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Clinical outcomes of lingual nerve repair

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Abstract

Lingual nerve injury, a well-described complication of third molar removal, may result in permanent lingual sensory deficit leading to symptoms including lost or altered sensation, inadvertent tongue biting, and the development of unpleasant neuropathic pain, with consequent impaired quality of life. We analysed outcomes of a prospective case series to determine whether direct anastomosis of the lingual nerve results in improved sensory recovery and reduced neuropathic pain, and whether delayed surgery is worthwhile. In 114 patients who underwent nerve repair at our nerve injury clinic following damage sustained during mandibular third molar removal, sensory deficit was assessed before and after surgery using a questionnaire and visual analogue scales (VAS) to assess pain, tingling, and discomfort. Neurosensory tests were utilised to evaluate light touch, pin-prick, and two-point discrimination thresholds. Subjectively, 94% patients felt their sensation had improved following nerve repair, with significant reductions in the incidence of tongue biting ($p < 0.0001$), impaired speech ($p < 0.0001$), and neuropathic pain ($p = 0.0017$). Quantitative neurosensory data showed highly significant improvements in light touch, pin-prick, and two-point discrimination (all $p < 0.0001$), and VAS scores for pain ($p = 0.0145$), tingling ($p < 0.0025$), and discomfort ($p < 0.0001$) were significantly reduced. Patients with high levels of pain preoperatively (VAS > 40) showed highly significant reductions in pain ($p < 0.0001$). No correlation was found between surgical outcome and patient's age or delay until surgery. Lingual nerve repair results in good sensory outcomes and significant improvements in the incidence and degree of neuropathic pain, even when delayed.

Keywords: case series; delay to surgery; lingual nerve surgery; neuropathic pain; treatment outcome

Introduction

Injury to the lingual nerve during mandibular third molar removal is a longstanding clinical problem. The lingual nerve runs in close proximity to the third molar, often in contact with the lingual cortical plate, making it susceptible to injury by a surgical burr.[1] The incidence of permanent lingual sensory deficit following wisdom tooth removal is up to 0.6%.[2–5] In addition to lost or altered sensation, patients suffering these injuries may develop unpleasant neuropathic pain; they may also complain of reduced or altered taste, impaired speech, or unpleasant inadvertent tongue biting, all of which can have a serious, detrimental effect on quality of life.[6,7] Patients may experience temporary symptoms following lingual injury, but those who have no significant resolution by three months are unlikely to recover spontaneously.

Lingual nerve injuries may result in neuroma-in-continuity, or a proximal terminal neuroma with nerve stumps fully separated. A variety of methods have been utilised to effect repair: end–end anastomosis, autograft or, more recently, nerve allograft.[8] In-vivo studies have shown that end–end anastomosis produces the best outcome;[9] many studies have shown that repair by anastomosis results in significantly improved sensation, although assessment lacks standardisation.[10] Intraneural scar formation at the repair site

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is a major barrier to recovery, causing a mechanical barrier that impedes axon regeneration,[7,11,12] and suggesting that a single repair site rather than a graft would result in improved outcome. Nerve allografts are an alternative when the extent of the nerve gap may result in tension on the repair.[8,12]

Many studies have shown lingual nerve repair to be effective for reducing neuropathic pain, and have demonstrated that patients with no preoperative pain have not developed pain following recovery.[13–16] It has been postulated that late repairs (more than six months) will not result in a reduction in pain,[17] although several studies have demonstrated the opposite.[14,15,18] There is also debate on the timing of repair, and whether late repair is worthwhile.[14,19,20]

We therefore asked three main questions:

1 Does direct anastomosis of the lingual nerve result in improved sensory recovery?
2 Does this procedure reduce neuropathic pain in patients suffering this unpleasant condition?
3 Is surgery for the recovery of sensation, or reduction in pain, worthwhile if it has been delayed?

This study represents, to our knowledge, the largest number of patients undergoing a standardised technique of direct lingual nerve repair who were assessed by a standardised protocol.

Patients and methods

This case series comprises 114 patients who were referred to our nerve injury clinic and underwent lingual nerve repair by direct end–end anastomosis. All patients had suffered their injury as a result of third molar removal or, in five cases, third molar coronectomy. Patients were assessed preoperatively (2000–2018) and reviewed at approximately four months and up to one year postoperatively (minimum six months).

All repairs were undertaken by one of a small team of senior surgeons (the first author included) using an identical technique, as reported previously.[9] Briefly, anastomosis was undertaken under general anaesthesia by means of a lingual flap with relieving incision lingual to the first premolar. Periosteum and scar tissue were carefully dissected under magnification to identify the nerve. Often, the nerve was completely transected, but in some cases a neuroma-in-continuity was identified. Other findings included bony perforations of the lingual ridge or cortical plate associated with the area of injury, and significant scar tissue. Sometimes metallic fragments were identified within the damaged nerve stumps or neuroma (confirmed by histopathology). Central and distal stumps were freed, allowing resection of the neuroma, and microsurgical repair with 8–10 non-resorbable sutures (8/0 Ethilon®, Ethicon). Due to the natural arc of the nerve, direct anastomosis was achievable in all cases. All patients received prophylactic perioperative and postoperative antibiotics and dexamethasone.

Sensation on the affected side of the tongue was assessed preoperatively and postoperatively using a questionnaire covering inadvertent tongue biting, speech impairment, and experience of tingling (paraesthesia), discomfort, and pain. Patients quantified their pain, tingling and discomfort on the affected part of the tongue using 100 mm visual analogue scales (VAS). Patients scored their symptoms on each VAS from 0 (an absence of symptoms) to 100 (worst pain and discomfort imaginable or continuous tingling symptoms). Patients were further asked to rate their feeling on the injured side of the tongue on a scale from 0% (no sensation) to 100% (normal sensation).

Neurosensory investigations to evaluate light touch and pain (pin-prick) sensation, and two-point discrimination were undertaken as follows:

Light touch sensation

A von Frey hair (20 mN; 2 g) was applied randomly to all areas of the tongue. Patients indicated sensation by raising a finger, whilst their eyes were closed and tongue protruded. For quantitative comparison, scores were noted on a four-point scale (0 = no response, 1 = response at the tip only, 2 = response in most areas, and 3 = response in all areas with no obvious difference from the contralateral side).[9,19]

Pinprick sensation

The ability to detect pain was assessed on a four-point scale as above but using a sharp probe with a force of 150 nM (15 g). Patients were asked to indicate only when they felt pain or sharpness.

Two-point discrimination

With the patient's eyes closed and tongue protruding, metal probes ranging from 2 mm to 18 mm apart were drawn 5–10 mm across the surface of both sides of the tongue. The minimum separation consistently reported as two points was recorded as the two-point discrimination threshold. For analysis, where two points could not be discriminated at 18 mm, the threshold was recorded as 20 mm.

Statistical analysis

Data were analysed using Prism 8 (GraphPad Software). The categorical (yes/no) incidence data from the patient questionnaire were compared before and after surgery by means of the McNemar test with continuity correction, using only paired data from patients with both preoperative and postoperative data. A Wilcoxon matched-pairs signed rank test or a paired Student's *t* test, as appropriate, was used to compare quantitative data from patients with both preoperative and postoperative data. Postoperative data were from the last visit (minimum of six months). All quantitative data were

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checked for normal distribution and correlations assessed with Pearson's correlation coefficient.

Results

This case series reports findings from 114 patients (mean age 34 years) who underwent lingual nerve repair in our nerve injury clinic during the years 2000–2018. Nineteen were excluded from the analysis because of a lack of sufficient postoperative review, giving a dataset of 85% of patients treated. The delay to surgery from injury ranged from 3 to 67 months (mean 16.1 months).

Questionnaire responses

Subjectively, the vast majority of patients (94%) felt their sensation had improved postoperatively (postoperative mean 46.9% compared with preoperative mean 18.0%: $p < 0.0001$).

Following nerve repair, there was a reduced incidence of inadvertent tongue biting (McNemar $\chi^2_{(1)} = 36.54$, $p < 0.0001$), impaired speech (McNemar $\chi^2_{(1)} = 22.40$, $p < 0.0001$) and neuropathic pain (McNemar $\chi^2_{(1)} = 9.818$, $p = 0.0017$) (Table 1). While the incidence of altered taste also reduced, this was not statistically significant.

Neurosensory tests

Quantitative preoperative and postoperative data for patients' responses to light touch and pin-prick stimuli, and two-point discrimination thresholds are shown in Fig. 1.

Patients' ability to detect light touch (20 mN) on the affected side of the tongue increased significantly following nerve repair, with 70/107 patients (65%) sensitive in most or all areas postoperatively, compared with only 13/112 patients (12%) before surgery. Sixty-three patients (56%) did not respond to light touch at all on the affected side before surgery. The pooled data showed a highly statistically significant postoperative improvement in response to light touch ($p < 0.0001$).

The ability to detect sharpness (pin-prick test) was also significantly increased. After surgery, 101/106 patients (95%) were sensitive to the pin-prick stimulus in most or all areas of the affected side of the tongue, compared with only 54/109 (50%) before surgery. Following surgery, 81 patients (76%) were sensitive in all areas of the affected side of the tongue. The pooled data showed a highly statistically significant postoperative improvement in response to the pin-prick stimulus ($p < 0.0001$).

Two-point discrimination thresholds also improved significantly. While 22 patients were unable to differentiate two points preoperatively, this improved to only three post surgery. The pooled data showed a highly statistically significant reduction in threshold after surgery (mean postoperative threshold 8.77 mm compared with mean preoperative threshold 13.87 mm, $p < 0.0001$).

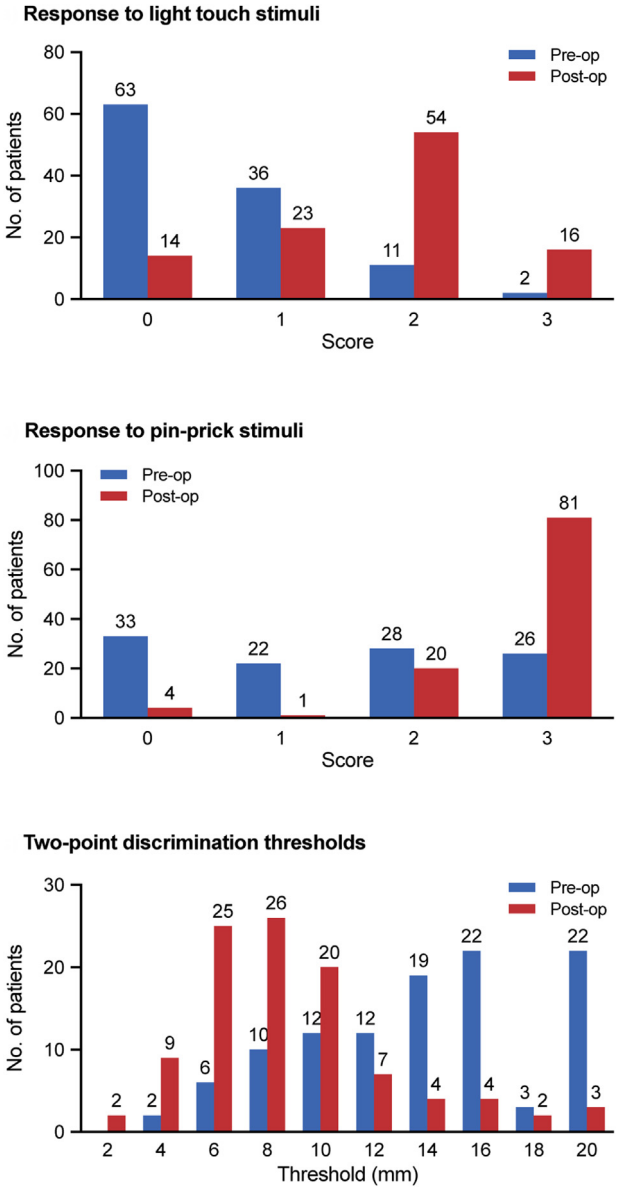

Fig. 1. Sensory data: the level of patients' responses to light touch stimuli with a 20 mN von Frey hair and pin-prick stimuli of up to 150 mN, and two-point discrimination thresholds. Scores for light touch and pin-prick stimuli: 0 = no response, 1 = response at the tip only, 2 = response in most areas, and 3 = response in all areas. Preoperative data are shown in blue and responses at the final postoperative test in red. The differences between preoperative and postoperative data were highly statistically significant for all sensory parameters (light touch and pin-prick: both $p < 0.0001$, Wilcoxon matched-pairs signed rank test; two-point discrimination: $p < 0.0001$, paired Student's *t* test).

VAS scores

In addition to the reduction in the proportion of patients reporting neuropathic pain in the questionnaire, patients' VAS scores for pain, tingling, and discomfort were also

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Table 1
Comparison between responses to questions asked preoperatively and at the final test. Data are number (%).

Question	Preoperatively	Postoperatively	χ^2 statistic[a]	p value[a]
Inadvertent tongue biting?	92/110 (84)	40/97 (41)	36.54[b]	<0.0001
Taste disturbance?	79/92 (86)	56/75 (75)	2.769[c]	0.0961
Speech affected?	80/107 (75)	37/93 (40)	22.40[d]	<0.0001
Pain?	52/110 (47)	29/104 (28)	9.818[e]	0.0017

Data are numbers of patients who responded "yes" out of the total number of patients with a response for that parameter. % data are percentage of patients with a response, who responded "yes".

[a] Chi squared statistic and two-tailed p value from McNemar's test with continuity correction for data from patients with both preoperative and postoperative responses (all calculations have one degree of freedom).

[b] n = 96.

[c] n = 70.

[d] n = 91.

[e] n = 102.

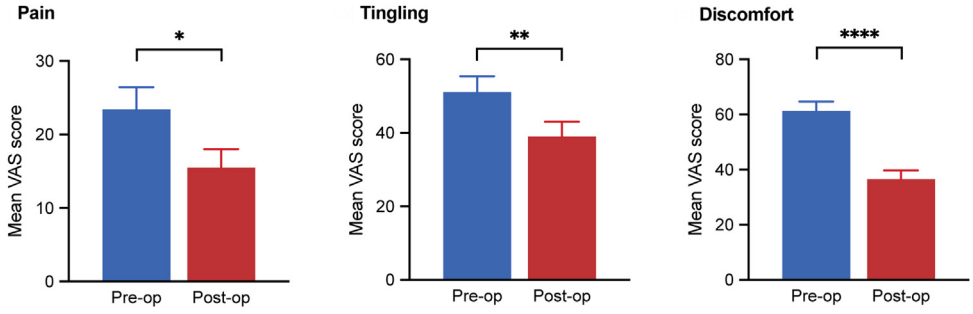

Fig. 2. Mean VAS scores (±SEM) for the level of pain, tingling and discomfort. Patients scored their symptoms on a 100 mm scale from 0 = an absence of symptoms to 100 = worst imaginable (pain and discomfort) or continuous (tingling) symptoms. Preoperative data are shown in blue and responses at the final postoperative test in red. There were statistically significant reductions in symptoms postoperatively as assessed by VAS, compared with preoperative levels, for all three parameters (pain: $p = 0.0145$; tingling: $p < 0.0025$; discomfort: $p < 0.0001$; paired Student's *t* test). Post-op = final postoperative test; pre-op = preoperatively; SEM = standard error of the mean; VAS = visual analogue scale.

reduced postoperatively (Fig. 2). All three symptom measures were statistically significantly reduced following lingual nerve repair (pain: $p = 0.0145$; tingling: $p < 0.0025$; discomfort: $p < 0.0001$). In particular, the great majority (79%) of patients with higher (over 40) pain VAS scores preoperatively had a large (mean 44.1) reduction in postoperative pain ($p < 0.0001$).

Effects of timing of surgery and patient's age

Any relation between the delay in surgical repair following nerve injury and surgical outcome (as assessed by the difference in discrimination thresholds between the affected and unaffected sides of the tongue), and between the patient's age at the time of surgery and surgical outcome, was assessed. In neither case was there any significant correlation (Fig. 3).

Discussion

The majority of patients seen at our nerve injury clinic benefit from advice and observation but do not require surgery due to satisfactory recovery from lingual nerve injury. Lingual nerve repair was undertaken on patients with significant anaesthesia and/or neuropathic pain, mainly in the form of dysaesthesia or hyperalgesia.

There was a significant reduction in tongue biting after surgery, which is something that patients find particularly unpleasant; this is likely to be associated with the highly significant improvement in ability to detect sharpness (pinprick) postoperatively.

Further, the threshold over which two points could be discriminated was significantly reduced, and the ability to detect light touch was improved following surgery. These findings corroborate the observation that 94% of patients felt subjectively that their sensation had improved, and are in keeping with earlier studies.[9,14,18,21]

Patients also reported a significant improvement in speech, yet interestingly there was no significant improvement in taste. This lack of improvement in taste contrasts with the study by Robinson et al[9] that showed a significant improvement in gustatory function, but correlates with the study by Riediger et al[22] that showed extremely poor recovery of taste following surgery. Nakanishi et al[6] observed a poorer return of gustatory function with an increase in delay to surgery, which may explain why we failed to demonstrate improvement, as many of our patients had a lengthy delay to surgery.

For some patients, lingual nerve injury can cause dysaesthesia, which can have a significant detrimental effect on

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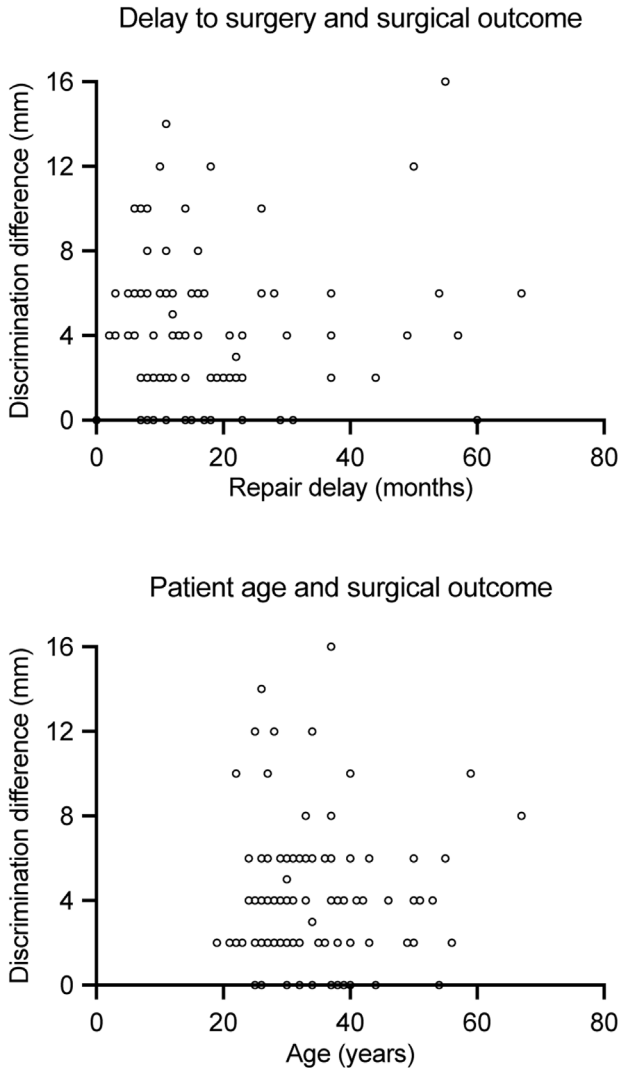

Fig. 3. Relation between surgical outcome and timing of surgery or patient's age. The final outcome expressed as the difference between the two-point discrimination thresholds on the affected and unaffected sides of the tongue at the final postoperative test, plotted against the delay between nerve injury and surgical repair, and the age of the patient at the time of surgery. No significant correlation was found between surgical outcome and either delay to surgery (Pearson's $r = 0.1060$; $p = 0.2892$) or age (Pearson's $r = 0.0046$; $p = 0.9632$).

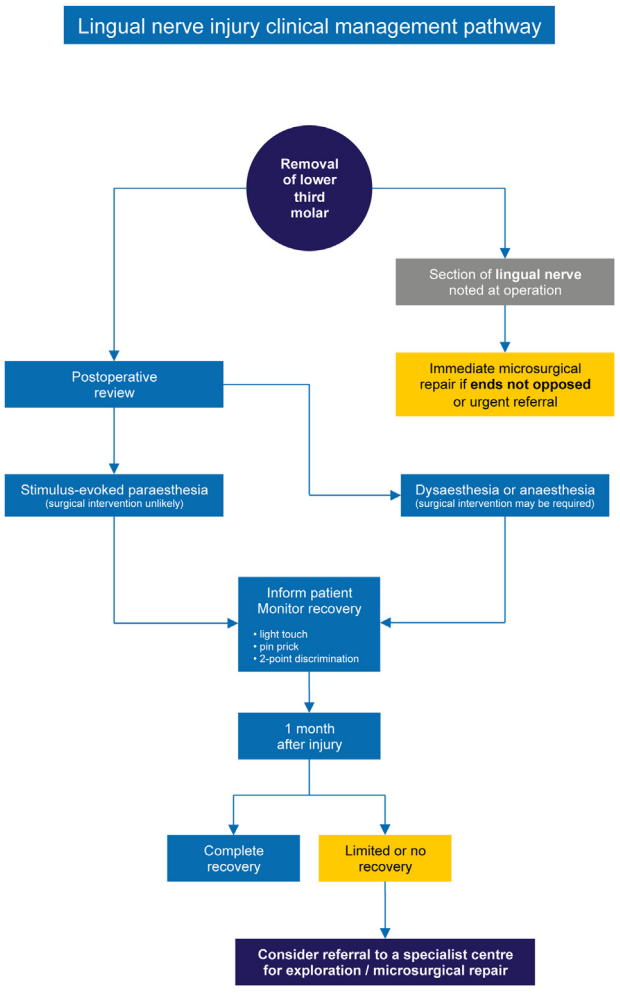

Fig. 4. Suggested clinical management pathway for lingual nerve injury.

quality of life.[23,24] Some authors have suggested that surgery (especially more than six months after injury) may increase the risk of neuropathic pain[25] or lead to no significant difference,[9] whilst others have shown a reduction in neuropathic pain[15,16] or even complete resolution.[13] Our results show a significant reduction in the number of patients who reported pain postoperatively, and also a reduction in patients' VAS scores for pain. This was particularly marked in patients with preoperative pain scores of more than 40.

The timing of repair following trigeminal nerve injury is the subject of much debate. Some surgeons have highlighted improved outcome with early repair,[20] others have shown no difference in outcome with delayed repair,[14] while others have demonstrated good outcomes with lengthy delay.[6,19,21] In the present study there was no correlation between delay to surgery and quality of outcome, and significant improvements occurred even after lengthy delay (more than three years). One study highlighted a reduced outcome for taste with longer delays,[6] but with no other adverse outcome, which is in keeping with our results. However, it is our belief that a more favourable result is likely, with less impact on a patient's quality of life, if repair is undertaken earlier (ideally before six months). It is of concern that patients are often denied early treatment due to a lack of onward referral in an appropriate time. This may be due to lack of follow up, embarrassment, fear of litigation or, in some cases, uncertainty over the management of patients with symptoms that indicate nerve injury. Surgeons may also quite reasonably delay referral whilst any recovery is being monitored, but this often leads to significant delay in any potential reparative surgery. We have therefore developed a management protocol for lingual nerve injuries (Fig. 4) and suggest that it should be implemented routinely.

One criticism of this research may be that 19 patients were excluded for lack of follow up, and that this may have been

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due to a poor outcome. It is our supposition that as the results are highly significant, this would not affect the outcome. Lack of follow up for all patients is more likely to be due to our centre treating patients who travel from all areas of the UK, with some requesting to be followed up by their local surgeons, who have often intimated a favourable outcome.

Lingual nerve repairs can be undertaken in a variety of ways: direct anastomosis (by far the most common), nerve autograft (used historically by some surgeons), vein conduits and, more recently, allografts, with differing results. Although Zuniga[8] showed comparable results with allograft in cases in which the nerve gap did not allow tension-free closure, we have shown, as have many previous studies,[9,14,18,21,26] that direct anastomosis can achieve excellent results.

Conclusions

We have clearly demonstrated that good sensation can be obtained following lingual nerve repair, even when delayed for more than a year. Further, a significant proportion of patients who underwent surgery no longer suffered from neuropathic pain. However, it is worth noting that although these differences were highly significant, no patient could be described as having a complete recovery. It is clear that surgery is worthwhile for patients with pain, as well as for those with sensory deficit.

Based on the success of our approach, we recommend that patients with limited or no recovery one month after lingual nerve injury should be referred to a specialist centre for further consultation to assess their suitability for nerve repair.

Conflict of interest

We have no conflicts of interest.

Ethics statement/confirmation of patients' permission

Not applicable.

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