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Original Research Paper

Dental Science

LATERALIZATION OF INFERIOR ALVEOLAR NERVE : TECHNIQUE AND A CASE REPORT

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ABSTRACT The request of replacing missing teeth with dental implants is increasing, and as a result, incidence of postoperative complications is increasing concomitantly (Kim et al., 2009)[1]. When the height of bone between alveolar crest and inferior alveolar canal is insufficient, implant placement in the posterior mandible is limited. One of the most difficult surgical challenges to the implant surgery is severe resorption of the posterior mandible processes (Ardekian et al., 2001)[2]. Understanding of the intrabony distribution of the IAN is important in the accurate preoperative planning for the placement of mandibular implants (Kieser et al., 2002) [3]. There are several treatment options for patients with inadequate bone height superior to the inferior alveolar canal. There are lots of alternative reconstruction methods of atrophic dental arch: use of autogenous bone grafting, allografts, xenogenic, or alloplastic materials with or without guided bone regeneration, distraction osteogenesis, IAN lateralization (McAllister & Haghighat 2007; Hashemi 2010)[4]. Placing the implants to the buccal side of the IAN or lateralization of it are the two of them (Misch & Resnik 2010)[5]. An ideal alveolar ridge with adequate bone height and width is essential for a successful dental rehabilitation (McAllister & Haghighat, 2007)[4]. The placement of dental implants to the posterior mandible with severe resorption can cause damage to the IAN. The technique of nerve repositioning has been used to create opportunity of insertion dental implants of adequately length in those cases. In cases with atrophic posterior mandibular ridges, the IAN repositioning technique is an acceptable alternative to augmentation procedure prior to dental implants placement (Ardekian et al., 2001)[1].

KEYWORDS :

INTRODUCTION

With the loss of teeth, the alveolar ridge undergoes a continuous and irreversible process of bone resorption in height and thickness. Thus, mainly the posterior bone resorption sextant jaw usually leads to a reduced bead, and therefore the installation of implants in these regions becomes a challenge Patients often desire fixed dental implant restoration of missing posterior teeth in the mandible, defined for the present report as the region posterior to the mental foramen. Placement of implants in the posterior mandible is limited by the height of bone between the alveolar crest and IAN transposition or lateralization is a treatment option for patients with an edentulous posterior mandible with inadequate bone height superior to the IAN (Scarano et al., 2011)[6]. The lateralization technique for the inferior alveolar nerve (LIAN) allows for the installation of implants to correct the positioning or to move them closer to the ideal, improving the possibility of direct view at the time of surgery [7]. Using the higher cortical and basal body of the mandible, the implant is encased in a better-quality bone, unlike the reconstruction implants installed in the region with grafts [[8]. Compared to the reconstruction me hods with grafts, the lateralization procedure does not require donor areas, which decreases patient morbidity, lowers costs, provides ready installation of long implants (because it uses all the remaining jaw bone), and prevents patients from waiting six to eight months for treatment [10]. The posterior mandible has a higher quantity of narrow bone when compared to chin symphysis region that has more cortical bone. The LIAN technique provides a biomechanically favorable result to chewing loads occurring in the posterior region of the mandible. This technique establishes a good proportion between the implant length and the prosthesis length [9] compared to the use of short implantsto preserve themandibular canal,which presents lower initial stability and poor biomechanics that have been impaired by having a unicortical anchor .[11]

Nevre lateralization carries a risk of epineurial damage or ischemic stretching. İmplant compression can cause neuropathy and drill punctures can result in neuroma formation of all types. In some cases it can cause centralized pain syndrome. Two patterns of neuropathy can be seen as a result; hypoaesthesias with impaired sensory function, often seen with phantom pain, and hyperaesthesias with minimal sensory impairment but presence of much-evoked pain phenomena (Gregg, 2000)[12].

Damage to the alveolar nevre is largely due to insufficient information about the location of the mandibular canal and it is one of the most frequent complications. Such damage can also occur in the absence of knowledge about the traveling courses of the IAN, artery, and vein within the mandibular canal (Kim et al., 2009)[1]. Neuropathic pain associated with implant placement is rare in literature. In the implantology literature, complications related to nevre are mentioned as 'sensory disturbances', focusing on the occurrence of paresthesia and dysesthesia, eventually accompanied by transitory pain sensations during bone drilling or implant placement (Hashemi, 2010)[13]. The first published report of IAN replacement for the insertion of dental implants appeared in 1987. In that study, , sensory function of the IAN returned to normal 5 weeks after surgery according to subjective criteria (Jensen & Nock, 1987)[14].

Anatomy of the mandibular nerve

The trigeminal nerve, which is the largest cranial nerve, is the sensory supply to the face, greater part of the scalp, the teeth, the nasal and oral cavity, the dura mater, the blood vessels of cerebrum. Additionally it gives the motor supply to the masticator muscles, and the mylohyoid and the anterior belly of digastric muscles. The mandibular nerve, the third and the largest branch of the trigeminal nerve which supplies the teeth and gums of mandible, the lower lip, the lower part of face and the muscles of mastication, the mucosa of both presulcal parts of tongue and oral cavity, skin of the temporal region, part of the auricle including the external meatus and tympanum. It has a large sensory root, which proceeds from lateral part of trigeminal ganglion to emerge almost at ones from the foramen ovale. As it descends from the foramen ovale, the nerve is about four cm from the surface and little anterior to neck of the mandible. The ventral trunk of the mandibular nerve gives rise to the buccal nerve, which is sensory, and the masseteric, deep temporal and lateral pterygoid nerves, which are all motor. The dorsal and larger mandibular trunk is mainly sensory but receives a few filaments from the motor root to mylohyoid muscle. It divides into auriculotemporal, lingual and inferior alveolar (dental) nerves (Standring et al., 2005)[15]. The IAN descends medial to the lateral pterygoid muscle and then, at its lower margin, passes between the sphenomandibular ligament and the mandibular ramus to enter mandibular canal by the mandibular foramen. The Mental Nerve (MN), a branch of the IAN, when emerges through the mental foramen and then divides into three branches that supply the skin of the chin and mucous membrane of the lower lip and gum. Two of them pass upward and forward nearby the mucosal surface of the lower lip. The third one passes through the intermingled fibers of platysma and depressor anguli oris muscles to harvest the skin of the lower lip and chin. As the MN is one of the two terminal branches of the IAN, it is understandable why one's chin and lover lip on the affected side lose sensation, as well. (Standring et al., 2005; Snell, 2011)[15].

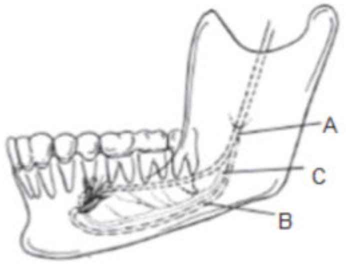

Fig. 1. Classification of the topography of the IAN. (A = the nerve has a course near the apices of the teeth, B = the main trunk is low down in the body, C = the main trunk is low down in the body of the mandible with several smaller trunks to the molar teeth.

Injury to IAN

The nerve trunk is surrounded of four connective tissue sheaths. These are themesoneurium, epineurium, perineurium, and endoneurium from the outside inward (Polland et al., 2001)[16]. The mesoneurium is a connective tissue sheath which is analogous to the mesentery of the intestine. It encloses the nerve trunk within the soft tissue, contains the segmental blood supply of the nerve, it continues with the epineurium. The epineurium is the loose connective tissue sheath which protects the nerve trunk against mechanical stress. Individual nerve fibers and their Schwann cells are surrounded by the endoneurium. The perineurium and endoneurium provide elasticity together.

There are 2 possible reasons of IAN injury

A) The IAN can be damaged secondary to the injection of a local anesthetic into the pterygomandibular space or when injecting in the region of the mental foramen. there are three possible causes

1. Direct intraneural injection with mechanical injury to the nerve such as severance of axons, partial or total, scar tissue or neuroma formation, Wallerian degeneration
2. Interruption of vessels of the mesoneurium with perineural and intraneural hemorrhage and secondary scar formation
3. Chemical toxicity of the anesthetic solution .

Regardless of its cause, it is recommended that aspiration be done before all local anesthetic injections. If there is a bloody aspirate or the patient complains of a paresthesia as typically, an electric shock-like sensation, the needle is withdrawn a few millimeters and aspiration is repeated. If there is now no bloody aspirate, it can be assumed that the needle tip is no longer in contact with a blood vessel or nerve, and the injection is completed.

B) Damage to the IAN as a consequence of bone preparation or implant placement may be caused by errors in radiographic planning, drilling, or direct contact of the implant with the nerve. Drill injuries to the IAN may be difficult to diagnose. Damage caused by drilling, the extent of injury of the IAN caused by the implant itself is related to the degree of encroachment of the implant into the IAC or its direct contact with the IAN. Nerve injury caused by implant placement may occur, despite correct osseous preparation, when the implant is inserted beyond the vertical confines of the prepared bone, compressing or breaching the superior wall of the IAC and forcing bone into the canal. Consecutive, extension of drilling into the IAC may favor over insertion of the implant cylinder beyond its intended depth and into the IAC, making direct contact with the IAN (Meyer & Bagheri 2011)[18]. The MN ranges in the mandibular buccal soft tissue and is at risk of injury during incisions.

Recognition of the changing anatomy of the edentulous mandible is especially helpful in minimizing risk of damage to the MN. As the cases ages, the alveolar bone in an edentulous area resorbs, and the position of the mental foramen becomes closer to the crest of the alveolar ridge. In some cases there is actual rupture of the IAN and the MN come to lie on the alveolar ridge crest. Placement of an incision must, therefore, take these anatomic changes into gravity. During the retraction of a mucoperiosteal flap it is potential to exert continuous improper pressure on the underlying IAN and MN. Gentle soft tissue retraction with frequent short relaxation of retraction pressure is advised nerve (Meyer & Bagheri 2011)[18].

C) Less common causes of nerve damage are related to placement of autologous or allogenic or also xenogenic bone grafts during simultaneous implant placement. In cases of complex implant reconstruction, the bone graft material may be placed into the donor site with additional force, thus severely compressing or even crushing the IAN. In 1943, Seddon described a triple classification of mechanical nerve injuries to characterize the morphophysiologic types.

Seddon's classification includes

1. Neuropraxia,
2. Axonotmesis
3. Neurotmesis and is based on the time course and completeness of sensory recovery (Seddon, 1943)[17]

1. Neuropraxia

Neuropraxia represents the mildest form of nerve injury. It is characterized by a conduction block, almost complete return of sensation or function, and no degeneration of the axon. The continuity of the epineural sheat and the axons is lasts and morphologic alterations are minor. Trauma to the endoneurial capillaries causes intrafascicular edema, resulting in a conduction block. The sensation or function returns to normal within 1 to 2 days following the resolution of intrafascicular edema, generally within 1 week following nerve injury. The function deficit recovers spontaneously and usually complete within 3 to 4 weeks (LaBanc,1992)[19].

2. Axonotmesis

Axonotmesis is a more severe nerve injury with disruption of the neuronal axon but with maintenance of the myelin sheath. This type of nerve damage may cause paralysis of the motor, sensory, and autonomic functions. It involves loss of the relative continuity of the axon and its covering of myelin, but preservation of the connective tissue framework of the nerve (the encapsulating tissue, the epineurium and perineurium, are preserved). Traction and compression are the usual mechanisms of this type of injury. This may cause severe ischemia, intrafascicular edema, or demyelination. Although the axons are damaged, there is no disruption of the endoneurial sheath, perineurium, or epineurium. Complete recovery takes place in 2 to 4 months, but improvement leading to complete recovery may take as long as 12 months. It is important to know that within 2 to 4 months following injury, signs of sensation or function begin and continue to improve over the next 8 to 10 months. Anesthesia followed by a paresthesia is the psychophysical response to an axonotmesis as recovery begins (LaBanc, 1992)[19].

3. Neurotmesis

Neurotmesis is the most severe lesion with potential of recovering. A neurotmesis is characterized by severe disruption of the connective tissue components of the nerve trunk. The etiology of nerve injury is traction, compression, injection injury, chemical injury, local anesthetic toxicity or in a complete distruption of the nerve trunk laceration and avulsion. In this type of nerve injury, sensory and functional recovery is never complete. The psychophysical response to these injuries is an immediate anestesia. This may be followed by paresthesia or possibly neuropathic responses such as allodynia, hyperpathia, hyperalgesia, or chronic pain. This type of nerve injury has a high probability of development of a central neuroma (LaBanc, 1992)[19].

Inferior alveolar nerve lateralization

Surgical procedure

IAN lateralisation is a new technique. In the literature of implantology, the techniques described are partial and located at the anterior part of the nerve, near the foramen mentalis. Total lateralisation technique can be used in dental prosthesis in mandibular posterior edentulism when the alveolar bone is reduced and when the prosthesis compresses the nerve in the foramen region. This technique can also be used in implantology when terminal implant restitution is needed.

Several Techniques have been recommended in literature over the last 10 years each with limitations . Some of the technique involve the repositioning of nerve that includes the mental foramen as well as the area of implant placement and then releasing the nerve from mental foramen and replacing the nerve distal to its 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 technique include lateralization of nerve by repositioning the nerve through a posterior cortical window rather than engageing a mental foramen . This procedure however requires a extensive stretching of nerve .

Case report

A 55 year-old female patient reported with missing teeth in the mandible. As she couldn't use removable partial denture, we evaluated posterior mandibular area. But mandibular posterior bone height was inadequate for implant placement. A preoperative panoramic radiograph (Fig 2) and computerized tomograhic (CT) scan revealed only 5 mm. of bone between the alveolar crest and the inferior alveolar canal.

Fig. 2. Preoperative panoramic radiograph

We planed alternative methods including IAN lateralization technique at this place. The procedure starts with Mandibular block by giving local anesthesia 2 % lignocaine with adrenaline. Intravenous sedation was also given because procedure is technique sensitive and requires patients full cooperation . Then the soft tissue incision slightly buccal to the crest of the residual alveolar ridge was given .The incision begins at the retromolar region and continues forward to the mesial portion of the cuspid tooth area, where a vertical relaxing incision is made. A full thickness mucoperiosteal flap is elevated to the inferior border of the mandible. For performing IAN lateralization, the corticotomy starts usually 3–4 mm distal to the mental foramen. Corticotomy should be extended 4–5 mm distal to the most distal implant position. Using CT (cone beam), the molar regions of the right jaw were observed and cutting lines for the osteotomy were planned for the remaining bone volume with 5.4mm thickness and 4.8mm height (Figure 3). Using a ruler, needle point, and a pencil of sterilizable graphite, it was possible to plan and carry it to the surgical area . For performing inferior alveolar nerve lateralization, the corticotomy started 4 mm distal to the mental foramen. A small round bur in a straight hand piece with high torque and copious amount of water irrigation was used to prepare the corticotomy site (Figure 3) . To remove the trabecular bone and gain access to the neurovascular bundle, only hand instruments (small curettes) were used. A small curved osteotome was then used to carefully remove the posterior rectangular segment of mandibular cortical bone overlying the IAN It is important to remove any sharp edge of the bone and cancellous spicules along the window that could lacerate the neurovascular bundle .The IAN was mobilized from its position. After the nerve was completely released from the canal and before starting to drill for implant osteotomy preparation , a piece of membrane was inserted between the nerve bundle and the bone where the drill was expected to reach. At second premolar and second molar region, we planned 3.5x12 mm. Cowelmedi implant (Fig 4). Once the drilling is completed, the implant is inserted while the nerve bundle remains retracted in situ ensuring that the apical ends of the implants are positioned inferior to the canal. Once the implants are in position, the nerve is repositioned over the lateral aspect of the implants. The releasing incisions were carried out and mucoperiostal flap were sutured by using 3.0 silk.

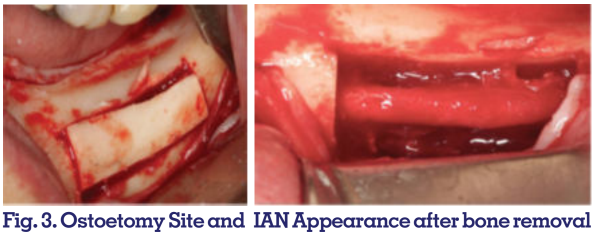

Fig. 3. Ostoetomy Site and IAN Appearance after bone removal

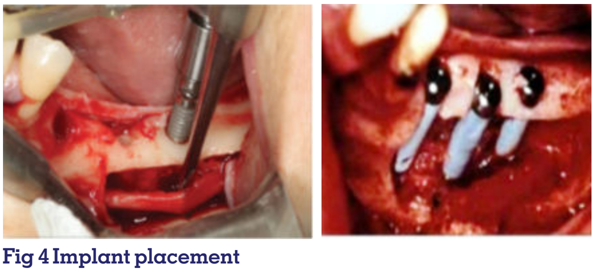

Fig 4 Implant placement

CT scan and panoramic radiograph (Fig 5) were taken after placing the endosseos implants. Surgical exposure and moving the nerve laterally results in a high incidence of sensory nerve disturbance and an excessive crown-to-root ratio of the prosthesis. Sensory function of the IAN returned to normal 6 weeks after surgery. After the implant placement demineralized freezed synthetic bone graft is placed between the implant and nerve to avoid any direct contact of implant with nerve. A collagen membrane was placed lateral to the nerve . A horizontal releasing incision were made in the periostium to enable tension free closure .

Figure 5 Post operative OPG

Postoperative Recovery

The patient was advised to use anti-inflammatory nimesulide 100mg), 1 tablet every 12 hours and Augmentin 625 mg for 5 days, . After surgery, a panoramic radiography was performed to evaluate the implants (Figure 5). The postoperative signs and symptoms were swelling, bruising, and loss of feeling in the region on left side. The patient underwent Perdnisolone 10 mg 2 tablets a day (1 tablets after each meal) for 30 days. Weekly mechanical tests were carried out with the intention of observing the restoration of sensitivity in surgical sites. After 30 days, the patient reported significant improvement in sensory changes; a reduction in both tingling and anesthesia was reported. The total return of sensorineural activity occurred in three months. In conclusion, the postoperative complaint was loss of feeling in the region.

To allow the sufficient time for osteointegration , 2nd stage surgery was performed after 6 months and PFM crown were placed.

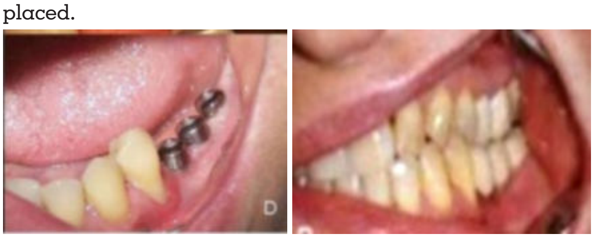

Figure 6 Abutment and PFM Crowns are placed after 6 Months

DISCUSSION

The installation of dental implants is directly related to the amount and quality of bone present in the region to be restored. Later surgeries on extant edentulous jaw are challenging due to the high degree of atrophy of the alveolar bone, preventing the installation of implants in the region. This is especially so in cases where the anatomical limitation has been caused by the presence of the mandibular canal and its contents, the IAN [20 21 22]. Some treatment options can be used for reconstruction of bone: guided bone regeneration, short implants, laterally tilted implants installed near the nerve, distraction osteogenesis, and IANT (inferior alveolar nerve transposition) or LIAN (lateralizationof the inferior alveolar nerve) [(23-30]. However, in the reconstruction with bone grafts, it is difficult to predict the gain of the alveolar crest due to difficulties in coating and bone quality [25]. Short implants have high failure rates for biomechanical problems as well as for bone quantity and quality [31]. The installation of the laterally inclined nerve implant is limited by abutments and it is at increased risk of biomechanical failure [23]. Distraction osteogenesis is a complex technique that requires great patient cooperation and two operations [32]. IANT and LIAN are techniques that most satisfy the later rehabilitation of atrophic jaws. In these procedures, the implant placement occurs in the correct position or as close as possible to the ideal, improving for a direct view at the time of surgery, unlike the implants inclined laterally to the nerve [33] Using the upper and cortical basal body of the jaw, the implant is encased in a better-quality bone, unlike the implants installed in the reconstruction of regions with short grafts and implants. Furthermore, implants have better distribution of occlusal loads, favorable biomechanics, a high success rate, a single operative step, a shorter treatment time, a smaller cost, and less patient morbidity [34]The disadvantages of the LIAN and IANT techniques are associated with potential complications such as sensorineural dysfunction (reported by all authors), mandibular fracture[26], and osteomyelitis[35]. Chrcanovic and Cust´odio [36] reported that the surgical technique does not recover the original anatomy of the jaw, leading to an impaired aesthetic of prosthetic rehabilitation. In cases of LIAN and IANT surgeries, the flaps required for IAN access to the cortical bone create a smaller exposure area. They also increase the possibility of making a smaller bone window, decrease the nerve traction in the chin, and decrease the possible sensorineural damage, all the while For the analysis of the neurosensory function of IAN, the most commonly used test is two-point discrimination, as reported by several authors. Other objective tests were used such as the light touch test light, the heat test, the cold pin prick test, and the pressure test, as reported by several authors . Nortji et al [37] Aside fromthese tests, a test was conducted to measure objective electrophysiological nerve conduction velocity and sensory action potential. In addition to the objective tests, Kan et al. [38], Nocini et al. [38], Morrison et al. [39], Ferrigno et al [41]. , and Hashemi [40] used a subjective analysis through a simple questionnaire, which patients used to report the presence or absence of pain, paresthesia, anesthesia, hypoesthesia, hyperesthesia, or dysesthesia. In this study, a sensorineural disorder patient was assessed by the light touch test to diagnose the type of nerve fibers damaged by the surgical procedure. The tactile discrimination test was also conducted to delimit the area affected by sensory damage in the case of hypoesthesia. Monitoring during the postoperative period was performed using the two-point discrimination test. Some LIAN procedures showed no sensory damage in the postoperative period, while in other procedures sensitivity returned in a month. Ferrigno et al.[41] performed 19 LIAN procedures and, through subjective and objective testing (light touch, pain, and two-point discrimination), observed that, after anesthesia, no sensory damage had occurred in nine of the procedures. It occured after a month in two patients and in one procedure the patient reported sensory damage and permanent hypoesthesia.preserving a larger amount of the remaining bone, thereby preventing mandibular fracture. The success rate reported in the LIAN and IANT implant techniques ranged from 96% to 100%. The case reports and literature review showed that the LIAN was suggested to be much safer than IANT.

CONCLUSION

The inferior alveolar nerve transposition technique has a higher initial rate of sensorineural dysfunction than the lateralization technique for the inferior alveolar nerve, but in this case report, the two techniques showed similar sensory feedback.The authors found that the implant success rate is linked to the possibility of installing implants with long biocortical anchor, which favors primary stability and biomechanics. The present study investigated neurosensorial disturbances related to IAN lateralization for up to 6 month follow-up. Subjective criteria, sensory function of the IAN returned to normal 6 weeks after surgery. IAN lateralization is a useful method for managing the atrophic posterior mandible with dental implants. The surgical protocol for IAN transposition, followed by implant placement, presented excellent results, with complete recovery of the sensitivity within 6 months after the surgical procedure. IAN lateralization is a useful method for managing the atrophic posterior mandible with dental implants. The risk of permanent damage of the IAN lateralization appears to be small.

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