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ABSTRACT

Background. This is a prospective study of patients referred to a tertiary care center with permanent alteration in sensation of the inferior alveolar nerves, lingual nerves or both that could have resulted only from an inferior alveolar nerve block.

Methods. Working with a subject pool of 83 patients, the researchers outlined and photographed the area of altered sensation on each patient, tested it with von Frey's hairs and two-point discrimination and tested temperature sensation and direction sense.

Results. Among a study population of 55 women and 28 men with a mean age of 41.2 years, the lingual nerve was affected in 79 percent of patients and the inferior alveolar nerve in 21 percent of patients. In 47 patients, the causative inferior alveolar nerve block was painful when administered, but in the other 25 patients, it felt like a normal injection. Of the local anesthetic agents used, prilocaine was found to be more frequently linked to cases of nerve involvement in this study.

Discussion. Occasionally, an inferior alveolar nerve block can result in permanent involvement of the inferior alveolar nerve, lingual nerve or both. The incidence and exact mechanism of involvement still are unknown. By extrapolation from this study, an incidence of anywhere between 1:26,762 and 1:160,571 inferior alveolar nerve blocks can be surmised to result in this complication. A difference in referral rates for male and female patients is difficult to explain. The 36 percent incidence of dysesthesia in the patients in this study is of concern.

Conclusion. Permanent nerve involvement after receiving an inferior alveolar nerve block is a documented but very rare complication of the inferior alveolar nerve block, and the exact mechanism involved is still unknown.

Clinical Implications. Permanent nerve damage can very occasionally occur as a result of an inferior alveolar nerve block. The exact mechanism is unknown, and there is no means of prevention. Knowledge of the risks and complications of local anesthesia is essential.

It has been documented that on rare occasions, an inferior alveolar nerve block can cause permanent alteration in sensation over the distribution of the lingual nerve, the inferior alveolar nerve or both nerves.[1,2] Studies have suggested that in the vast majority of cases when a nerve is affected abnormally by local anesthetic, spontaneous recovery occurs over an eight-week period.[1,3] It has been estimated that between 85 percent[1] and 94 percent[2] of such injuries resolve in this way. However, another study has suggested that if recovery does not occur fairly quickly, then only about one-third of these patients may go on to experience recovery and two-thirds of them may have permanent impairment.[3]

The true incidence of permanent nerve involvement and its possible etiology and management remain controversial. An article in 1995 by one of the present authors (M.A.P.) and colleagues[3] documented 12 patients with residual nerve involvement as a result of an inferior alveolar nerve block. Since this article was published, the primary author has received many communications worldwide on this condition and has had the opportunity to examine many more patients with this problem, allowing further conclusions to be drawn.

TABLE

NERVES PERMANENTLY AFFECTED BY INFERIOR ALVEOLAR NERVE BLOCK.

NERVE AFFECTED	NUMBER OF PATIENTS WITH PERMANENT INVOLVEMENT
Right inferior alveolar nerve	13
Right lingual nerve	34
Left inferior alveolar nerve	14
Left lingual nerve	32
TOTAL	**93***

* Total is more than the total number of patients (N = 83), as the lip and tongue on the same side were permanently affected in seven patients, and both inferior alveolar nerves and both lingual nerves were affected in one patient.

This article reports on a study of these patients and others who had experienced what appeared to be permanent nerve involvement after receiving an inferior alveolar nerve block.

SUBJECTS AND METHODS

The subject group consisted of 83 consecutive patients with altered sensation over the distribution of the lingual nerve, inferior alveolar nerve or both nerves as a result of receiving an inferior alveolar nerve block. The study population consisted of eight subjects from the original 12 previously described in 1995[3] (the other four patients recovered) and an additional 75 patients seen since 1995. All of these patients have had altered sensation for more than one year with no signs of improvement—the criterion that must be met for this condition to be considered permanent. Of the 83 patients, 70 were from northern California, 12 were from the United States outside of northern California, and one was an international patient. In all cases, only restorative dentistry had been performed after the administration of the nerve block, and there was no other possible cause of the nerve involvement.

The patients consisted of 55 women and 28 men. The mean age was 41.2 years (range, 21 to 83 years).

RESULTS

The nerves involved in the study group are shown in the table. The total shown is more than the number of patients because in seven patients, both the lip and tongue were affected on the same side, and in one patient, both inferior alveolar nerves and both lingual nerves were permanently affected after three inferior alveolar nerve blocks (two on one side and one on the other side).

Sixty-seven patients were given the causative injection by a general dental practitioner, five by an endodontist and one by a periodontist. In the cases in which the local anesthetic was known, 33 patients received lidocaine, 32 patients received prilocaine and three patients received mepivacaine. Twelve patients received multiple inferior alveolar nerve blocks with different agents: six received a carpule of prilocaine followed by a carpule of lidocaine; two received a carpule of prilocaine followed by a carpule of mepivacaine; one received a carpule of prilocaine followed by a carpule of etidocaine; one received a carpule of mepivacaine followed by a carpule of lidocaine; and one received three carpules of mepivacaine, two carpules of bupivacaine and one carpule of lidocaine. The reasons for these multiple injections varied. In some cases, it was the routine practice; in others, it was because the first block was ineffective. In three cases, the local anesthetic used was unknown. This was either because the dentist involved had left the practice and no information was available, or because more than one local anesthetic was in routine use in the dental office and the particular agents had not been recorded and could not be recalled by the dentist.

Of the 83 patients, 36 could not recall anything unusual about the injection and were not aware of the "electric shock sensation" that often accompanies nerve involvement. The other 47 patients either received a very painful injection or felt the electric shock sensation. From a symptomatic standpoint, 28 patients reported dysesthesia as their most troublesome symptom, while, in the other 55 patients, paresthesia or anesthesia as predominant.

To date, five patients have undergone surgical exploration of their injuries. The senior author (M.A.P.) operated on three of these patients. The

other two were treated by different surgeons, and we obtained reports on their operations and spoke to the surgeons. In all five cases, there was no obvious damage to the nerve seen at surgery even when the fascicles were dissected, apart from a slight increase in adhesions around the nerve and a slightly whiter appearance of the nerve in the area of the injections compared with a creamier appearance elsewhere. Patients had not received nerve grafts or other nerve surgery, and none of the five patients benefited symptomatically from the surgery. In fact, two patients stated that their pain was worse after the surgery. In five patients, the symptoms of dysesthesia have taken on the characteristics of causalgia or sympathetically mediated pain with a deep, boring, burning pain and occasional flushing over the associated cheek, symptoms that have been reported previously.[4] In six patients, the dysesthesia appeared to have spread proximally to involve other trigeminal nerve trunks, particularly the maxillary branch (Figure 1).

Several of the patients with dysesthesia have been referred to a pain management clinic. The senior author examined all patients and tested them with pinprick to outline the area of altered sensation, which was photographed. Within the affected area, sensation was evaluated with von Frey's hairs[5] and two-point discrimination, as well as with temperature sensation (hot and cold water) or Minnesota Thermal Discs[6] or both, and patients also were tested for direction sense.

Residual nerve involvement ranged from mild to complete anesthesia (in two cases) and, in all cases, the area outlined covered virtually the whole distribution of the affected nerve.

Figure 1. The area of altered sensation (anesthesia and dysesthesia) resulting from an inferior alveolar nerve block in two patients. In each case, the area increased over a one-year period after commencing on the lower lip.

DISCUSSION

The incidence of nerve involvement from inferior alveolar nerve block is unknown, but it can be informally calculated in the following manner. First, current sales of local anesthetics for dentistry in the United States are approximately 161 million carpules per year (Richard D. Finkelman, D.D.S., Ph.D., Astra-Zeneca Corp., oral communication, 1999). In this study, 75 patients living in northern California (population 10.2 million) who had such nerve involvement were seen over a 48-month period beginning in August 1995 (an average of 18.75 patients per year). Northern California contains about 3.74 percent of the U.S. population (approximately 272,878,000 people). Using these figures for the basis of an informal estimate, and calculating that around half of all the local anesthetic carpules administered during that 48-month period were for inferior alveolar nerve blocks, this gives an estimated incidence of permanent nerve involvement of 1:160,571 inferior alveolar nerve blocks. This is around four times greater than previous studies have suggested.[2,3,7,8] Even so, it probably represents an underestimate, as it is doubtful that we in the University of California San Francisco Department of Oral and Maxillofacial Surgery are seeing all cases of this condition.

In terms of anecdotal evidence, the senior author kept a telephone log of calls received since our previous article on this subject was published.[3] For each patient actually seen and examined who have this prob-

lem, telephone information has been received for five other patients who apparently have the same problem. If all these other patients were examined and found to be similarly affected, this would mean the incidence would be on the order of 1:26,762 inferior alveolar nerve blocks, which is within the range of blocks that the full-time practicing dentist might administer during a lifetime of work. Thus, perhaps every full-time practitioner will find that he or she has one patient during his or her career who has permanent nerve involvement resulting from an inferior alveolar nerve block. However, it is still doubtful that we are receiving information about all the patients with the condition, so the true incidence remains unknown.

In any patient who has had surgery and suffered nerve damage, we have to assume—given the present state of knowledge—that the damage was caused by the surgery. It is possible that in some of these cases, the nerve involvement was caused by the inferior alveolar nerve block and not the surgery, but there is no way of determining that.

In terms of incidence, there was no statistical difference between the right and left sides. However, the lingual nerve was affected 79 percent of the time; this may be because when the mouth is wide open, the lingual nerve is held tightly in the tissues and is unable to be deflected by the needle. Taste also was affected often, indicating involvement of the corda tympani. In the current study, when the type of local anesthetic was known and only a single agent was used, 48 percent of patients received lidocaine, 47 percent received prilocaine and 5 percent received mepivacaine. This corresponds with national sales figures that suggest that of all local anesthetics used by dentists in the United States, lidocaine is used 62 percent of the time, mepivacaine 23 percent of the time, prilocaine 13 percent of the time and a long-acting local anesthetic such as etidocaine or bupivacaine 2 percent of the time (Richard D. Finkelman, D.D.S., Ph.D., Astra-Zeneca Corp., oral communication, 1999).

Perhaps every full-time practitioner will find that he or she has one patient during his or her career who has permanent nerve involvement resulting from an inferior alveolar nerve block.

Although the numbers in this study are small, it does appear that prilocaine may be involved more frequently and mepivacaine may be involved less often than either agent's rate of use nationwide (as gauged by sales) would indicate, though there may be regional differences in use of the different anesthetics. Other researchers also have noted a higher incidence of permanent nerve involvement with prilocaine.[8,9] All three manufacturers selling local anesthetics for dentistry in the United States (Astra-Zeneca Corp.; Cook-Waite, whose product is manufactured by Abbott Pharmaceuticals; and Novocal of Canada, which manufactures Septodont and its own name brands) were represented in this study. There were examples of nerve damage resulting from each relevant product; no products were exempt.

The difference in referral rates in women as opposed to men with nerve involvement caused by local anesthetic injections is hard to explain, when it would be assumed that the incidence of the condition would not have a gender bias. It is possible that some of the same etiologic factors are involved as in temporomandibular joint dysfunction, in which the incidence may be equal between the sexes but women more frequently seek care for the condition at a referral center.[10] Alternatively, however, there have been some recent animal studies suggesting that nerves may respond differently to injury in female animals than in male animals.[11]

The fact that several patients suffered from dysesthesia and even causalgia and sympathetically mediated pain is of obvious concern. The true incidence of this is unknown; furthermore, this study may well represent a self-selected group with a greater preponderance of such patients, as they are more likely to be referred for evaluation. Comparisons need to be made with the dysesthesia and causalgia rate associated with nerve involvement stemming from other sources, such as third-molar removal.[12,13] The fact that the area affected in all cases involved the whole area served by the nerve suggests that whatever process is involved affects the whole nerve

and not just one or two fascicles.

Information gathered in a previous study[13] showed that when nerve involvement resulted from tooth removal, eight of 95 patients (8 percent) complained primarily of dysesthesia, compared with 28 of 83 patients (34 percent) in the present study. The reasons for this difference are unclear. Haas and Lennon[8] stated that 12 percent of their patients reported experiencing a burning feeling in addition to altered sensation.

The etiology of this condition remains uncertain. Direct trauma from the needle seems unlikely, because it is known that most cases of trauma resulting from needle contact resolve spontaneously.[1] It is difficult to envision how needle trauma can damage the whole nerve, which appeared to be the case with all patients.[2] Additionally, in the five patients who underwent surgery, no evidence of macrotrauma caused by a needle was observed.

Another prospective study by the senior author has been carried out in an attempt to evaluate the normal incidence of contact between a local anesthetic needle and the inferior alveolar or lingual nerve in the course of performing general dentistry. For the present study, the authors contacted local dentists via dental society meetings and personal contacts and gave them forms to complete prospectively, recording the number of inferior alveolar nerve blocks they gave each day and the number of presumed contacts between the local anesthetic needle and the inferior alveolar lingual nerve. A contact was presumed to have been made when the patient felt an electric shock sensation or stated that injection was particularly painful. They were to keep records for six months. Forms were returned by 42 dentists. The results are quite variable and to a certain extent reflect the workload of the dentists involved. However, it does appear that the average busy dentist administers around eight to 12 inferior alveolar nerve blocks per day and is made aware of a needle contact with a nerve somewhere between once every two weeks and once every eight weeks (anywhere between one in 80 and one in 320 inferior alveolar nerve blocks). This is a further indication that for the vast majority of inferior alveolar nerve blocks in which contact is made directly with the nerve, there are no subsequent long-term sequelae. Other studies have suggested that patients may feel the electric shock with between 3 percent[1] and 7 percent[2] of inferior alveolar nerve blocks.

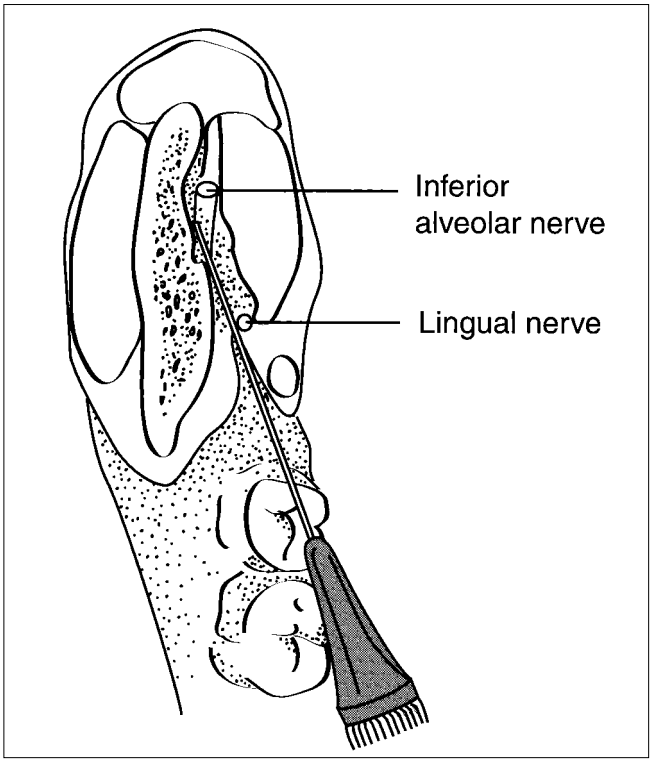

Figure 2. Axial view of the mandible at the level of the lingula showing the relative positions of the inferior alveolar nerve, the lingual nerve and a needle administering an inferior alveolar nerve block. Note that the needle passes the lingual nerve some distance before it contacts bone.

Although potentially dangerous barbs can develop on the needle tip after contact with bone[14] and therefore cause trauma on withdrawal or on second use, it appears that most of the nerves in the present study were involved before withdrawal of the needle and on first use of the needle.

Intraneural hematoma caused by the needle's striking one of the smaller intraneural blood vessels remains a possible hypothesis, as it is known that intraneural hematomas are neurotoxic.[15] Hematomas could explain the findings in the five patients who underwent surgery. There appeared to be some intraneural fibrosis among these patients, as well as extraneural adhesions that could be the result of leakage of blood and blood products through the epineurium via the hole or holes created by the needle.

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Chemical damage from the local anesthetic itself remains a possibility,[16-25] though technically it is difficult to envisage how local anesthetic could be injected directly into the nerve. Experimentally, it is extremely difficult to inject local anesthetic into a nerve because the epineurium will not stretch, and in this study, as in others, the lingual nerve is predominantly affected. Also, at the time the injection is given, the needle tip is well past the lingual nerve and is in approximation to the lingual plate of the mandible and closer to the inferior alveolar nerve (Figure 2). To inject local anesthetic directly into the lingual nerve (which is the nerve affected in more than 70 percent of cases), one would have to hold the needle 3 to 4 millimeters beneath the mucosa but well short of the mandible itself. This does not happen in practice. Nevertheless, it could be envisaged that were the needle to have transfixed the lingual nerve and then gone on to be injected normally adjacent to the mandible, a tiny amount of the local anesthetic could come in contact with the intraneural contents as the needle is withdrawn through the lingual nerve. This is because some local anesthetic would remain within the lumen of the needle and also may coat the outside of the needle. However, it appears that in most cases, the problem occurs before needle withdrawal.

The number of patients suffering from dysesthesia and causalgia that appeared to spread to other nerve branches (Figure 1) in some cases is of concern. It is conceivable that chemical injury may explain some of these symptoms, but the mechanisms remain obscure and in some respects resemble those of demyelination. It is again difficult to conceive how all the fascicles of the nerve could be affected, as seems to be the case in all 83 patients examined for this study.

Exploratory surgery has been unhelpful in patients with permanent nerve involvement and may even have exacerbated the symptoms.

Exploratory surgery has been unhelpful in these patients and may even have exacerbated the symptoms. If the cases explored in this study are representative, then no macrotrauma is seen, but possibly some intraneural fibrosis and slight increase in extraneural adhesions may occur. It is tempting to think that excision of the area of the nerve showing intraneural fibrosis and replacement with a graft of some kind may be helpful. However, in the senior author's experience, it is extremely difficult to accurately delineate the area of nerve involved. In addition, the nerve's position is deep to the medial pterygoid muscle (further proximal than a nerve that would be involved in a third-molar removal), and so it is virtually impossible to perform a satisfactory grafting procedure at the proximal anastomosis site without having to extensively mobilize the medial pterygoid muscle and even detach it. This is not justified in light of the relatively poor results that are obtained from nerve-grafting procedures and the morbidity that could result.

At the present time, the optimum treatment is unknown, but it probably should be medical. If dysesthesia is the prime concern, it should be managed by a pain management professional.

CONCLUSION

An inferior alveolar nerve block can cause occasional peripheral nerve damage. The exact mechanism is unknown and there is no known prevention or treatment. ■

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