, only case no. 10 who underwent resection of a neuroma and nerve anastomosis, obtained relief. External and internal neurolysis performed for the other cases gave no relief of the unpleasant sensations. This would suggest that where dysaesthesia is a symptom, the lesion is intrafascicullar. The management of such cases is difficult, particularly in long standing cases such as patient no. 3 who had undergone previous nerve division; and in cases such as patients nos. 18 & 20 who subjectively and on sensory testing had otherwise regained a normal power of discrimination in their tongues. There may be a need for repeated procedures in such cases, weighing loss of tactile sense against possible relief of symptoms. Trial injections with local anaesthetic might be used to help the patient reach a decision.

The concern of making the patient worse influenced this series, and this led to a somewhat timorous approach, especially in the second category cases, where the patient sometimes retained some useful sensation. With later cases a bolder approach was taken, with a readiness to open the epineurium and examine the fascicles. The results in these cases (nos. 11, 13, 14 & 18) would indicate that faced with the situation of a scarred nerve running in scar, internal neurolysis should be performed, rather than external neurolysis, and proceed according to the findings. Release from external scar might only be considered sufficient where the findings fall into the third category, although two of those three patients failed to regain normal sensation.

The findings broadly described as category two form the major part of this series. For many, where severe internal derangement is found following internal neurolysis, the only hope may lie with resection of the damaged segment and anastomosis of the stumps, as performed for case 10. However, case 17 is a case where such would have been performed if it had not been for considerable difficulties due to persistent

haemorrhage and poor access, despite both approaches having been used. She made considerable unexpected recovery following what was only an external neurolysis. The problem of how to proceed, following exposure of the fascicles, will clearly depend on the merits of each case, but one approach may be to accept a staged procedure. If individual fascicles appear to be intact following neurolysis, no matter how disrupted, or how bad the surrounding scar, it may be better to adopt a 'wait and see' approach, reserving resection of the segment for a second occasion if the patient is dissatisfied with the outcome. The price to be paid would be the additional scarring, which was encountered in case 15 at the second procedure.

In cases where the nerve has been divided and continuity lost, intervention at an early stage is necessary, perhaps at 3 months, but certainly before the distal segment has degenerated to the extent that anastomosis becomes impractical. For this to be achieved a sound method of diagnosis is required. The diagnostic method used proved adequate, at least for the preoperative assessment and the monitoring of recovery. However, to determine residual deficits other methods of sensory testing should be evolved, for example the testing of taste and temperature discrimination.

The recording of somatosensory evoked potentials (SEP's) was considered useful. The findings for the group as a whole, following stimulation of the affected side, were of delayed latency and reduced amplitude, as might be expected. It was always possible to record SEP's following stimulation of the normal side of patients' tongues, and these were identical to the responses obtained from a series of normal subjects (Blackburn, 1988) in terms of latency, amplitude and overall configuration.

No responses were recorded following stimulation of the affected side of those cases where the nerve was divided, namely patients 1, 2, & 3; following the second procedure in patient 15 and in case 10 which was totally anaesthetic, with the formation of a neuroma.

SEP's were particularly useful in the case of patient 6. The referring surgeon had very good reason to doubt the veracity of this patient's complaint. In addition the patient gave equivocal responses on sensory testing. The finding of latency delays in the responses allowed the surgical exploration to be undertaken with confidence.

While an abnormal response was obtained only in cases where sensation was reported to be abnormal, the reverse was not the case. In other words, a normal response does not equate with normal sensation. Normal responses were obtained following affected side stimulation in six cases in this series preoperatively.

A return to normal of the SEP response was seen in four patients postoperatively (nos. 7, 13, 17 & 19), and these changes were mirrored by improvement in the results of sensory testing and subjective report, but not by a return to normal sensation.

The final and most important consideration is prevention. In all the cases in this series, the procedure used to remove the wisdom tooth which resulted in lingual nerve damage, involved the use of a bur, and as far as is known a Howarth's or similar instrument was positioned 'to protect the nerve'. While other agents of injury such as a suture cannot be excluded, the bur seems to be the villain of the piece. The lesson to be learnt is quite simple: never let the bur enter the tissues on the lingual side of the mandible, whether there is a lingual flap retractor/guard in position or not.

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