Outcome Assessment of Inferior Alveolar Nerve Microsurgery: A Retrospective Review

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Purpose: This retrospective study was performed to assess the clinical outcome of patients who have undergone trigeminal nerve microsurgical repair of the inferior alveolar nerve.

Materials and Methods: This study includes all patients who underwent microsurgical repair of the inferior alveolar nerve at the University of Medicine and Dentistry of New Jersey from July 1, 1998 through June 30, 2003. Each patient underwent a thorough evaluation of sensory nerve function that included the type of injury, date of injury, and neurosensory testing. The evaluation was performed pre- and postoperatively to assess sensory improvement. Through chart review and quantitative statistical analysis, the outcome of inferior alveolar nerve microsurgical repair was assessed to ascertain which sensory variables were statistically significant in showing improvement from microsurgical procedures.

Results: Thirty-two patients underwent microsurgical repair of their inferior alveolar nerve injury by the same surgeon. The average period of time from initial nerve injury until primary surgical repair was 6.6 months. Four patients did not follow-up postoperatively and were excluded from the final data. Of the remaining 28 patients, mean follow-up period was 9.5 months. It was determined that 26 patients (92.9%) had statistically significant neurosensory improvement, with 14 reporting (50%) significant improvement, 12 patients (42.9%) with slight improvement, and 2 patients (7.1%) demonstrating no improvement. No statistical evidence was found to support that a decrease in time from injury to surgery had improved results in this limited patient population.

Conclusion: Microsurgical repair provides an improvement in neurosensory function in patients that present with an inferior alveolar nerve injury.

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The inferior alveolar nerve is susceptible to injury from maxillofacial trauma and iatrogenic causes in the practice of dentistry and oral and maxillofacial surgery. Patients that experience these injuries often complain of sensory disturbances that affect their everyday lives because of their effects on speech, mastication, deglutition, food and liquid incompetence, and social interaction. Often these injuries resolve spontaneously; however, they may become permanent with varying degrees of sequelae.[1,2] Although the surgical outcome may improve sensory function, the results generally fail to restore complete nerve function. It is possible to greatly increase neurosensory function postsurgically, thus greatly improving a patient's quality of life.

Sensory deficits lasting 1 year or more are likely to be permanent and attempts for microsurgical repair are often unsuccessful after this time. Surgeons must be aware of this complication and provide detailed informed consent to their patients because this is one of the highest sources of malpractice litigation in oral and maxillofacial surgery.[3] Presently, there is not a standardized protocol in the evaluation and management of these patients other than referral to a surgeon trained in trigeminal nerve microsurgery within approximately 3 months. In addition, the long-term results of microsurgery appear to be varied and often

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anecdotal with most data reported as case series or retrospective studies.[4] The long-term results of surgical treatment have been inconclusive in the current and past literature. Some studies reported that early nerve repair appears to provide better results than does late repair.[5,6] This conclusion is not always substantiated, with some reports stating that timing may or may not have an effect on the success of nerve repair procedures.[7] However, it is still recommended by most surgeons trained in trigeminal nerve microsurgery to perform procedures within approximately 3 to 4 months to maximize outcomes.

Materials and Methods

Thirty-two patients underwent microsurgical repair of their inferior alveolar nerve at the University of Medicine and Dentistry of New Jersey from July 1, 1998 through June 30, 2003. The type of surgical procedure(s) performed was determined at the time of surgery after complete external neurolysis was completed and the nerve was dissected from its surrounding tissues and examined under microscopic guidance. Of the 32 patients, 4 were excluded from the study because of lack of follow-up postoperatively. The remaining 28 patients underwent a thorough evaluation of sensory nerve function that included the type of injury, date of injury, and neurosensory function testing. These neurosensory testing modalities included: sensitivity to heat, cold, touch, vibration, 2-point discrimination, von Frey filaments, direction, and pin prick perception. The evaluation was performed by the same clinician pre- and postoperatively to assess the patients' progress. In addition, both the patient and surgeon rated the outcomes, which were compared statistically. Through chart review and quantitative statistical analysis, the outcome of inferior alveolar nerve microsurgical repair has been analyzed to determine which variables were statistically significant in demonstrating improvement postoperatively.

Results

Indications for trigeminal nerve microsurgery included patients with no improvement in serial neurosensory exams in the 3 months following injury, complete anesthesia of more than 3 months after injury, or those patients with a direct observed injury that was visualized by the original surgeon. Eleven (39%) males and 17 (61%) females with an average age of 38.5 years constituted the group (range, 17 to 67 years). The average follow-up period postsurgically was 9.5 months, with a range of 2 to 18 months. The mechanisms of injury are listed in Table 1. The most frequent form of injury was caused by extraction of a third molar (42.9%), followed by root canal therapy (17.9%) and implant placement (14.3%).

Table 1. MECHANISM OF INFERIOR ALVEOLAR NERVE INJURY

Mechanism of Injury	Total	Percentage (%)
Apicoectomy	1	3.6
BSSO	1	3.6
Third molar extraction	12	42.9
Incision & drainage	1	3.6
Implant placement	4	14.3
Mandible fracture	2	7.1
Laceration	1	3.6
Root canal treatment	5	17.9
Enucleation of cyst	1	3.6

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Surgical procedures performed on patients included external neurolysis, internal neurolysis, and microsurgical repair for those injuries requiring primary neurorrhaphy and excision of a neuroma. All patients underwent external neurolysis, 11 patients (39.3%) had internal neurolysis performed in addition to external neurolysis, and 12 patients (42.9%) additionally underwent primary microsurgical repair. Five patients (17.8%) required only external neurolysis.

To facilitate statistical analysis, a common numeric value was assigned to the degree of deficit observed in tests of hot, cold, wisp, vibration, stroke, direction, and pin prick, where "0" indicated normal, "1" indicated a mild deficit, and "2" indicated a severe deficit. These scores were computed for all patients who had valid preoperative and postoperative tests for each variable. Pre and post measures were then compared by a paired samples t test. Mean improvement for hot was 0.56 ($P = .007$), cold was 0.68 ($P = .001$), pinprick was 0.80 ($P = .000$), wisp was 0.76 ($P = .001$), vibration was 0.50 ($P = .041$), and directional improvement was 0.47 ($P = .008$). The improvement in fine touch was indicated by a reduction in the threshold for perceptible stiffness of von Frey filaments by 1.10 units ($P < .001$), and in 2-point discrimination (using boley gauge measurements) of 8.73 mm ($P = .000$) following surgery. Thus, all measures showed significant improvement after surgery, relative to presurgical neurosensory assessments (Table 2).

The average time from injury to surgery was 6.6 months (range, 1 to 28 months). To determine whether sensory function improved more among patients with shorter delays before surgery, the correlation between latency to surgery and the sensory change was computed. While in the expected direction ($r = 0.26$; $P = .21$), sensory improvement in this limited patient population was not significantly associated with shorter times to surgery.

Table 2. STATISTICAL ANALYSIS OF INDIVIDUAL NEUROSENSORY TESTING MODALITIES AS INDICATORS OF SENSORY IMPROVEMENT

Test	Presurgical Mean	Postsurgical Mean	Mean Difference	SD	N	*P* Value
Hot	1.69	1.13	0.56	0.727	15	.007
Cold	1.42	0.74	0.68	0.749	18	.001
Wisp	1.47	0.71	0.76	0.752	16	.001
Vibration	1.38	0.88	0.50	0.894	15	.041
2 pt	19.13	10.40	8.73	3.86	14	.000
von Frey	5.10	4.00	1.10	0.95	15	.000
Direction	1.62	1.15	0.47	0.519	12	.008
Pin	1.80	1.00	0.80	0.516	14	.000

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Each patient's rating of global improvement was recorded and compared with that of their surgeon in 3 categories including no improvement, mild improvement, and significant improvement. The surgeon's assessment was based on standardized neurosensory testing and the patient's opinion as to their perceived overall sensory improvement. Amongst patients, 53.6% reported mild improvement, 35.7% reported significant improvement, and 10.7% reported no appreciable improvement. The surgeons reported mild improvement in 42.9% of the patients, significant improvement in 50.0%, and no improvement in 7.1%. There was strong agreement between patients' and surgeon's assessments of outcome ($\kappa = 0.75$; $P < .001$). In all 4 cases of disagreements, the surgeon rated improvement higher than the patient (Fig 1).

Discussion

Primary surgical repair of the inferior alveolar nerve has been shown to be highly effective in restoring sensory nerve function.[4,8] Animal studies confirm that neuronal cells are capable of supporting axonal regeneration re-establishing functional connections with distal nerves following trigeminal nerve microsurgery.[9] Approximately 90% of the patients in this study reported to have increased sensory nerve function postoperatively, including 35% who reported significant improvement. Although the literature on inferior alveolar nerve repair is limited, a few recent studies have shown that patients respond well to surgical treatment. Pogrel[4] reported that greater than 50% of patients that undergo trigeminal nerve repair experience an improvement in sensation postoperatively. In a study performed by Lam et al,[8] it was reported that more than 55% of patients receiving surgical repair for inferior alveolar and lingual nerve injuries had an overall postoperative satisfaction of good to excellent. In that study, only 17% of patients surveyed rated their surgical outcome as poor. Robinson et al[10] reviewed a group of patients that had undergone lingual nerve repair and determined that 82% reported a score of 5 or better on a 10-point scale, regarding sensory improvement on patients 12 months post repair. The current study further supports the literature that patients can significantly improve neurosensory function after nerve injury with the aid of surgical intervention. Our own published data[11] for lingual nerve microsurgery outcome assessment show moderate to significant improvements in sensory function postoperatively.

If trigeminal microsurgery is performed before 1 year, based on known neurologic responses to injury, recannualization or neurotization of distal end organs can be expected to occur. Significant distal nerve scarring and atrophy will occur by 1 year, making microsurgical outcome less predictable.[1,12] Several authors[5,6] have supported earlier surgical repair for lingual nerve injuries based on the premise that there is no anatomic guidance for spontaneous regeneration, in comparison to the inferior alveolar nerve that has a bony canal to act as a conduit. Donoff[5] has advocated early repair of trigeminal nerve injuries; however, he cites clinical evidence by Carmichael and McGowan[13] that shows an extremely small im-

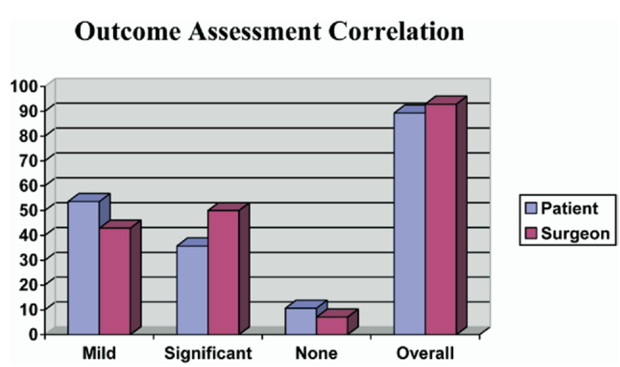

FIGURE 1. Correlation of patient and surgeon perceived outcome assessments.

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provement of neurosensory function in relation to time. Zuniga[14] reported that outcome would not be improved if the mental nerve was treated sooner rather than later. Gregg[15] reported that there was no conclusive evidence that early intervention in the case of inferior alveolar nerve injuries was better than nonsurgical management with delayed treatment (defined as more that 3 months after injury) because the majority of inferior alveolar nerve injuries are known to resolve spontaneously.

Sensory re-education may help some patients improve their quality of returned sensation. Patients must be educated before surgery as to what can be expected after microrepair. Realistic expectations should be discussed for the postoperative period, and patients must understand that a complete sensory recovery is unlikely. The primitive sensations mediated by the C-fibers and A-delta fibers return first, marked by the perception of pain and temperature, which usually begins to occur by 3 months postsurgery.[16] Patients may relate unpleasant sensations and the feelings of tingling, electrical shocks, and crawling within the affected region. More complex sensory functions such as vibration, fine touch, and directional sense can be delayed for up to 1 year. Therefore, serial examinations should be performed postoperatively to demonstrate to the patient the areas of improvement. After examination, it is important to discuss their improvement and review how certain abnormal behaviors such as tongue biting, drooling, and food incompetence may have resolved. Sensory levels achieved by the end of the first year are usually the maximum neurosensory levels obtained by most patients.[12]

Microsurgical repair of the inferior alveolar nerve can provide sensory improvement for many patients. The high correlation between patient opinion and surgical opinion as to perceived improvement in neurosensory function after trigeminal nerve microsurgery further supports the benefits of this interventional surgical procedure.

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