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NEUROSENSORY FUNCTION AFTER LATERALIZATION OF THE INFERIOR ALVEOLAR NERVE AND SIMULTANEOUS INSERTION OF IMPLANTS

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New methods were developed in 1987 by Sailer to allow the insertion of endosseous titanium implants in severely atrophic jaws.[15–17] Insertion of implants distal to the mental foramina is often impossible because of insufficient bone height cranial to the inferior alveolar nerve. The lateralization of the nerve via a buccal approach enables the use of the total mandibular height for implant insertion. In cases of extreme atrophy, the mandibular height can be augmented by performance of a sandwich osteotomy after lateralization of the nerve. In addition to the benefit of implant placement in the posterior mandibular area, considerable improvement of the alveolar profile is obtained in case of remaining dentition in the interforaminal area, because the denivellation of the alveolar ridge distal to the shortened dental arch is corrected.

This article describes the surgical technique and presents the long-term effects of the lateralization on the function of the inferior alveolar nerve.

MATERIAL AND METHODS

Between 1988 and 1992, lateralization of the inferior alveolar nerve or posterior sandwich procedures, or both, have been performed on 28 patients. Fifteen of them had undergone previous surgical procedures in the area of the inferior alveolar nerve (cystectomy, tumor removal, decortication, partial mandibular resection, osteosynthesis) and were therefore not included in this study. This study concerns 9 of 13 patients who had not yet been operated on (except for extractions and wisdom tooth removal), with an undisturbed function of the inferior alveolar nerve and who were available for late follow-up. There were 7 female and 2 male patients, aged between 30 and 65 years. One patient underwent a unilateral procedure, and 8 patients a bilateral procedure. Lateralization was performed in all cases, and posterior sandwich operations were performed on nine sides. Every procedure was combined with the simultaneous insertion of cylindric titanium implants (40 implants). The implants used were osseointegrated Brånemark implants with a well-documented long-term success-rate.[1] In all cases the procedure was performed under general anesthesia with antibiotic coverage (clindamycin).

Follow-up ranged from 12 to 36 months,

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with an average of 18. The patients were examined preoperatively; 1 week and 6 and 12 months postoperatively; and at the end of the observation period. Each time, neurosensivity was examined by static light touch with a cotton wisp, brush directional stroke, sharp-blunt discrimination, and thermal discrimination.[7] Subjective testing consisted of the patient's description of neurosensivity, both spontaneously and actively, and the patient's judgment concerning the acceptance of possible neurosensory alterations. Neurosensory testing using somatosensory evoked potentials was not used.

Surgical Technique

Lateralization of the Inferior Alveolar Nerve (Fig. 1A and B)

After completion of the incision along the remaining fixed gingiva and raising of a mu-

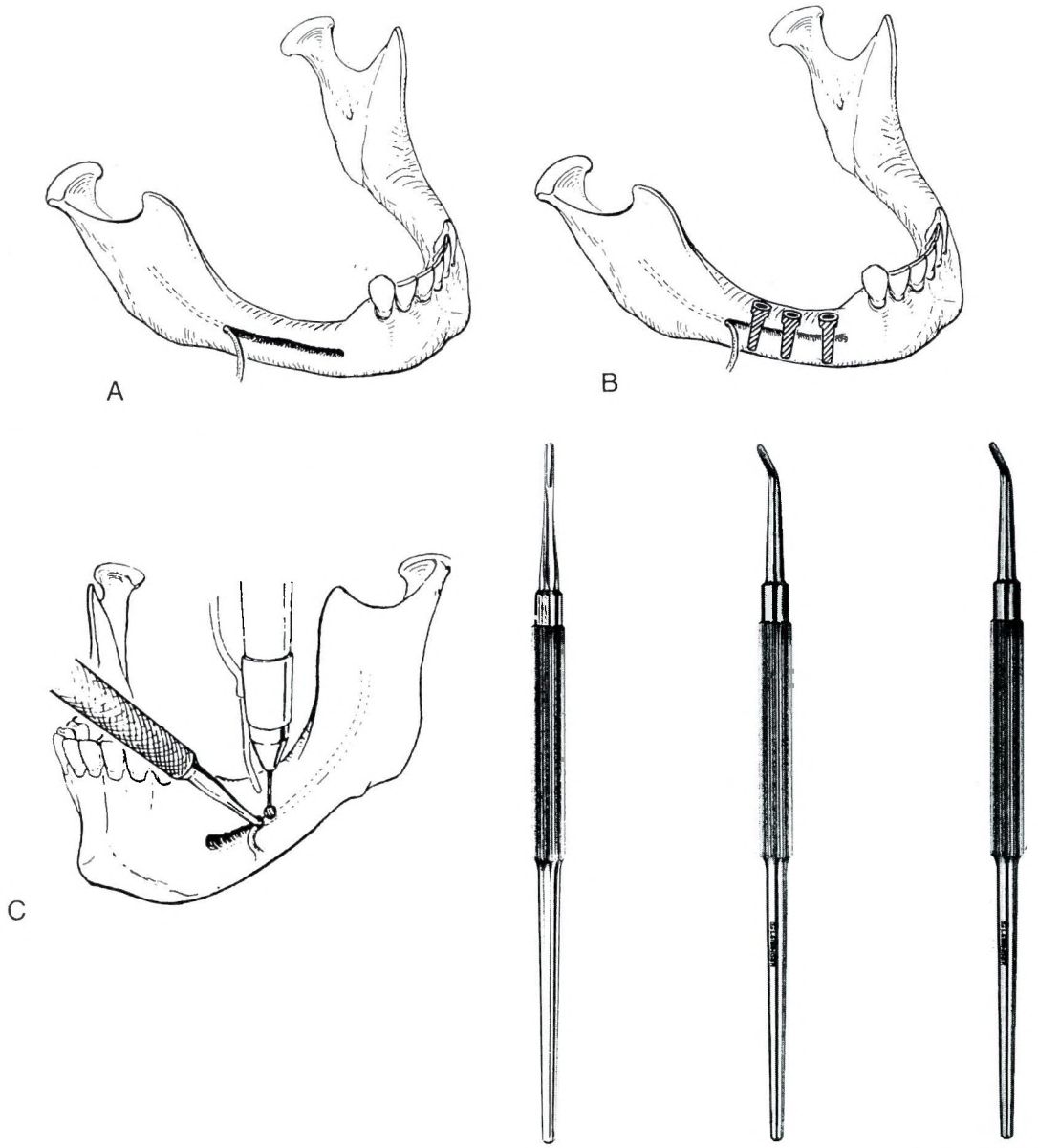


Figure 1. *A,* Lateralization of the inferior alveolar nerve. *B,* After insertion of the implants. *C,* Specially developed nerve retractors that fit in the mandibular canal.

coperiosteal flap, the mental nerve is visualized. Special care is given to ensure atraumatic handling of the nerve. For this purpose, nerve protectors with different angulations were developed to enter the mandibular canal and cover the nerve while the buccal bone is removed with a drill (Fig. 1C). The nerve is freed from the mental foramen, and the incisor branch is cut systematically to prevent traction on the nerve during lateralization. The nerve protector fits into the inferior alveolar canal and is inserted on the lateral aspect of the nerve and slid along the canal as further bone from the buccal cortex of the canal is removed. Care should be taken to leave as much bone as possible, especially in the inferior part of the mandible and at the lower border (Fig. 2). During lateralization, the nerve is freed only as far posteriorly as necessary to create enough space for the insertion of the planned number of implants. Longer implants with anchorage in the inferior border cortex can then be inserted (Fig. 2*B*). The mandibular canal is filled with bone chips and bone morphogenetic protein paste to prevent fibrotic scar tissue from covering the implant surface in that area. Six months postoperatively, the abutment procedure is performed (Figs. 3 and 4).

The Posterior Mandibular Sandwich Operation (Fig. 5)

First, the nerve is lateralized as previously described. Subsequently, the posterior sandwich is created by coronal splitting of the mandible at the level of the mandibular canal or below (Fig. 6*A*). The cranial part is pedicled on the soft tissues of the floor of the mouth, including the mylohyoid muscle. After superior repositioning to the planned level, which is usually dictated by the presence of the remaining anterior dentition, a bone graft is interpositioned and the completed sandwich is immobilized with the specially designed clamp before the implants are inserted (Fig. 6*B*). The interposition grafts used are lyophilized sternum, autogenous iliac crest, and calvarium. The abutment procedure is carried out 6 months postoperatively (Fig. 7).

RESULTS

Seventeen inferior alveolar nerves were lateralized as far as needed to insert the implants. Forty implants were inserted in 17 sides. On average, the nerve was lateralized over a length of 25 mm, with a minimum of 18 mm and a maximum of 38 mm. There was no accidental transection of the nerves involved. One week postoperatively, anesthesia was noted on one side. Thermal discrimination and intact sharp-blunt discrimination were present in all other sides but one. Reaction to static light touch was absent in 7 sides and two-point discrimination was superior to 20 mm on 5 sides.

Six months postoperatively, sharp-blunt discrimination, direction, and thermal discrimination were present on all sides but one. Static light touch was not noticed in this and 2 other sides. Two-point discrimination was



Figure 2. Clinical view of the procedure. The nerve has been lateralized only as far as is needed for implant insertion.

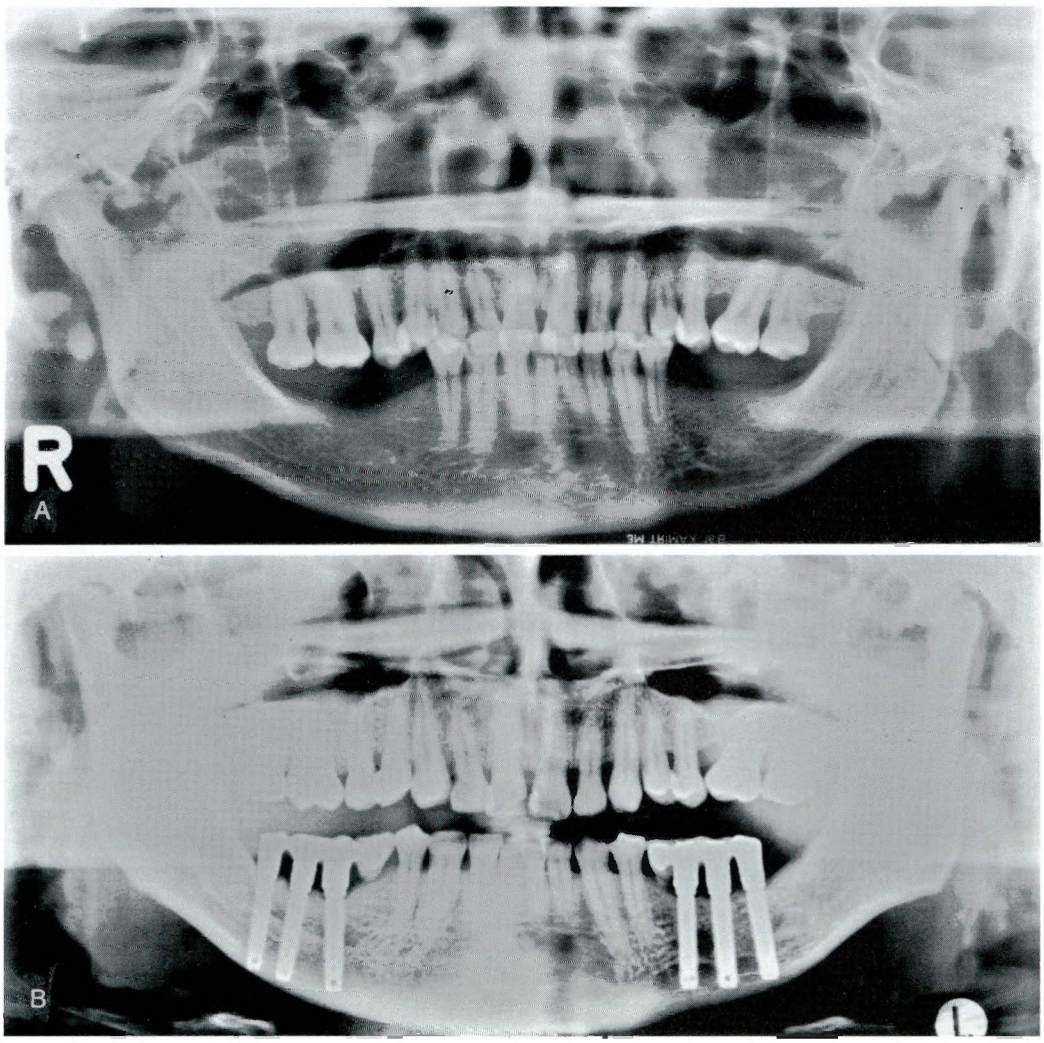


Figure 3. *A*, Preoperative panoramic radiograph showing reduced bone height cranial to the mandibular canal. *B*, View 3 years postoperatively.

inferior to 14 mm on 12 sides, between 15 and 20 mm on 2 sides, and superior to 20 mm on 3 sides. The 3 cases of neurosensory disturbance occurred twice after a posterior sandwich procedure with simultaneous insertion of three implants and once with two implants. The latter patient suffered from painful dysesthesia during the first 6 postoperative months after a posterior sandwich procedure had been performed, but it disappeared after scar removal during the abutment procedure. Another patient complained about hyperesthesia when the soft tissues covering the area where the inferior alveolar nerve leaves the mandible were touched. One year postoperatively, the results of objective neurosensory tests were normal on all sides, and two-point discrimination was inferior to 14 mm on all sides; however, subjective appreciation of the sensibility still revealed light paresthesia on 13 of 17 sides.

At the end of the follow-up, subjective appreciation of the neurosensitivity was normal in 4 sides. Four patients mentioned paresthesia that disturbed them occasionally on 6 sides. One of these patients mentioned that the occasional hyperesthesia caused by touch to a specific trigger point had decreased in intensity and the area was no longer painful. In this patient, results of all objective tests performed were normal. The sensitivity in the remaining 7 sides was described by the pa-

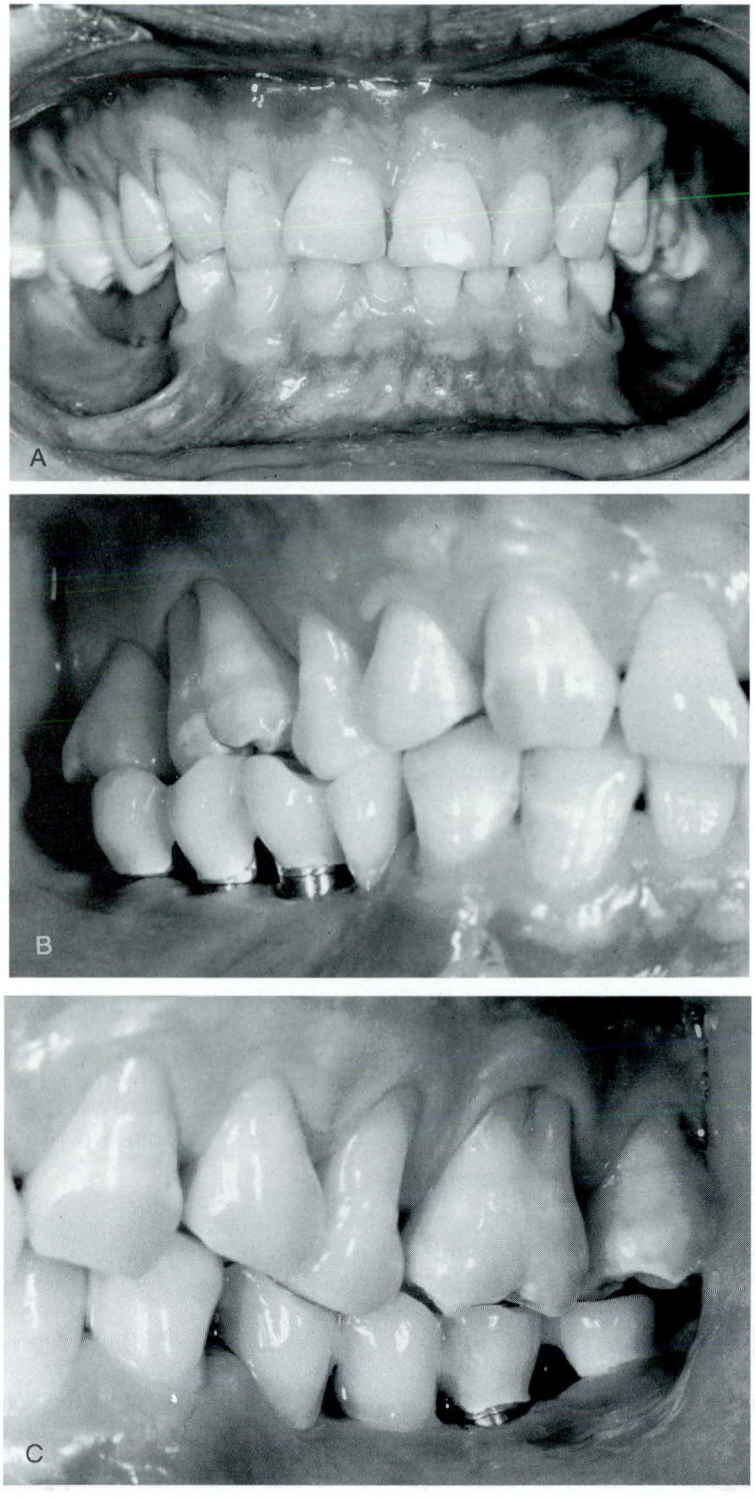


Figure 4. *A*, Preoperative oral view of the free-end situation. *B* and *C*, Views 3 years postoperatively of the implant-supported fixed devices.

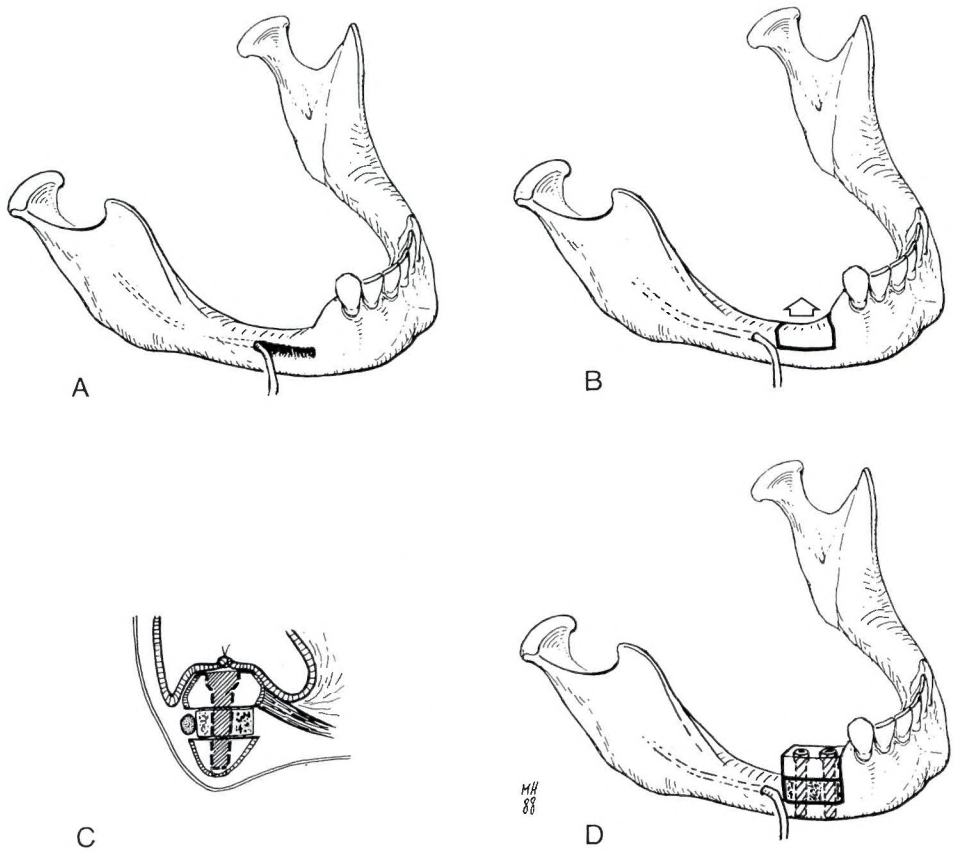


Figure 5. Schematic drawing of the posterior sandwich technique. *A*, Lateralization of the inferior alveolar nerve. *B*, Osteotomy of the cranial part of the mandible, which is pedicled to the lingual soft tissues and musculature *(C)*. *C* and *D*, A sandwich osteotomy with interpositioned bone graft has been performed and is held together by the implants.

tients as almost normal although with a different character from preoperatively. In no case was permanent anesthesia or severe dysesthesia evolving toward a chronic pain syndrome present.

DISCUSSION

Lateral repositioning of the inferior alveolar bundle has been described already in combination with subapical and body osteotomies of the mandible[11] as well as in extremely atrophic mandibles to prevent impingement of the mental nerve by dentures or subperiosteal implants.[2]

The procedure presented by Sailer at the International Congress on Preprosthetic Surgery in 1989 and published in 1991 was developed to insert implants of maximal length distally to the mental foramen and is characterized by the specially designed nerve protectors and the length of the lateralization, which may extend to the third-molar area.[16,17]

This procedure is indicated when implants distal to the mental foramen are necessary to support fixed devices. In severe atrophy, even the insertion of the shortest implants (7 mm) is impossible. Moreover, a prospective multicenter study on 558 Brånemark implants in partial edentulism clearly demonstrated that the prognosis of short osseointegrated implants, varying in length between 7 and 13 mm, is significantly inferior to the prognosis of longer implants.[16] Therefore, an additional posterior sandwich procedure may be indicated to enable the insertion of 18 or 20 mm implants with anchorage in the inferior cortex.

The time needed to lateralize the nerve is variable. The procedure is more delicate and time consuming as the length of the nerve to

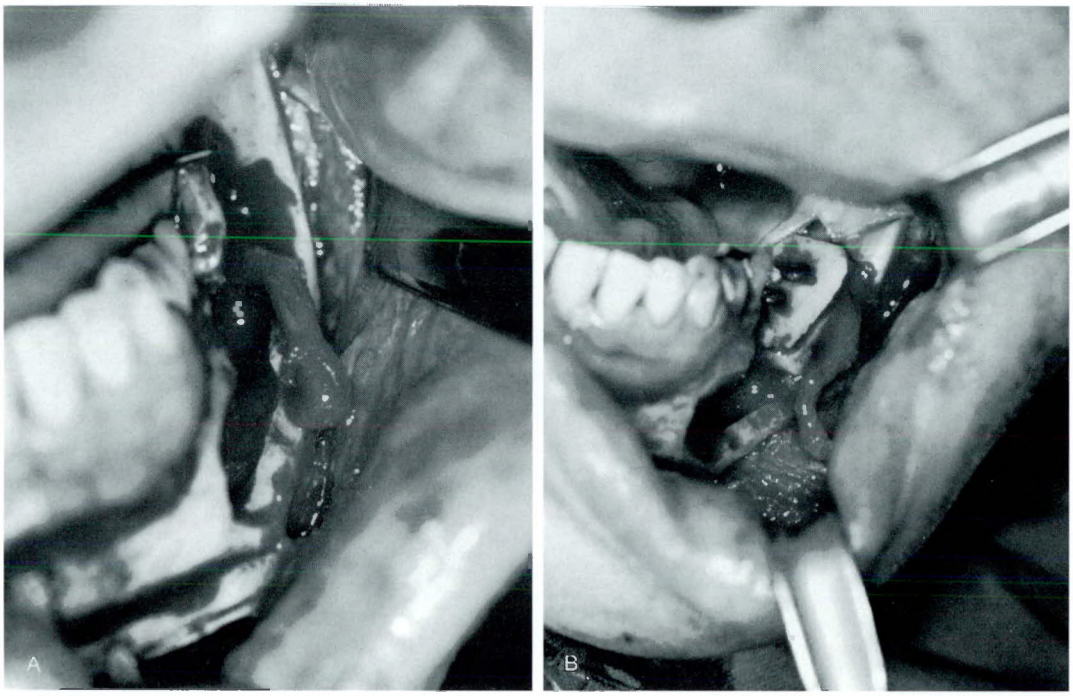


Figure 6. *A*, After lateralization and sandwich osteotomy, the lingually pedicled cranial part of the mandible is lifted. *B*, An iliac crest graft is interpositioned, and the implants are inserted.

be mobilized and the lesser diameter of the nerve increase. Although the nerve protectors seem to be efficient in that there was no accidental nerve transection, temporary objective and permanent subjective sensory alterations occurred, probably because of minor lesions caused by the mobilization and stretching of the nerve after it was freed from the mandibular canal. Moreover, according to Nishioka et al,[12] increased age is associated with an increased risk of neurosensory disturbance after sagittal splitting of the mandible. Because most of the patients were older than 50 years, this age factor must surely play a role.

A similar procedure was presented by Rosenquist[14] in 1991 and by others in 1992.[6] The preparation also starts at the mental foramen, the incisor branch is cut likewise, and the buccal cortex is removed en bloc without the use of special nerve protectors. The author examined nerve morbidity by determining the two-point discrimation and noted a normal response in 2 of the 10 sides immediately postoperatively and on all sides 1 year postoperatively[14]; however, he does not mention whether subjective changes did occur. An alternative method for repositioning of the inferior alveolar nerve, in which a decortication is performed with removal of a rectangular window in the cortical bone posterior to the mental foramen and simultaneous implant insertion, was described by Smiler.[18] He reports results from 10 sides and mentions that temporary neurapraxia occurred on 3 sides. A case report presenting a similar technique without manipulation of the immediate surrounding of the mental foramen was reported some years earlier.[9]

Other authors report severe permanent neurosensory dysfunction after lateralization of the inferior alveolar nerve and have a more reluctant attitude toward the procedure.[3, 5] Ehrenfeld et al[5] report that all 13 patients in their series complained of persistent subjective sensibility disturbances on all 19 sides involved after lateralization; however, in their series, lateralization was done for implant reasons in only 2 patients and for various reasons in all others, so comparison of the results is difficult. Bailey and Bays[3] report long-term sensory changes after mandibular augmentation procedures in 12 patients, with lateralization in 10 of them, and concluded that procedures requiring repositioning of the inferior

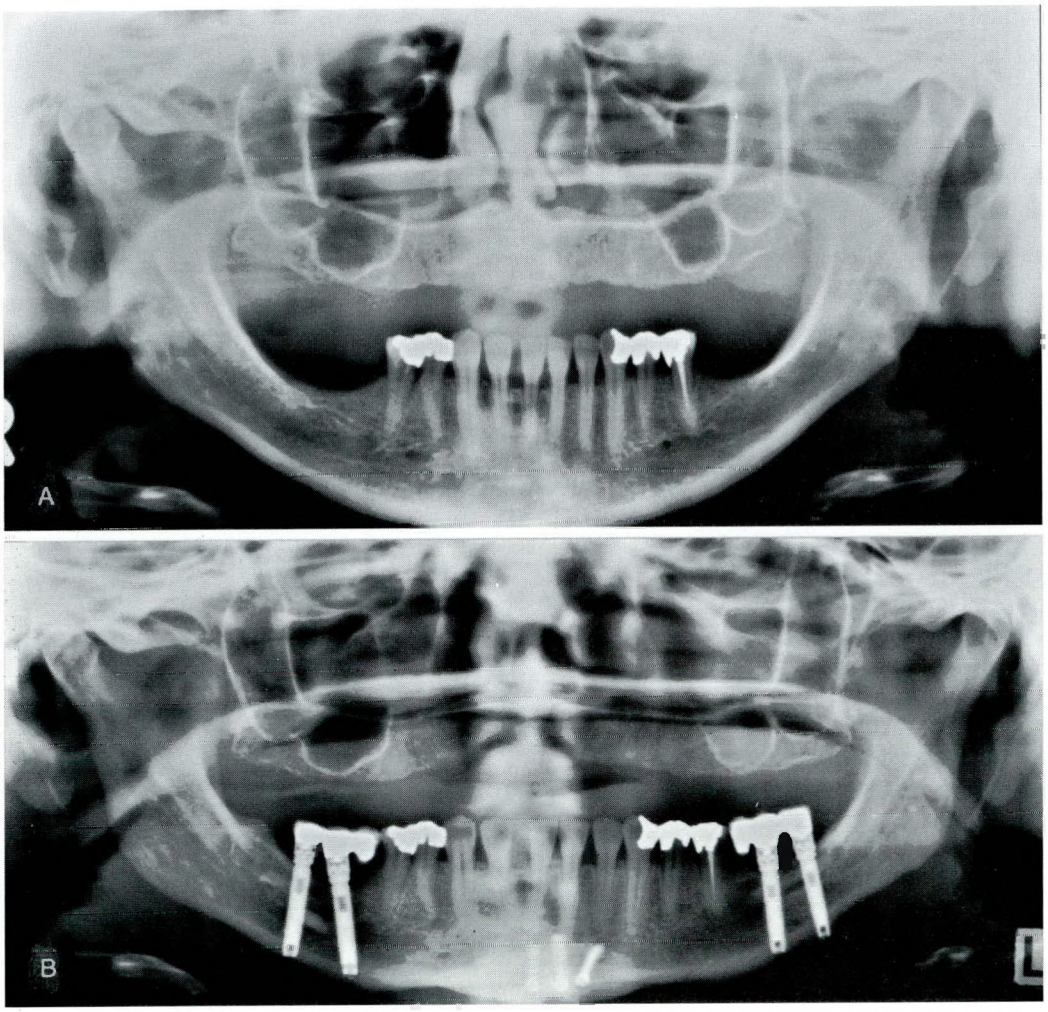


Figure 7. Preoperative *(A)* and postoperative *(B)* panoramic radiographs. Chin bone for interpositioning was harvested when a vertical reduction genioplasty was performed.

alveolar neurovascular bundle lead to permanent subjective and objective neurosensory alteration. Little correlation was found between the area objectively tested as abnormal and those subjectively mapped as altered, and the level of subjective complaint was disproportionately higher than the objectively tested level of deficit.[3] This finding is confirmed in our study in that even mild subjective alterations are detectable at the end of the follow-up period, whereas the objective tests reveal normal findings. A report about 25 transpositions of the mental nerve in association with subapical osteotomies in 16 patients also revealed a high incidence of dysesthesia immediately postoperatively.[11] The nerve was lateralized from the mental foramen until the area of the first-molar root tips, during which tearing of part of the nerve occurred three times. In the immediate postoperative period, hypesthesia was found in 16 mental regions, total anesthesia in 3 regions, and paresthesia on 4 sides. At 18 months, 15 mental regions in 8 patients examined showed normal sensitivity, but there was remaining paresthesia in 1 region.

To give a correct interpretation of the results concerning the function of the mandibular and mental nerves after lateralization, a comparison should be made with other preprosthetic and orthognatic procedures in the mandible without transposition of the inferior alveolar nerve but in which impairment of the neurosensitivity can occur.

In a follow-up study of 2 to 5 years in 92 patients who underwent augmentation of the severely resorbed mandible using corticocancellous bone grafts in the symphysis and an onlay augmentation with hydroxyapatite in the posterior mandible, slight sensory disturbance was seen in 19 patients (21%) at the end of the observation period; however, the importance of this side effect on the overall appreciation by the patients in this study appeared to be minimal.[8] Therefore, the question arises: to what extent are patients disturbed by paresthesia and/or minimal qualitative change of sensibility? Likewise, different reports about long-term neurosensory disturbances after sagittal splitting of the mandible reveal an incidence of sensory alterations between 7% and 52%.[4, 12, 13, 20] In some cases sensory alterations were described as following sagittal splitting of the mandible during which the nerve had not been exposed. This finding means that stretching of the nerve due to mandibular advancement is responsible for the functional disorders and that the occurrence of neurapraxia and axonotmesis is inherent to any direct or indirect manipulation of the nerve during all types of mandibular surgery. This phenomenon also probably explains the remaining qualitative alterations noted in our series at the end of the obseration period. Neurosensory testing with somatosensory evoked potentials is probably capable of illustrating the effects of these lesions but is not very relevant for patient and surgeon because there are indications that this examination is sensitive to subclinical neurosensory disturbances.[10]

Most authors cited conclude that the final incidence, as well as the patient's perception of functional nerve disturbances, is such that the surgeon should not be deterred from performing standard orthognathic and preprosthetic procedures. Although lateralization of the inferior alveolar nerve over a longer distance augments the risk of neural lesions, careful handling of the nerve with specific nerve protectors did not lead to a significant increase in neurosensory disturbances in our series in comparison with the standard procedures mentioned, nor did it cause permanent anesthesia or permanent hyperesthesia. Therefore, this procedure can be recommended when implant insertion in the posterior mandible is indicated; however, painful dysesthesia and hyperesthesia, as well as accidental transection of the inferior alveolar nerve with ensuing anastomosis, can never be excluded. Therefore, the use of this procedure should be restricted to experienced maxillofacial surgeons, and appropriate preoperative patient information by the surgeon is mandatory.

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