



A method of assessment in cases of lingual nerve injury

C. W. Blackburn

Department of Oral and Maxillofacial Surgery, University Dental Hospital, Higher Cambridge Street, Manchester

SUMMARY. A method for assessing lingual sensation is described, comprising sensory testing, using touch and moving two-point discrimination and patient subjective reporting. The clinical application is seen to be the evaluation of lingual nerve injury consequent upon lower third molar surgery. Using this method it is considered possible to identify many of those patients unlikely to make full spontaneous recovery at the stage of 3 months following injury, with a view to achieving an earlier timing of surgical repair than that which prevails at present.

INTRODUCTION

Lingual nerve damage is a well recognised complication of the removal of lower third molars. While in most cases lingual sensation recovers spontaneously, patients are occasionally seen who have experienced only partial recovery, or no recovery at all. In one series (Blackburn & Bramley, 1989) the incidence of lingual nerve damage overall was found to be 11%, with permanent impairment of sensation resulting from as many as one in 200 procedures.

The problem faced by the clinician is to identify, at the earliest possible stage, those unlikely to make a full recovery; as, while little is known of the outcome following lingual nerve repair, it is generally agreed in other situations that the results are best when the repair is performed early (Seddon, 1975; Merle *et al.*, 1986). At present whenever lingual nerve repair is undertaken, it is usually on the basis of a failure of recovery, which may be acknowledged 2 years or more following injury, rather than on the basis of clinical findings. What is lacking is an established method of assessment for routine clinical use.

In general, the few articles concerning injuries to the lingual nerve which occur in the literature give but scant account of any method of sensory testing used. The most detailed study reported is that by Ferdousi and MacGregor (1985), who compared a number of methods to test the tongues of 20 patients who had suffered lingual nerve damage. Mason (1988) reports the use of light touch, tactile discrimination, two-point discrimination and pain awareness in a series of 120 cases of lingual nerve damage.

A number of papers concerning the assessment of lingual sensation with respect to speech servo-mechanisms may be found, such as those by Ringel and Ewanowski (1965) and McCall (1969). Among the methods described is two-point discrimination. McCall and Cunningham (1971) using this test repor-

ted an asymmetry in the thresholds obtained from each side of the tongue, and concluded that such 'sensory sidedness' may be a normal neurological phenomenon for the tactile sensory system.

In examining the experience obtained in other clinical situations, it is the hand, particularly lesions of the median nerve, which has received most attention. Two-point discrimination is widely considered to be the most reliable method of assessing sensation in this situation (Onne, 1962; Gellis & Pool, 1977). The test is not considered reliable after nerve suture, however, by some authors. Parry and Salter (1976) by way of explanation, state that following nerve suture fibres do not align properly; accordingly accurate stereocognition, measured by two-point discrimination, is unlikely to return.

Dellon (1978) describes the test of moving two-point discrimination, which he found to be a valid method of examination in nerve compression syndromes and nerve lacerations, as well as following nerve suture; where it returned to normal in advance of classical two-point discrimination. In describing the rationale for this method, he draws attention to the fact that movement is an essential part of tactile exploration. Further, he refers to the work of Werner and Mountcastle (1965) and Mountcastle *et al.* (1967), who demonstrated that the sensation of touch is mediated through two populations of large myelinated nerve fibres, later termed quickly adapting and slowly adapting fibres. Quickly adapting fibres which mediate moving touch are reported by Talbot *et al.* (1968) to greatly outnumber slowly adapting fibres, which respond to increasing indentation of the skin. Thus a moving stimulus can be considered to evaluate a greater proportion of touch fibres than a constant or static stimulus. For this reason Dellon considers that a constant stimulus underestimates a patient's actual and potential recovery following nerve injury.

The method of assessment used in this study

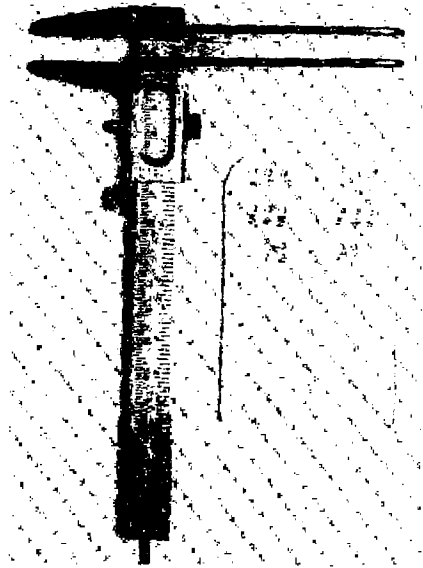


Fig. 1 – Template used for marking points of reference, and callipers used for moving two-point discrimination. The latter are the type which can be readily obtained from hardware stores. The tips should be narrow but not sharp, approximately 1 mm in width, and should contact one another when the scale reads zero. The rows of holes in the template are 1.25 cm apart. The horizontal line is positioned at the tongue tip, and the vertical line along the midline furrow.

comprised sensory testing, using touch and moving two-point discrimination, and the patient's own subjective assessment. The material presented is of overall findings, rather than individual subject and patient data. It forms part of a wider study of the problem (Blackburn, 1988), where greater detail may be found.

MATERIALS AND METHODS

A method of testing using moving two-point discrimination was determined in pilot studies. This was applied to the tongues of 55 normal subjects. In addition, 117 patients who had suffered lingual nerve injury during lower third molar surgery were examined. The time of initial examination varied. Some were seen shortly following injury, while at the other extreme some had been 'numb' for many years. Patients were re-examined at monthly intervals. The methods used were as follows.

Points of reference

These were created on the dorsal surface of the tongue using a perspex template with measured numbered holes (Fig. 1), through which was inserted an orange stick dipped in Bonney's Blue. The result was a line of three dots on each side of the tongue, by reference to which the boundaries of the area insensitive to the touch stimulus could be measured. In the test of moving two-point discrimination they defined the path along which the points of the callipers were drawn, a distance of approximately 4 cm. Holes were selected on the basis of being

approximately halfway between the lateral margin and the midline. The numbers of the holes chosen were recorded, so that if testing was repeated the same reference points could be used.

Touch

One inch lengths of 2/0 and 3/0 prolene suture material, embedded in perspex handles, were used as a touch stimulus. This form of stimulator was chosen as it can be readily manufactured by anyone wishing to reproduce the method. Using a chemical balance it had been found that the force required to make the filaments bend, that is the maximum force they could exert, was 4.5 g and 0.5 g for the 2/0 and 3/0 materials respectively.

During testing patients were required to keep their eyes closed. Care was taken to avoid prolonged mouth opening or tongue protrusion, as resultant discomfort might affect performance. The stimulus was applied at irregular intervals so that the patient could not anticipate it, and give a response in error. Areas where the patient was unable to perceive the stimulus were charted on a printed tongue diagram, as were areas where the stimulus felt 'different'.

Moving two-point discrimination

Modified Vernier callipers (Fig. 1) were used to stroke the dorsal surface of the tongue from behind forwards, following the line of reference points, applications being made to each side in turn. Subjects and patients were asked to discriminate one-point, with the callipers closed, from two-point at varying distances between the points.

Testing followed a proforma test sheet which was in two parts. The first part comprised a random sequence of one-point and two-point at distances ranging between one and ten millimetres at 1 mm increments. This served to establish an approximate threshold and to acclimatise the subject/patient to the test. The second part comprised sets of five applications of one-point, randomly dispersed with five of two-point at the distance selected to be tested. The smallest distance between the points at which the patient could achieve a score of eight out of 10 responses correct or better was taken to be the threshold.

The results obtained from normal subjects were examined to determine:

1. normal threshold measurements for the tongue,
2. the degree of symmetry, in terms of the results obtained, between the two sides of the tongue. This knowledge would be worthwhile in view of the fact that, in most cases, lingual nerve damage occurs unilaterally, and the unaffected side can then act as a control,
3. whether or not there are factors which might influence the result obtained. Consideration was given to age, sex, smoking habits and whether the subject was right or left handed.

Patient subjective report

Experience has shown that when asked to describe the loss or alteration of sensation, most patients are unsure how to respond. A series of specific questions were therefore designed to elicit information of various aspects of tongue sensation:

- Touch – if you touch your tongue with your finger, can you feel your finger with your tongue?
 Taste – is your sense of taste affected?
 Temperature – can you tell the temperature of food and drink on that side of your mouth?
 Teeth – if you rub your tongue over your teeth, can you tell if they are clean or dirty?
 Trauma – do you bite your tongue by accident?
 Tingling – do you have any tingling of your tongue?
 Talk – is your speech affected?

The same questions were asked of all patients at each visit.

As a working hypothesis 3 months was taken to be a likely stage following injury, when consideration may be given to the need for surgical exploration and repair. The results obtained from patients at this time interval, using all aspects of the method, were examined to determine if a basis for interventional surgery could be established.

RESULTS

Touch

The pattern of return of sensation appeared consistent, with recovery occurring initially at the tip and progressing posteriorly, such that the area found to recover last was quite far back, generally on the lateral margin (Fig. 2). At intermediate stages the response from the dorsum was variable. Sometimes a distinct boundary was apparent. On other occasions the responses were 'patchy', with some small areas sensitive to the stimulus and others insensitive. In patients who failed to recover completely this progression was found to be arrested at various stages.

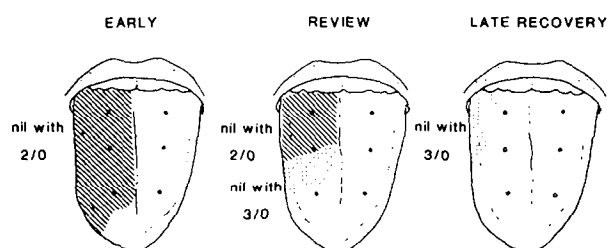


Fig. 2 – Pattern of recovery found when testing touch. The three small circles seen on each side represent the points of reference. The right side of the tongue in the 'early' diagram is seen to be incompletely shaded at the tip. This represents the maximum extent of the 'wedge shaped area', described in the text, which was found in some patients.

Table 1 – The results obtained using moving two-point discrimination from four subjects who were found to have high thresholds on initial testing

Subject	Threshold (mm)		Spices?
	Right tongue	Left tongue	
20	6	6	curry
	1	2	no curry
25	5	5	curry
	1	1	no curry
31	5	5	curry
	2	2	no curry
32	4	4	curry
	8	8	peppered fish
	1	1	no spices

Table 2 – Thresholds obtained using moving two-point discrimination from both sides of the tongue of 55 normal subjects, with revisions for four subjects

Threshold (mm)	No. of sides
1	31
2	53
3	24
4	1
5	0
6	1
	110

Of the patients tested before any recovery was judged to have occurred, 50% (21 cases) were found to have an area at the tip which was partially or fully sensitive to the touch stimuli. This area was roughly wedge-shaped and varied in size. It was present in two out of four patients where the lingual nerve was known to be divided on the basis of exploratory findings.

Three patients were seen in which the area of anaesthesia differed from the rest of the series, being restricted to the triangular area at the tip described above. These three patients also had an area of anaesthesia at the point of the chin, corresponding to the area supplied by the mylohyoid nerve.

Moving two-point discrimination—normal subjects

Threshold measurements

Both sides of the tongues of 55 normal subjects were tested to yield 110 threshold measurements, 91% of which were found to lie between 1 and 3 millimetres. Four subjects were found to have high thresholds (5–8 mm) on both sides of their tongues. Three had eaten curried food in the previous 24 h, and the fourth a dish of highly peppered fish. These subjects were retested at a time when they had not recently consumed spices. The opportunity arose to test one of these subjects a third time following a further curried meal. The results are shown in Table 1. While it would be foolhardy to draw any firm conclusions from these results, it was considered reasonable to substitute the second results obtained from these subjects for the first. The effect of this revision was that 98% of the thresholds determined lay between 1 and 3 mm (Table 2).

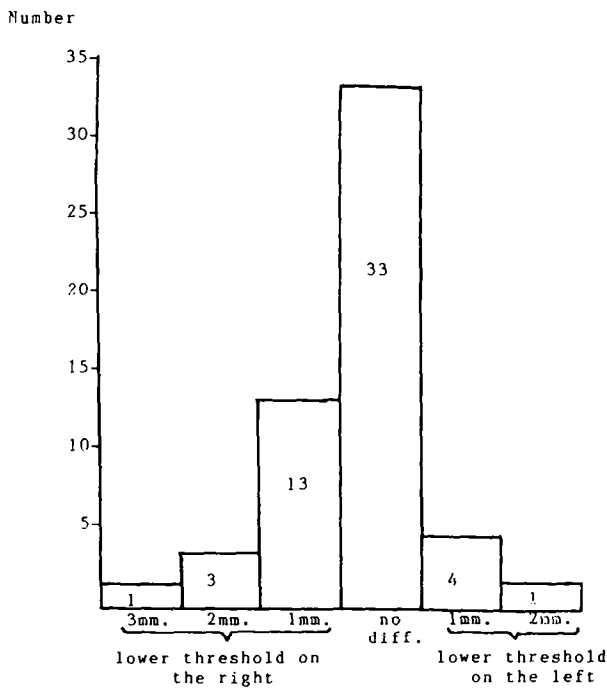


Fig. 3 - The differences in threshold between the two sides of the tongue, obtained from 55 normal subjects, using moving two-point discrimination.

The degree of symmetry in terms of the thresholds obtained

Comparison was made of the thresholds obtained from each side of the tongue of individual subjects. The differences found are shown in Figure 3. It can be seen that 91% of subjects had no more than a 1 mm difference in threshold between the two sides of the tongue, and that 98% of subjects had a difference no greater than 2 mm.

Seventeen subjects had a lower threshold on the right side, whereas only five subjects had a lower threshold on the left side. This difference was found to be significant using chi square ($p < 0.02$).

Consideration of the influence of age, sex, handedness and smoking habits

While subjects had not been selected on the basis of any of these factors, record had been made of them for each subject. The age range of the group of subjects was 18 to 48 years, with a mean of 25.4 years. Four subjects were left handed, five were smokers and 33 subjects were female. When comparison was made of the results obtained between groups for each of the various parameters, no significant difference was found in terms of either the degree of symmetry or the threshold measurements.

Moving two-point discrimination—patients

When testing the normal side of patients' tongues, the threshold was found to lie between 1 and 3 millimeters on 98% of occasions. This corresponds to the findings of the study of normal subjects. There

were 42 patients who were tested when sensation was declared normal. None had a difference in threshold between the two sides greater than one millimeter.

From the data of 61 patients who are known to have made a full recovery the following observations could be made:

1. An improvement was evident, in terms of a reduced threshold difference between the two sides, in all cases where testing was repeated. This is illustrated in Figure 4.
2. In many cases a normal result was obtained even when sensation was declared to remain abnormal.
3. The latest time when it was not possible to obtain a threshold from the affected side, in this group of patients, was 6 weeks following injury.
4. As a working hypothesis, 3 months had been taken to be a likely stage when consideration may be given to surgical exploration. At this stage, there was a group of 35 patients who had yet to achieve full recovery. In these not only could a threshold be obtained in all cases, but the majority (90%) of those tested prior to this time, had already yielded a normal result, even though they continued to experience altered sensation.
5. In general it was found that the higher the threshold on initial testing, the longer the recovery period was likely to be. However there were exceptions to this, which preclude use of the method to predict the likely time of recovery.

From the data of 31 patients who failed to make a complete recovery (which included two bilateral cases) the following could be observed:

1. The pattern of results, in terms of the threshold difference measured against time, was far more random than those of the patients who made full recovery.
2. In 12 cases no threshold was obtained at points in time later than 6 weeks.
3. Only one patient in this group yielded a normal result before 3 months.
4. Seven patients yielded results which became worse with the passage of time.

Comparison was made of the results obtained when testing touch with those of moving two-point discrimination. While in general changes in one were mirrored by changes in the other, there was no constant relationship. In addition the following observations were made:

1. At the initial examination of patients who would ultimately recover, a large proportion (33%) were unable to feel the touch stimuli, but had a threshold with moving two-point discrimination. A small number of patients were unable to discriminate with either method.
2. There was no response using either method, on repeated testing, in cases where the nerve was subsequently found to be divided at exploration.
3. Among those who made only a partial recovery, some could feel the touch stimuli to a limited

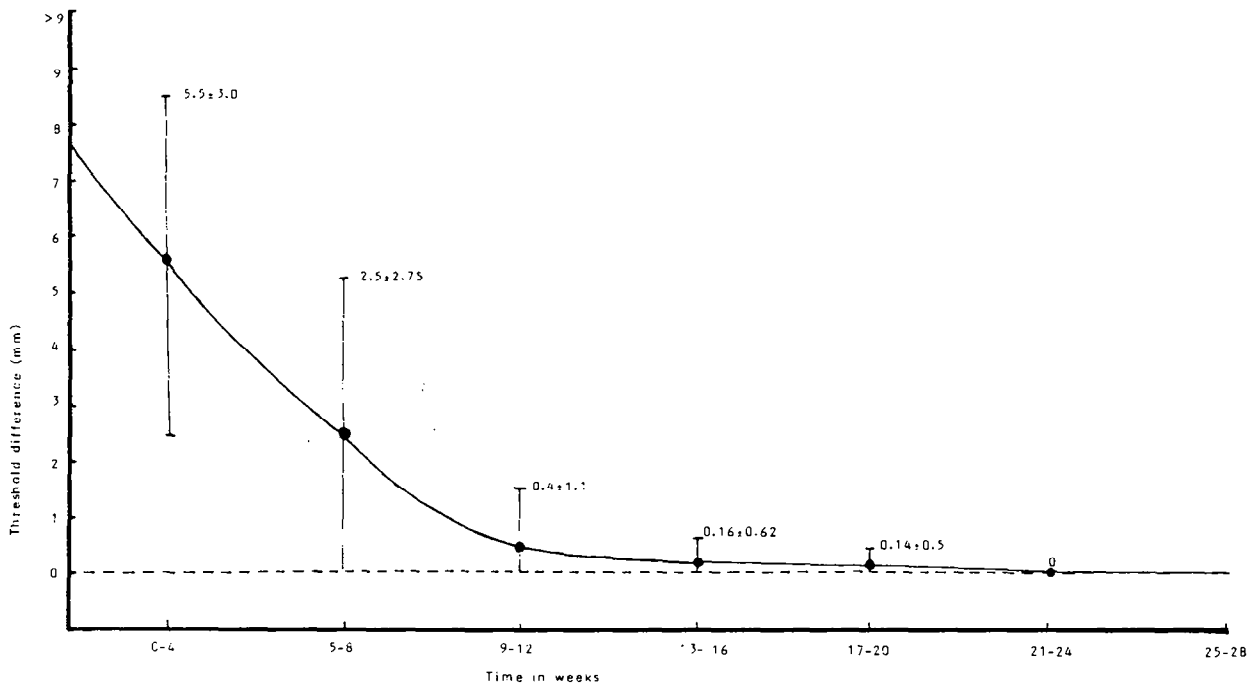


Fig. 4 - The mean threshold differences using moving two-point discrimination, with one standard deviation, obtained from the tongues of patients who recovered, plotted against time since injury.

extent, yet had no threshold with moving two-point discrimination; while in some of the other cases in this group the reverse was seen. On repeated testing, changes evident using one method, were not always mirrored in the results of the other.

4. In some cases normal results were obtained using both methods, and yet the patient complained of altered sensation.
5. By the stage of 3 months, all patients who would ultimately make a full spontaneous recovery had yielded a threshold with moving two-point discrimination, and could feel the touch stimulus on the affected side, albeit to a limited extent.

Patient subjective assessment

In general, the responses to questioning revealed a spectrum of special problems. A tendency to lisp had led to several patients being accused of drunkenness at work. Problems with speech were reported to be most marked on the telephone. Loss of the sense of taste threatened the livelihood of one patient who was a chef, and resulted in complaints about the family cooking to patients who were housewives.

The responses given to each question at the initial examination were studied. Patients were grouped into those who would ultimately make full recovery, and those who would not. The former group was restricted to those seen within 4 weeks of the time of injury, and who had significantly long recovery times. Comparison was made of the proportion in each group who reported an abnormality in response to each question. Any differences which occurred were tested using chi square.

No significant difference was found between the two groups for any of the questions. Of particular interest the presence of paraesthesiae, such as tingling, was not found to be associated with an increased likelihood of recovery. The proportion of patients who experienced such sensations was the same in both groups (80%).

Consideration was given to the responses of patients seen at 3 months. A 'score' was determined for each patient, calculated as the number of 'abnormal' responses out of a total of seven. Patients were again divided into those who would make full recovery, and those who would not. Considerable difference was seen, and when the mean scores of the two groups was tested using a t-test for unequal variances, the difference was found to be very significant at the 1% level.

Use of the data obtained at 3 months was made in the following way. A score of 1-3 out of 7 was taken to indicate that a patient was likely to recover, and a score of 4 and over that a patient was unlikely to recover fully. On comparing true and predicted recovery it was found that 87.5% of patients could be correctly predicted to recover, while 90% could be correctly predicted not to recover.

DISCUSSION

In seeking a method of sensory testing to adopt for the tongue various factors require consideration. Foremost among these is the relative inaccessibility of the tongue, with the need to avoid prolonged mouth opening and tongue protrusion; such might lead to fatigue with resultant poor concentration and

performance. Using the methods described it is necessary to protrude the tongue for only brief intervals.

Also to be considered are the circumstances in which testing is likely to be performed. Patients who have sustained lingual nerve injury are likely to be reviewed in busy clinics by staff of varying experience. There is a need for a method which is reproducible, simple, and quick. No elaborate instrumentation is required for these methods. Indeed Dellon (1978) used a paper clip in his account of moving two-point discrimination. No special skills or expertise are necessary, and the results of repeated testing, even by different clinicians, may be readily compared.

Several important aspects of the procedure for moving two-point discrimination had been revealed by earlier studies:

1. It is necessary to demonstrate what one-point and two-point feel like, each time the distance is changed in the second part of the test, otherwise confusion may occur.
2. When testing at different distances for two-point on each side, it was realised that the test should be completed on one side before moving to the other, again to avoid confusion.
3. The best results were obtained if the points were applied in a rhythmical fashion. In this way subjects and patients appeared to give a spontaneous response rather than a considered one, and in being able to anticipate the stimulus their concentration seemed better. It also reduced the period of time for which the mouth was kept open.
4. The movement of the callipers should be fast but deliberate; slower, for example, than one might strike a match. Only light pressure should be used.
5. If any contact occurred, other than that of the calliper points on the tongue, concentration was lost. Care was required to prevent the callipers striking the teeth or lips. This also applies when testing touch.
6. If an interruption occurred the responses on resuming testing tended to be poor. A quiet environment without distractions is a basic requirement for sensory testing.

Testing was restricted to a maximum separation for two-point of 10 mm. Beyond this, for smaller tongues, there is the possibility of encroaching on the opposite side. There is also the possibility of patients being unable to discriminate on their tongue surface, but recognising that two-point had been applied as a result of the calliper points leaving the curved edge of the tongue tip one after the other, if greater separations are used.

Over 95% of subjects had thresholds of between 1 and 3 mm, and it is therefore not surprising that they were found to have differences of 2 mm and less when the degree of symmetry was considered. In the clinical situation most cases of lingual nerve damage are unilateral. It is then possible to consider

both the threshold measured from the affected side, and the difference between the thresholds obtained from each side. The need to always test both sides is demonstrated by the raised thresholds found in some subjects, which appeared to be associated with the ingestion of spicy foods. In cases of bilateral lingual nerve damage comparison can only be made between the thresholds obtained and those determined in this series.

Of the various factors studied which might influence the threshold obtained, none was found to have a significant effect. A greater number of subjects had a lower threshold on the right than on the left, which may represent the findings of McCall and Cunningham (1971). However, in this study repeated testing of each subject, for the purpose of determining whether or not the asymmetry could be consistently demonstrated, was not performed. Although in terms of magnitude the asymmetry may be considered to be of no very great clinical importance, it should clearly be borne in mind.

The pattern of recovery seen when testing touch was relatively consistent. However, that it should start distally and progress proximally, is the reverse of what one might expect. An explanation may lie in the pattern of distribution of the terminal filaments of the lingual nerve to the dorsum of the tongue. In a dissection of one cadaver the terminal portion of the lingual nerve appeared to arc backwards, after passing from the floor of the mouth, with filaments passing initially to the tip, and subsequent branches passing more posteriorly.

Testing was restricted to the dorsal surface of the tongue in the main. Attempts to test the ventral surface and floor of mouth proved unsatisfactory due to problems with access and the need to use a retractor, which distracted patients from the stimulus which was being applied.

A frequent finding when testing touch was the small area at the tip where sensation remained intact. This has previously been described by Tier *et al.* (1984). On the basis of the three patients seen in this study, who had anaesthesia restricted to the tongue tip, and who also had altered sensation of the chin, it seems possible that afferents from the tip of the tongue may on some occasions pass with the mylohyoid nerve. It is important to recognise that this area may be found even in cases where the nerve has been divided, otherwise one may be misled into believing that recovery is occurring.

Difficulties were encountered when testing touch in determining a dividing line between where a patient could and could not feel the stimulus, as in some areas it could be felt, but 'felt different'. There was often a need for reference to the normal side, where one occurred. No very precise measurements could be made in many cases.

It was sometimes possible at the initial examination to obtain a threshold using moving two-point discrimination, in cases where the tongue otherwise appeared to be totally anaesthetic on the affected side. This provided reassurance to patients who considered that the nerve may have been cut.

Using both methods clear differences were seen on repeated examination between those patients who would later make full recovery, and those who would not. In the latter group there were patients whose results became worse with the passage of time. Some of these patients were indeed aware of increasing impairment, most commonly through changes in the senses of temperature and taste. This is likely to be related to progressive formation of scar tissue. Increasing experience of surgical repair is likely to show the need to recognise this phenomenon early.

In the group of patients who failed to recover fully, changes in the results of touch were not always mirrored by changes in those of moving two-point discrimination, and sometimes conflicted. This would seem to imply that the two methods test different populations of fibres, with different regenerative properties.

Experience has shown this method to be useful. It has, for example, provided a basis for the exploration and repair of 20 lingual nerves injured during third molar surgery. In addition, the impression gained is that such an approach goes a long way to assuage any hostility felt by the patient. However, while the method may be useful for deciding a basis for surgical intervention, it is clearly less useful in defining any residual sensory impairment. This is illustrated by the fact that normal results were sometimes obtained using both methods of testing in cases where sensation remained subjectively impaired. In this situation the testing of other modalities, such as temperature and taste, may provide greater information.

The responses to specific questioning gave a clearer overall concept of the degree of sensory impairment than the results of sensory testing. The responses given by patients were remarkably consistent, both at repeated examinations of individual patients, whose recovery was slow or failed to occur, and in terms of the symptoms described by the group as a whole.

By tradition patients who experience paraesthesiae, such as tingling, are frequently told that this is a sign that heralds recovery. This can be misleading, and may give rise to a false sense of security. Indeed in some long-standing cases it is these paraesthesiae which may be the main complaint. In this study the presence of such sensations did not indicate an increased likelihood of full recovery.

Using all three components of this method may take up to half an hour, which is too long for a routine busy out-patient clinic, especially if several patients present with the same complaint. This problem of management might be solved by using a system of specific questioning, such as described here. The responses obtained at initial presentation, which may be the time of suture removal, should be noted and compared with those obtained at next review, which should be within 3 months. If there is little or no change then sensory testing should be resorted to, ideally with sufficient time set aside.

While 3 months is a relatively late stage to undertake repair, earlier intervention can seldom be achieved at present, faced by the knowledge that the majority of cases make spontaneous recovery, and

the various issues involved. The exception would be those situations where there is good reason to suspect that severe damage might have occurred.

Although 100% accuracy cannot be guaranteed for this method, it would seem possible to distinguish by the stage of 3 months those patients unlikely to make full recovery, from those likely to recover fully. In the case of the 'temporary anaesthetics', as many as 70% will have already recovered (Mason, 1988; Blackburn & Bramley, 1989). Of those remaining all will have a threshold using moving two-point discrimination, and most will have already yielded a normal result. An appreciable area of the dorsum of the tongue will be sensitive to the touch stimulus. On specific questioning the majority of patients will give three or less 'abnormal' responses. Where the findings are those of a high threshold or no threshold with moving two-point discrimination, little or no area sensitive to the touch stimulus, and a score of four or more abnormal responses to specific questioning, this would support the case for surgical exploration of the nerve.

This in itself is not the full diagnostic method which might be applied. The information obtained by this means leads to the identification of patients unlikely to make full recovery, and who might then benefit from interventional surgery. However, little or no information is obtained with regard to the nature of the nerve lesion. Such information may be obtained by the recording of somatosensory evoked potentials, a technique which is described elsewhere (Blackburn, 1988).

It is to be hoped that through the routine use of a method such as that described here, early identification of patients who may benefit from surgical intervention may be made, with a view to achieving optimal results following lingual nerve repair.

Acknowledgements

My thanks go to Mr D. F. Meechan, Operational Research Unit, Trent Regional Health Authority, for his help with the statistical analysis, to Trent Regional Health Authority who provided financial support for this study, to colleagues who referred patients, and to the staff and students of the Charles Clifford Dental Hospital, Sheffield, who so very kindly gave their time to act as subjects.

References

- Blackburn, C. W. (1988). A study of lingual nerve damage associated with the removal of third molar teeth. *M.D.S. Thesis, University of Sheffield*.
- Blackburn, C. W. & Bramley, P. A. (1989). Lingual nerve damage associated with the removal of lower third molars. *British Dental Journal*, **167**, 103.
- Dellon, A. L. (1978). The moving two-point discrimination test: clinical evaluation of the quickly adapting fibre/receptor system. *Journal of Hand Surgery*, **3**, 474.
- Ferdousi, A. M. & MacGregor, A. J. (1985). The response of the peripheral branches of the trigeminal nerve to trauma. *International Journal of Oral and Maxillofacial Surgery*, **14**, 41.
- Gellis, M. & Pool, R. (1977). Two-point discrimination distances in the normal hand and forearm. *Plastic and Reconstructive Surgery*, **59**, 57.

- Mason, D. A. (1988). Lingual nerve damage following third molar surgery. *International Journal of Oral and Maxillofacial Surgery*, **17**, 290.
- McCall, G. N. (1969). The assessment of lingual tactile sensation and perception. *Journal of Speech Disorders*, **34**, 151.
- McCall, G. N. & Cunningham, N. M. (1971). Two-point discrimination: asymmetry in spatial discrimination on the two sides of the tongue, a preliminary report. *Perceptual and Motor Skills*, **32**, 368.
- Merle, M., Amend, P., Cour, C., Foucher, G. & Michen, J. (1986). Microsurgical repair of peripheral nerve lesions. A study of 150 injuries of the median and ulnar nerves. *Peripheral Nerve Repair and Regeneration*, **2**, 17.
- Mountcastle, V. B., Talbot, W. H., Davien-Smith, I. & Kornhuber, H. H. (1967). A neural base for the sense of flutter-vibration. *Science*, **155**, 597.
- Onne, L. (1962). Recovery of sensibility and sudomotor activity in the hand after nerve suture. *Acta Chirurgica Scandinavica Supplementum*, **300**.
- Parry, C. B. N. & Salter, M. (1976). Sensory re-education after median nerve lesion. *Hand*, **8**, 250.
- Ringel, R. L. & Ewanowski, S. J. (1965). Oral perception I: Two-point discrimination. *Journal of Speech and Hearing Research*, **8**, 389.
- Seddon, H. (1975). *Surgical Disorders of the Peripheral Nerves*, pp. 9–31. Edinburgh, London and New York: Churchill Livingstone.
- Talbot, W. H., Darien-Smith, I., Kornhuber, H. H. & Mountcastle, V. B. (1968). The sense of flutter vibration: comparison of the human capacity with response pattern of mechanoreceptive afferents from the monkey hand. *Journal of Neurophysiology*, **31**, 301.
- Tier, G. A., Rees, R. T. & Rood, J. P. (1984). The sensory nerve supply to the tongue: a clinical reappraisal. *British Dental Journal*, **157**, 354.
- Werner, G. & Mountcastle, V. B. (1965). Neural activity in mechanoreceptive cutaneous afferents: stimulus-response relations, Weber functions and information transmission. *Journal of Neurophysiology*, **28**, 359.

The Author

C. W. Blackburn MDS, FRCS, FDSRCS

Lecturer

Department of Oral and Maxillofacial Surgery

University Dental Hospital

Higher Cambridge Street

Manchester M15 6FH

Correspondence and requests for offprints:

Mr. C. W. Blackburn

Department of Oral and Maxillofacial Surgery

Hull Royal Infirmary

Anlaby Road

Hull HU3 2JZ

Paper received 7 July 1989

Accepted 31 August 1989