

Lateralization of the Inferior Alveolar Nerve with Simultaneous Implant Placement: A Modified Technique

Michael Peleg, DMD¹/Ziv Mazor, DMD²/Gavriel Chaushu, DDS³/Arun K. Garg, DMD⁴

Purpose: Several nerve repositioning techniques have been presented in the literature, each with limitations. This article presents a new technique involving the use of 2 osteotomies, which minimizes particularly the potential duration of sensory disruption and the risk of nerve paresthesia and inadvertent nerve transection or compression. **Materials and Methods:** Ten patients ranging in age from 47 to 67 years were selected for nerve lateralization utilizing the modified technique. A total of 23 cylindrical implants were placed. An average follow-up period was 29.8 months. **Results:** Of the 10 patients, 4 experienced total return of sensation within 3 to 4 weeks. One patient experienced complete recovery at 6 weeks. **Discussion:** Creating 2 osteotomies as described minimizes the chances for postoperative neuropraxia and nerve paresthesia or anesthesia. **Conclusion:** When there is moderate-to-severe bone resorption of the mandible posterior to the mental foramen, repositioning the inferior alveolar nerve using both an anterior and posterior osteotomy allows for more bone to accommodate ideal placement and greater length of implant. (INT J ORAL MAXILLOFAC IMPLANTS 2002;17:101–106)

Key words: dental implants, inferior alveolar nerve, nerve repositioning, nerve transpositioning, neurosensory disturbance

Progressive bone resorption often occurs following tooth loss or extraction, resulting in a moderately to severely atrophied mandible. Often, the bone height posterior to the mental foramen is inadequate to allow proper placement of endosteal implants and the use of optimal fixture lengths without potentially injuring the inferior alveolar nerve. One approach to avoiding nerve injury when placing implants in these situations is to reposition the inferior alveolar nerve laterally and then place the implants medial to the nerve.¹

Several repositioning techniques have been presented in the literature over the past 10 years, each with limitations.^{2–10} Some of these techniques involve transpositioning the nerve by creating a window that includes the mental foramen as well as the

area of implant placement, then releasing the nerve from the mental foramen and replacing the nerve distal to its original location. Because this creates a large bone segment that must be manipulated within the mental nerve area, permanent nerve damage is a significant risk. Other techniques involve lateralizing the nerve by repositioning it through a posterior cortical window rather than engaging the mental foramen. This approach, however, requires extensive stretching of the nerve.

This article presents a new technique involving the use of 2 osteotomies, which minimizes these limitations—particularly the duration of sensory disruption and the risk of nerve paresthesia and inadvertent nerve transection or compression (Figs 1a and 1b).

MATERIALS AND METHODS

Ten patients (8 women, 2 men), ranging in age from 47 to 67 years (mean 56 ± 7 years) were selected for lateralization of the inferior alveolar nerve via the modified surgical approach described in the next section. Each patient presented with less than 8 mm of bone height for implant placement, superior to the inferior alveolar nerve. A total of 23 implants were placed posterior to the mental foramen in the

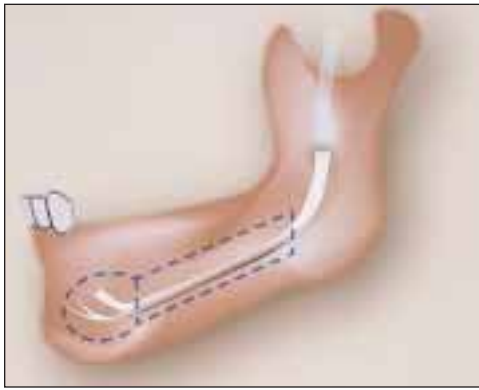
¹Associate Professor, Department of Oral and Maxillofacial Surgery, The Chaim Sheba Medical Center, Tel Hashomer, Israel.

²Private Practice, Periodontics, Tel Aviv, Israel.

³Associate Professor, Department of Oral and Maxillofacial Surgery, The Chaim Sheba Medical Center, Tel Hashomer, Israel.

⁴Professor of Surgery, Division of Oral and Maxillofacial Surgery, University of Miami School of Medicine, Miami, Florida.

Reprint requests: Dr Arun K. Garg, 6633 Roxbury Lane, Miami Beach, FL 33141. Fax: 305-865-1148.



Figs 1a and 1b Technique involving the use of 2 osteotomies; one in the posterior edentulous area and the other around the mental foramen.

mandible using the simultaneous placement approach. Each implant was cylindrical type and hydroxyapatite-coated, measuring 15 mm in length and 3.25 mm in diameter. Follow-up after loading ranged from 16 to 46 months (mean 29.8 ± 10 months). The effects on neurosensory dysfunction were evaluated using the pin-prick sensation test.

Surgical Procedure

The preoperative work-up included an assessment of the inferior alveolar nerve using appropriate diagnostic records, such as a panoramic radiograph, a computed tomography (CT) scan, casts, diagnostic wax-up, and surgical templates. During preoperative consultation with the patient, the risk of postoperative neurosensory disturbances that can result following the inferior alveolar nerve repositioning was discussed. This possibility gives many patients pause to consider ramifications of the procedure. To help the patient decide whether this would be tolerable, the clinician can perform a preoperative block with a long-acting local anesthetic, such as Marcaine (Abbott Laboratories, North Chicago, IL), which reproduces symptoms lasting 8 to 16 hours that are similar to the postoperative anesthesia the patient may experience.

To begin the actual repositioning procedure, local anesthesia was obtained by infiltrating xylocaine 2% containing 1:100,000 epinephrine. Intravenous sedation is recommended because of the procedure's technique-sensitive nature and the need for patient cooperation.⁷

A crestal incision with anterior- and posterior-releasing incisions was made, and a labial mucoperiosteal flap was reflected, exposing the alveolar ridge and buccal cortex. The incision should extend at least 1 cm beyond the anticipated site of the osteotomy. Care was taken during flap reflection to preserve the integrity of the periosteum and the

neurovascular bundle where it exits the mental foramen and enters the soft tissue. To increase flap relaxation and improve exposure, dissection was performed below the neurovascular bundle where it exits the mental foramen.⁷ CT was used to locate the approximate area of the mental foramen, after which blunt dissection was used to identify and isolate the mental nerve. A headlamp for lighting and visibility as well as 2 surgical assistants to provide nerve retraction were optimal for this procedure.

In the area that is 2 to 3 cm posterior to the mental foramen, a 702-bur was used to create a rectangular osteotomy. A second circumferential osteotomy around the mental foramen was then created. The posterior osteotomy should extend 1 to 2 cm posteriorly beyond the intended position of the most distal implant. This allows for passive positioning of the neurovascular bundle after implant placement. A small curved osteotome was then used to carefully remove the posterior rectangular segment of the mandibular cortical bone overlying the inferior alveolar nerve. Next, the anterior round segment of mandibular cortical bone, which included the mental foramen, was gently lifted. Small curettes were used to carefully remove the medullary bone lateral to the neurovascular bundle along the entire length of the bony window. It is important to remove all sharp edges of bone and any cancellous spicules along the window that could lacerate the neurovascular bundle.

After the neurovascular bundle has been identified, it was carefully "teased" from the inferior alveolar canal using a nerve retractor and small curettes. These instruments should be blunt, and new instruments can be altered in the laboratory to reduce the possibility of traumatizing the neurovascular bundle. If possible, the retraction instruments should be left in place during the procedure because repeatedly introducing and retracting the instruments increases the risk of trauma to the neurovascular bundle (Figs 2a and 2b).



Fig 3 DFDBA is placed after implants are placed and before replacing the nerve.



Figs 2a and 2b Posterior window has been removed. Anterior window along with the nerve has been lateralized and implants placed.



Fig 4 Particulate graft placed and collagen membrane placed lateral to nerve.

While the neurovascular bundle was retracted laterally, the endosseous implants were placed using standard techniques. Note that cylindrical nonthreaded implants are recommended as threaded implants in close contact with the nerve may cause neurosensory problems.^{3,8-10} Paralleling pins were used to assess the final implant location. The paralleling pins were removed while the nerve retractor held the repositioned nerve in place. The implants were then placed medial to the inferior alveolar nerve. After implant placement, demineralized freeze dried bone allograft (DFDBA) was placed between the implant and the nerve to avoid any direct contact between the two (Fig 3). A collagen membrane was placed lateral to the nerve (Fig 4). In situations involving a narrow buccolingual width, the cortical plate is used for ridge augmentation and to cover any dehiscence on the buccal aspect of the implant. Releasing horizontal incisions were made in the periosteum to enable a tension-free closure. It is important to document the new location of the neurovascular bundle in the medical record in case any future surgical intervention is required.

Postoperative follow-up in this study included radiographic examinations and assessment of inferior alveolar nerve function using the pin-prick sensation test (Fig 5). To allow an adequate amount of time for osseointegration, stage-II surgery was performed after 6 to 8 months.

RESULTS

Of the 10 patients who underwent repositioning of the inferior alveolar nerve, 4 experienced sensory recovery immediately after the local anesthesia. Six patients had hypoesthesia immediately after the procedure. Five of these patients experienced a total return of sensation within 3 to 4 weeks. One patient did not experience complete recovery until week 6. None of the patients experienced permanent sensory damage. All implants were stable at second-stage surgery and were found to be clinically osseointegrated (Table 1).

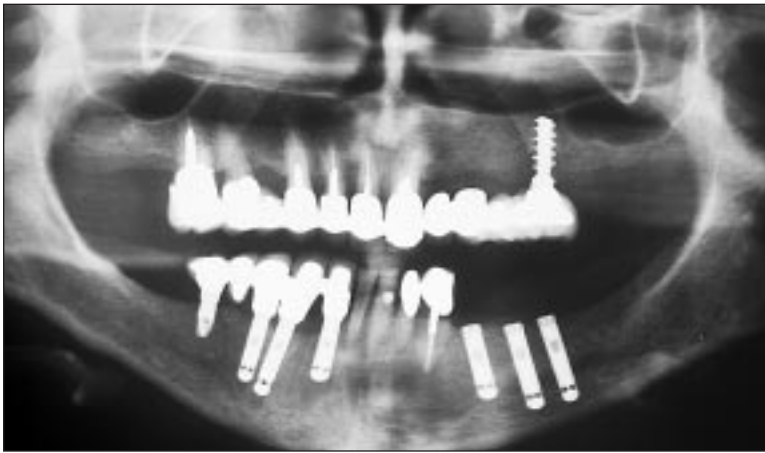


Fig 5 Panoramic view of implants in place.

Table 1 Patient Data

Patient	Age	Sex	No. of implants	Follow-up after loading (mo)
1	55	F	3	28
2	55	F	2	28
3	57	F	3	16
4	60	F	2	34
5	60	F	2	16
6	63	F	2	24
7	48	F	2	38
8	51	M	3	46
9	67	M	2	40
10	45	F	2	28

DISCUSSION

Attempting to place implants lingual, superior, or anterior to the neurovascular bundle in severely resorbed posterior mandibles is complicated, requires extensive radiographic examinations, and carries a high risk of trauma to the nerve.^{1,5} In certain situations, an implant placed anterior to the mental foramen can come in contact with the incisive branch of the nerve, thus stretching the main nerve and interfering with the vascular supply. When nerve injury occurs while placing an implant (without nerve exposure), the consequences can include canal deformation, nerve compression with or without bleeding into the canal, and direct mechanical damage. Bleeding into the canal can result in the formation of a hematoma or compartment syndrome.¹¹

Inferior alveolar nerve repositioning, performed by a skilled surgeon, is a useful procedure for providing the additional bone needed for optimal

implant anchorage in these situations while reducing the risk of nerve damage or transection.¹²

Generally, the literature describes 2 basic nerve transposition techniques and variations thereof. With “true” transposition, an anterior osteotomy is created, and the nerve is released from the mental foramen and replaced distally.⁴⁻⁶ The technique involves extending the medial edge of the osteotomy medial to the mental foramen and removing the outer cortex in 1 piece. This creates a large bone segment that is difficult to manipulate and that has its axis of rotation within the mental nerve area. As a result, permanent mental nerve damage is a serious risk with this approach.

Lateralization of the nerve without engaging the mental foramen reportedly produces fewer side effects than nerve transposition.¹⁻³ Traditionally, the nerve is repositioned through a posterior cortical window. By manipulating only the thicker component of the bundle that lies within the inferior alveolar canal, as opposed to the smaller, more terminal nerve branches, postoperative neuropraxia and permanent nerve anesthesia and paresthesia may be reduced.¹³ With only a single window posterior to the mental foramen, however, an extensive amount of stretching is required to remove the nerve laterally to accommodate implant placement medial to it.

Creating 2 osteotomies, 1 in the anterior and 1 in the posterior as described herein, minimizes the chances for postoperative neuropraxia and nerve paresthesia or anesthesia. This is largely because of the decreased amount of stretching required to create a longer window. With only the posterior osteotomy, a greater degree of pressure and/or traction is placed on the neurovascular bundle during the nerve transpositioning. This increases the risk of insult to alpha sensory nerve fibers, which causes neurosensory disturbance.³ The duration and

degree or neurosensory disturbances following nerve transpositioning surgery have been directly linked to the amount of compression or tension applied to the nerve during the procedure.^{14,15} With only the anterior osteotomy, there is a higher risk of nerve damage because the nerve and bone are moved in 1 motion.

Some degree of neurosensory dysfunction appears to affect all patients who undergo inferior alveolar nerve transpositioning for simultaneous implant placement. Indeed, some authors suggest this altered sensation should be considered a natural sequela and not a complication of nerve transpositioning.^{2,14} In most cases, these disturbances appear to be minor and resolve spontaneously, and most patients interviewed postsurgery report satisfaction with the procedure, despite the discomfort level and duration.¹⁶

The main risk of nerve repositioning is prolonged or even permanent neurosensory dysfunction, such as hypoesthesia, paresthesia, and causalgia affecting the distribution of the inferior alveolar nerve.^{2,14} Approximately 1% to 3% of patients with only the posterior osteotomy experience prolonged, and sometimes permanent, neural dysfunction, which may be associated with a burning sensation.² When nerve injury occurs because of nerve impingement during drilling or implant placement, the dysesthesia may last longer or be permanent compared with an injury secondary to nerve repositioning. Nerve paresthesia can also potentially occur from direct contact between the inferior alveolar nerve and the sharp implant threads. Thus, cylindrical implants are recommended when performing this procedure.¹⁷⁻²⁰ In a recent study in dogs, Kahnberg and associates showed that a resorbable membrane used as a barrier cushion between the implant and nerve may also prove useful in protecting the nerve.²¹

Over time, the intensity and size of significant nerve disturbance may lessen; however, the amount of neurosensory regeneration that occurs is difficult to quantify. In addition to the patient's own awareness, light touch, brush stroke direction, and 2-point discrimination tests can be used to record the qualitative character of the neurosensory dysfunction. Other more objective tools for assessing nerve injuries during and after surgery are also available.^{16,22}

It is also important to note that the use of CT scans may be crucial for these nerve repositioning operations to accurately locate the mandibular canal.^{17,18} Conventional panoramic radiographs show the distance from the crest of the ridge to the nerve, but often do not allow adequate visualization of the canal. Thus, clinicians may select shorter than ideal implants, increasing the risk of implant failure in the posterior mandible.¹⁹

Bone quality in the mandible and nerve location can also be better assessed with a CT scan. In some cases, the mandibular medullary cavity contains a large amount of dense bone in which the nerve canal will appear as a well-circumscribed lucent channel. In many cases, the medullary bone is less dense and appears on CT as a distinct bony margin surrounding the nerve with a dark fatty marrow cavity between. If patients have severe bone loss or osteoporosis, the residual bone matrix may be too small to see in a CT image. In turn, the nerve may be well-visualized in some cross-sections and absent in others. Nonetheless, it may still be possible to obtain important anatomic information with the CT scan. Because of the predictable downward slope of the inferior alveolar nerve, some authors suggest a line may be drawn connecting the top of the nerve canal on a series of CT scans that span the zones in which the canal cannot be seen. The nerve must lie on a plane below this line. Although one cannot predict the buccolingual position of the inferior alveolar nerve within a particular arch, the CT scan will show the nerve's buccolingual position in oblique cross-sections at 2 mm intervals.¹⁹

If manipulation of the inferior alveolar nerve is minimal and traction of the nerve is less than 5%, normal nerve function should return within 4 to 6 weeks.²⁰ However, this can be minimized further by the described modified technique, whereby 2 osteotomies are created. A study by Kan and coworkers³ found that when the mental nerve was released from the mental foramen (entire osteotomy in 1 piece), the incidence of neurosensory disturbance was 77.8%. With only the posterior osteotomy, the incidence of neurosensory disturbance was 33.3%. In the present study involving a technique in which 2 osteotomies were created—1 anterior, including the mental foramen, and a second posteriorly—the overall incidence of transitional neurosensory disturbance was less than 8%. This is likely attributable to the fact that this technique involved first moving a large bone block and then the mental foramen and a small bone block. There was no movement of large bone block and mental foramen in 1 motion. No permanent damage was seen in this patient population.

CONCLUSION

When there is moderate-to-severe bone resorption of the mandible posterior to the mental foramen, repositioning the inferior alveolar nerve using both an anterior and posterior osteotomy allows for more bone to accommodate ideal placement and greater length of the implant. It also minimizes the risk of

nerve paresthesia and inadvertent nerve transection or compression by minimizing the amount of nerve stretching necessary and avoiding 1 movement of a large bone block and the mental foramen. CT scans are necessary to accurately locate the mandibular canal before undertaking nerve repositioning for implant placement, and it is important that only well-experienced surgeons perform this surgery. In this study, postsurgical neurosensory disruption using the described technique was notably minimal.

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