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Repositioning of Inferior Alveolar Nerve, Literature Review

Ahmed Wallan AlAhmary, Assistant Professor, Department of Oral & Maxillofacial Surgery, Al Farabi Colleges of Dentistry and Nursing, Riyadh, Saudi Arabia.

Corresponding author: Ahmed Wallan Al Ahmary, Assistant Professor, Department of Oral & Maxillofacial Surgery, AlFarabi Colleges of Dentistry andNursing, Riyadh, Saudi Arabia.

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Abstract

Bone resorption in the edentulous posterior mandibular region can result in a higher position of inferior alveolar canal with its contents, which represents a challenge for the installation of dental implants in this region. Several alternative treatments were suggested, as the use of short dental implants, appositional bone grafting, distraction osteogenesis, and reposition of inferior alveolar nerve. This objective of this article was to clarify and give a comprehensive review of the indications, contraindications, surgical techniques of inferior alveolar nerve transposition, and lateralization, with possible postoperative complications. It was concluded that both techniques have a high success rate; especially in lateralization one; when precise preoperative planning and very accurate surgical procedure were applied.

Keywords: Inferior alveolar nerve, Repositioning, Lateralization, Transposition, Dental implant.

Introduction: Early loss of mandibular posterior teeth without replacement of the lost teeth and the subsequent physiological changes in the bone may result in progressive resorption of the alveolar ridge in this region. Many treatment strategies are available for the management of patients with atrophied posterior mandibular bone [1]. Such strategies can include the use of removable or fixed prosthetic appliances or the use of dental implants [2]. These treatment methods may necessitate the use of bone augmentation techniques using bone grafts, hydroxyapatite, vestibuloplasty, or the use of several osteotomies' techniques[3]. As the alveolar ridge resorption progress especially in a vertical manner, the inferior alveolar nerve becomes more superficial, demanding the use of techniques that compensate for the deficiency in bone height like guided bone regeneration, onlay bone grafting, distraction osteogenesis. All these techniques may require the use of short dental implants and inferior alveola nerve repositioning. Repositioning of IAN has been widely described in the literature, Becker (1970) [4] reported three out of four successful lateralization procedures for IAN during mandibular

resection. In 1977, Alling [5] reported on the repositioning of the inferior alveolar nerve to rehabilitate patients with severe atrophy for dentures, Jenson, and Nock in 1987 carried out IAN repositioning for placement of dental implants in posterior mandibular regions [6]. In 1992, Rosenquist [7] performed the first case series study on 10 patients using 26 implants, with an implant survival rate of 96%. In this review, it was aimed to give a comprehensive review of this technique, and its implications.

Anatomy of the inferior alveolar nerve: The inferior alveolar nerve (IAN) is a branch of the mandibular nerve (V3) which is itself the third branch of the cranial nerve V (Figure 1). It runs downward on the medial aspect of the internal pterygoid muscle and passes in-between the sphenomandibular ligament and the mandibular ramus entering through the mandibular foramen into the inferior alveolar canal innervating the teeth posterior to the mental foramen. At the mental foramen, the IAN divides into two branches namely the incisal and mental nerves. The incisal nerve is often described as the extension of the IAN innervating mandibular canines and incisors by passing through the bone [8].

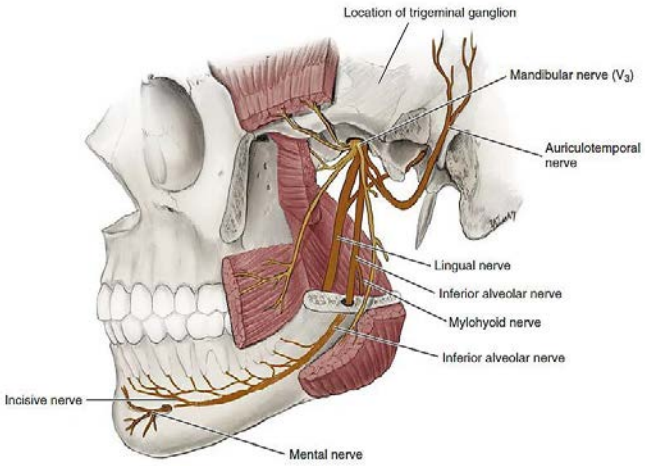

Figure 1: The pathway of the posterior trunk of the mandibular nerve.

According to Kieser et.al [9], the IAN is branched in the edentulous mandible in one of the four following patterns:

Type 1: Presence of one single trunk with no branching.

Type 2: Presence of a series of separate nerve branches (most common type).

Type 3: Presence of a molar plexus.

Type 4: Presence of proximal and distal plexuses.

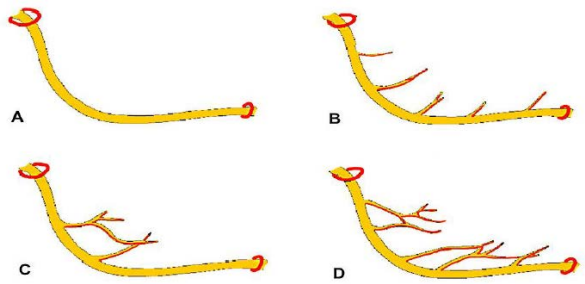

Figure 2: Branching patterns of the inferior alveolar nerve (classification by Kieser et al.): A– single unbranched nerve; B – series of individual branches to the superior border of the mandible; C – fine molar plexus; D – proximal and distal nerve plexus.

Lateralization vs Transposition of IAN

The purpose of both surgical procedures that reposition the IAN during implant placement without bone augmentation. Here, the buccal cortex surrounding the mandibular canal is removed to allow IAN repositioning [10]. Paresthesia, hypoesthesia, and anesthesia of the IAN are possible risks following these surgeries. In IAN lateralization, a lateral reflection of the IAN posterior to mental foramen, with preservation of the incisive nerve [11]. Exposure and traction are used to deflect the IAN laterally while the implants are placed. The IAN is then left to fall back in against the fixtures. While in the IAN transposition, a corticotomy is done around the mental foramen and the incisive nerve is severed to allow transposition of both the mental foramen and the IAN,

here the mental foramen will be moved more posteriorly [12], Figure 3.

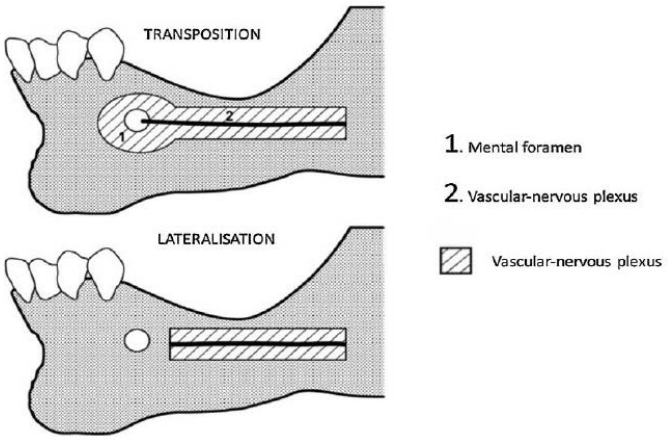

Figure 3: IAN Transposition Vs Lateralization Techniques

Indications & contraindications of IAN repositioning:

Referring to many studies [1, 13-15], these indications may be summarized:

1- Prevention of IAN injury in implant placement procedures (represent the most common indication).

2- In certain orthognathic surgeries, as in total mandibular subapical osteotomy.

3- In Preprosthetic surgery.

4- In repairing and anastomosis of injured IAN.

5- In severe atrophic mandible requiring implant therapy, with the residual bone above the mandibular canal vary between 0.5 & 1.5 mm.

6- When the bone height above the mandibular canal is less than 10 – 11 mm, and the spongy bone quality does not support sufficient stability for implant placement.

7- Class V or VI of Cawood and Howell with the presence of interforaminal teeth.

8- Class V or VI of Cawood and Howell if the patient desires a fast implant-prosthetic rehabilitation with predictable outcomes.

In the other hand, the following contraindications can be outlined [13, 16]:

1- Severe advanced resorption of the mandibular alveolar process.

2- Poor patient general health, with the presence of systemic diseases that will interfere with the patient's health condition following IAN repositioning.

3- Presence of surgical access limitation.

4- Patient's susceptibility to infection and bleeding.

5- Presence of thick cortical bone buccally and a thin neurovascular bundle.

6- Patient's unwillingness to tolerate numbness of the lower lip, or for the surgery in general.

Surgical procedures:

Repositioning procedures of IAN are either transposition or lateralization depending on the required amount of stretching needed to mobilize the IAN [10]. The first steps for surgery are unified for both techniques as following, the preoperative workup including patient assessment, radiographic examination using panoramic and CT views, diagnostic casts and wax-up, and surgical templates should be completed [13, 17]. The procedure should be discussed with the patient, exploring all possible postoperative neurosensory disturbances. And to allow the patient to sense the real feeling of anesthesia, an IAN block anesthesia using long-acting local anesthesia (8 – 16 hours), such as Marcaine, can be performed [10]. At the beginning of the surgery, both IAN block and local infiltration anesthesia are performed. Intravenous sedation may be required for more patient cooperation. A crestal incision with both anterior and posterior releasing incisions are made, followed by mucoperiosteal flap reflection to expose the alveolar ridge and buccal cortex. The incision line should extend about 1 cm beyond the expected surgical site. During flap reflection, care should be taken to prevent the damage of the neurovascular bundle emerging from the mental foramen and to preserve the periosteum integrity [13, 17, 18]. Dissection can be

applied below the mental neurovascular bundle, and in the buccal vestibule to improve exposure and flap relaxation. The approximate location of mental foramen can be guided through the use of CT. after this point in the surgery, it can be decided either to complete with lateralization or with transposition.

A- IAN Transposition

Here the mental foramen will be included with the osteotomy. Drilling is started using a round drill about 5 mm anterior to the foramen orifice to preserve the mental nerve over its anterior loop, then a posterior window is performed through the external cortical layer along the intrabony trajectory of the IAN (figures 4 & 5). When drilling is closer to the mandibula canal, the round drill is replaced by a diamond drill to reduce the risk of nerve damage. Another choice is the use of piezosurgery to minimize nerve damage [13, 17, 18].

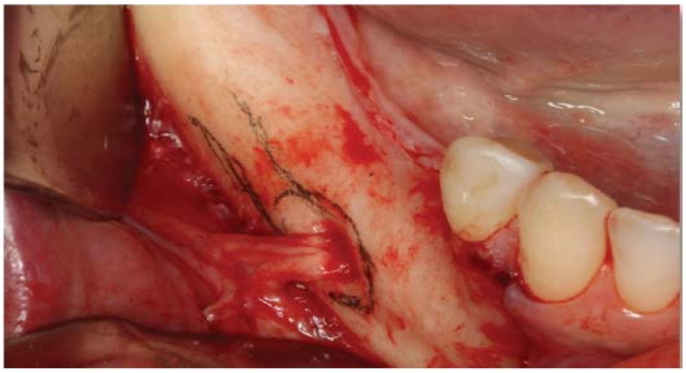

Figure 4:Outlining the mental foramen and mandibular canal. (courtesy of Pimentel AC et al.)

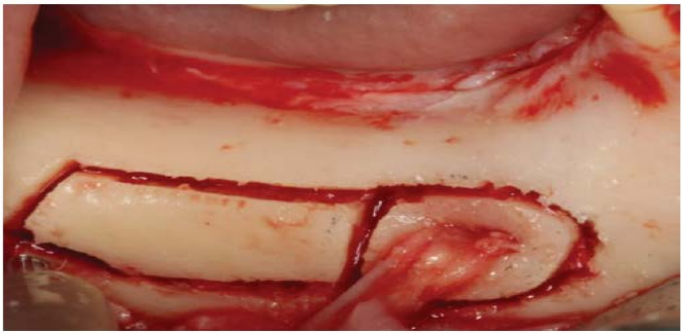

Figure 5: Osteotomy including the mental foramen and the mandibular canal. (courtesy of Pimentel AC et al.)

Now, the bone is removed around the nerve using round bur 700 or 701 with straight handpiece under copious normal saline irrigation or by the use of piezosurgery. To achieve complete and free mobilization of IAN, its incisive branch must be severed (Figure 6 & 7).

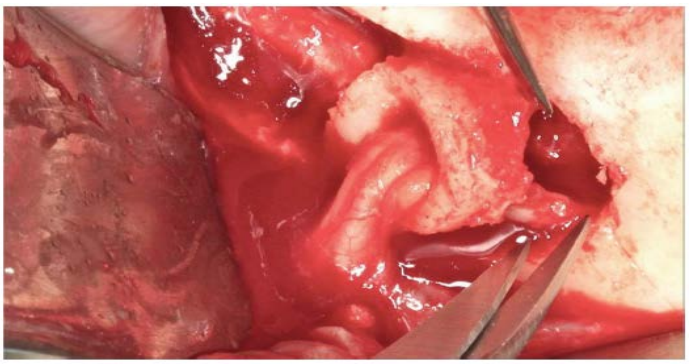

Figure 6: Sectioning of the incisive nerve. (courtesy of Pimentel AC et al.)

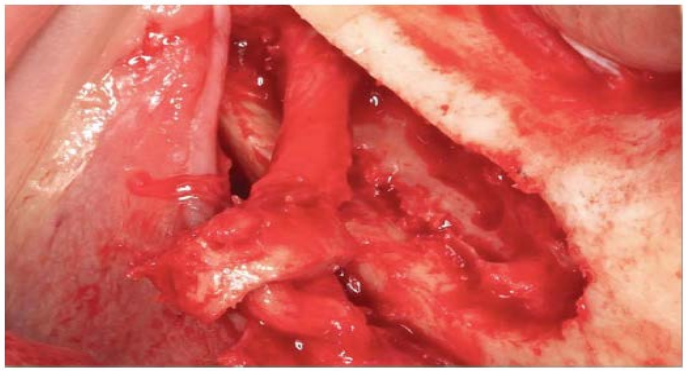

Figure 7: Mental foramen displacement. (courtesy of Pimentel AC et al.)

Following that, the IAN can be easily lateralized using a gauze band or elastic of 10 mm wide [19] to protect it from any damage during implant placement (Figure 8). The dental implants can be inserted under direct visualization, ensuring that the dental implants engage the basal bone (Figure 9) below the canal to achieve sufficient primary stability [1, 13].

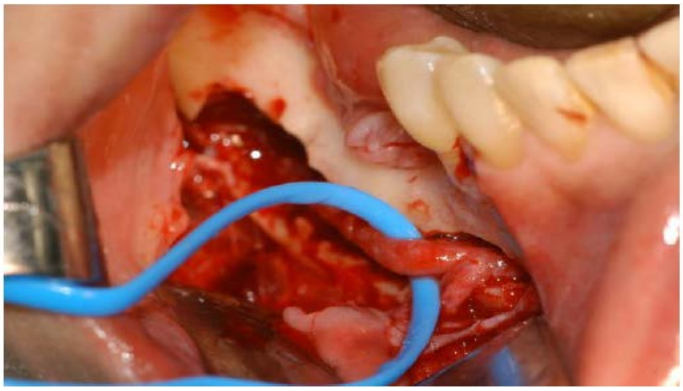

Figure 8: Vessel loop in place to retract the IAN. (courtesy of García-Ochoaet al.)

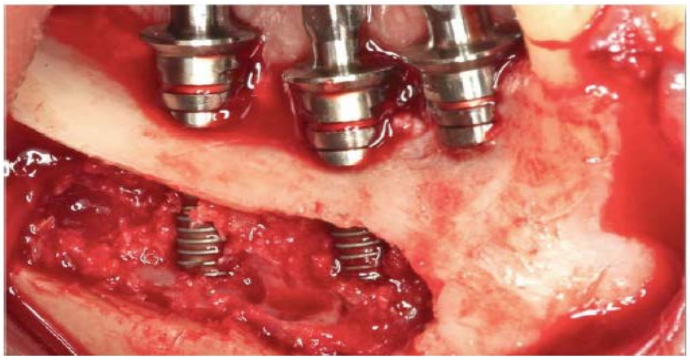

Figure 9: Implants in place reaching the basal bone. (courtesy of Pimentel AC et al.)

Before releasing the nerve from the retraction, an intermediate material; such as autogenous bone graft or a collagen membrane; is placed between the implants and the nerve to improve the contact area between the bone and implant, also the nerve will be in a slot between the implants medially and covered by the mucoperiosteal flap (Figure 10 & 11).

Figure 10:Filling of bone graft.(courtesy of Pimentel AC et al.)

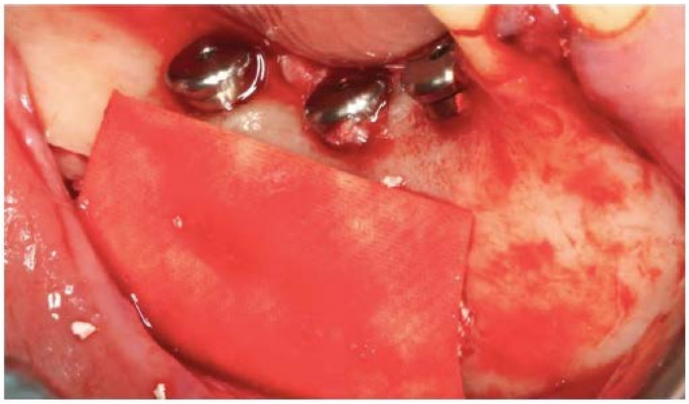

Figure 11: Placement of resorbable collagen membrane. (courtesy of Pimentel AC et al.)

Alternatively, the inferior alveolar neurovascular bundle may be left to lie passively outside of the mandibular canal. After that, the decision to submerge the dental implant using a cover screw or using a healing abutment for single-phase implant surgery should be made based on the condition of the surgical site, presence of an adequate amount of bone at alveolar crest and type of implant used [13]. Finally, the surgical wound is then sutured.

B- IAN Lateralization

In this technique, the terminal branches of the IAN will not be dissected, as the incisive branch will not be severed as in the transposition technique. A cortical bony window will be established just posterior to the mental foramen [13, 20]. Round bur number 700 or 701 mounted on a straight handpiece will be used to remove the bone under copious irrigation with normal saline or with the use of a piezosurgery device (Figure 12). Following the removal of the cortical bone, a curette is used to remove the spongy bone and the cortical layer of the mandibular canal. The IAN should be protected in the phase of cortical layer removal. Any sharp bony spicules around the nerve should be removed. The neurovascular bundle inside the canal is freed using special curettes and is moved laterally using a nerve hook (Figure 13). Then, a 10 mm wide gauze cord or elastic band is passed below the nerve to retract it from the surgical site to decrease the risk of ischemic trauma to

the nerve and to protect the nerve itself from any possible damage [13, 21].

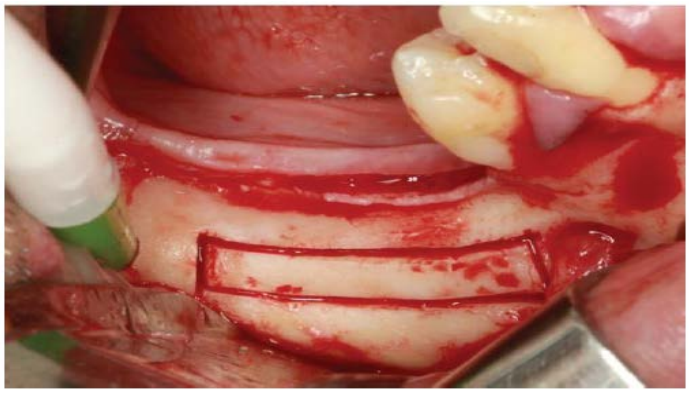

Figure 12: Osteotomy in lateralization technique (courtesy of Pimentel AC et al.)

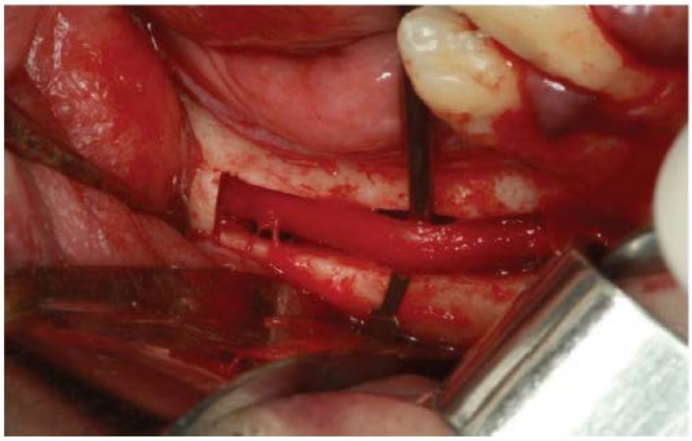

Figure 13: IAN traction with nerve hook(courtesy of Pimentel AC et al.)

Now, after freeing and retracting the IAN using a vessel loop, the dental implants can be inserted and should be long enough to engage the basal body passing the mandibular canal to achieve primary stability. The IAN is then replaced, and a resorbable membrane is inserted between the nerve and the bone window to prevent direct contact with the implant [18, 21]. Later on, the procedure is finished by suturing the mucoperiosteal flap as discussed in the first technique.

Later on, antibiotics and anti-inflammatory medications as corticosteroids should be prescribed to overcome any possible postoperative symptoms, and to reduce the swelling caused by excessive soft tissue manipulation during the surgery [16, 20, 22].

As reported by Lorean et al [23], nerve stretching by 10 – 17 % of its original length may end with internal disruption of the nerve fibers. Depending on this fact, the choice between the IAN transposition or lateralization is decided.

Some studies [7, 18, 24-26] reported success rate was high for both techniques, ranging from 96% to 100%. However, the transposition techniques showed a lower success rate comparing to the lateralization.

Advantages and disadvantages of IAN repositioning procedures

Some studies [11, 13, 17, 20-23, 27] reported some advantages that can be gained especially related to the combined implant therapy; such as; use of longer implants, greater primary stability, use of a greater number of implants, immediate placement of implants at the same time of repositioning procedures with the possibility of immediate loading with a success rate approaching these implants managed with standard techniques, also more resistance to occlusal forces will be obtained. Other advantages include the restoration of the lost vertical dimension, stabilization of occlusion, prevention of tissues atrophy, stabilization of the anterior dentition, temporomandibular joint, and masticatory muscle balance.

On the other hand, some disadvantages; or can be called complications; are inevitable, like neurosensory alterations, the anatomy of the alveolar ridge will be affected, mandibular weakness caused by cortical bone removal which may lead to mandibular fractures [28] in some cases with severe atrophy. Some studies [10] suggest the use of cylindrical non-threaded implants instead of threaded implants to decrease nerve injury, this will produce lower surface area and complain the primary stability especially in patients with bruxism or poor

occlusal relationship. As well as, loss of dental implants and osteomyelitis are potential risks following these procedures [1, 27].

Conclusion

The high position of IAN in patients with mandibular atrophy represents a challenge for prosthetic replacement with dental implants. Over the last 30 years, repositioning techniques of IAN were developed and applied to overcome this problem with a high success rate and survival rate of inserted dental implants. Like any surgical procedure, IAN repositioning may encounter complications such as the neurosensory deficit, alterations in mandibular anatomy, and postoperative infections like osteomyelitis with the possibility of mandibular fracture. IAN repositioning involves both lateralization and transpositioning techniques with a higher success rate in the first one. With careful preoperative planning and imaging and extremely accurate surgical techniques, both techniques can be used successfully for dental implant placement in patients with atrophic posterior edentulous mandible.

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