

Inferior Alveolar Nerve Injury during Implant Placement -A Review

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Abstract

The mandibular nerve is the third and most inferior division of the trigeminal, or fifth, cranial nerve. The trigeminal nerve is predominantly a sensory nerve, innervating most of the face. The

IAN is a branch of the posterior division of the mandibular nerve that contains both sensory and motor fibers. It enters the mandibular foramen, runs in the mandibular canal, and supplies the mandibular teeth. It leaves the mandibular canal through the mental foramen as the mental nerve. Within the canal, the nerve is about 3 mm in diameter, and its course varies. It is interesting to know that the IAN is the most commonly injured nerve (64.4%), followed by the lingual nerve (28.8%). Inferior alveolar nerve injury is one of the most serious complications in implant dentistry. This nerve injury can occur during local anesthesia, implant osteotomy, or implant placement. Proper understanding of anatomy, surgical procedures, and implant systems and proper treatment planning is the key to reducing such an unpleasant complication. Effective management of these cases is based on providing treatment-conservative or surgical, immediately upon diagnosis of damage. That is to say, early diagnosis is the key for successful treatment. This review discusses the causes of inferior alveolar nerve injury and its diagnosis, prevention, and management.

Keywords:

Implant dentistry, Inferior Alveolar Nerve, Nerve injury, Alteration of Sensation, <management of nerve injury

1.Introduction

The IAN supplies the mandibular molar and premolar teeth and adjacent parts of the gingival. Its larger terminal branch emerges from the mental foramen as the mental nerve. Three nerve branches come out of the mental foramen. One innervates the skin of the mental area, and the other two proceed to the skin of the lower lip, mucous membranes, and the gingiva as far posteriorly as the second premolar. The incisive branch, a continuation of the IAN, supplies the canine and incisor teeth.^{1,2}

It is interesting to know that the IAN is the most commonly injured nerve (64.4%), followed by the lingual nerve (28.8%)^{3,4} One of the most serious complications is the alteration of sensation after implant placement in the posterior mandible. The prevalence of such a complication has been reported as high as 13%⁵. This can occur as a result of injury to the inferior alveolar nerve (IAN) or the lingual nerve from traumatic local anesthetic injections or, most important, during dental implant osteotomy or placement. Many critical factors must be kept in mind when placing implants in the posterior mandibular region. The first is understanding the anatomy of early resorption patterns in the posterior edentulous mandible, which usually produce vertical and horizontal alveolar atrophy on the lateral aspect of the ridge. A second critical factor is radiographic magnification errors. In traditional CT scans of the mandible, magnification errors are reported to be from 0% to 8% and with cone beam CT as high as 3.8%.⁶Other diagnostic tools such as periapical radiographs have a magnification error reported at an average distortion of 14%.⁷

This complication is one of the most unpleasant experiences for both the patient and the dentist, so every precaution should be taken to avoid it. Effective management of these cases is based on providing treatment-conservative or surgical, immediately upon diagnosis of damage. That is to say, early diagnosis is the key for successful treatment. Renton and coworkers state that peripheral sensory nerve injuries are more likely to be persistent when there is an increased duration between injury and reviewing of the patient.^{8,9} The problem is that occasionally the

diagnosis is delayed, which may have a crucial effect on treatment results. Once it happens, the dentist should provide the patient with appropriate care and should know when to refer the patient to a microneurosurgeon.¹⁰ Depending on the degree of nerve injury, alteration in sensation varies from mild paresthesia to complete anesthesia. Also, it may be transient, manageable, or, in certain cases, permanent.

Previously our department has published extensive research on prosthetic dentistry¹¹⁻¹⁹, on effect of various drugs^{20,21}, oral hygiene status of women²², on the effect of impregnated gingival retraction cords²³, on the medical management of cellulitis²⁴, this vast research experience has inspired us to research inferior nerve injury due to implant placement. The best way to prevent these iatrogenic damages is to have clear three-dimensional vision of the jaw. This can be achieved by combining the practical knowledge of basic mandibular anatomy and the data obtained from clinical and radiological examination. Currently, guidelines for the management and prevention of implant related nerve injury are lacking. Therefore, the purpose of the present article was to review aetiological factors, mechanism, clinical symptoms, diagnostic methods and treatment for the management of inferior alveolar nerve injury before or after dental implant placement.

2. Inferior Alveolar Nerve

The mandibular nerve is the third and most inferior division of the trigeminal, or fifth, cranial nerve. The trigeminal nerve is predominantly a sensory nerve, innervating most of the face. The upper branch of the trigeminal nerve is the ophthalmic nerve, which innervates the forehead. The middle branch, the maxillary nerve, innervates the maxilla and the midface.²⁵ The lower branch, the mandibular nerve, innervates the teeth and the mandible, the lateral mucosa of the mandible, and the mucosa and skin of the cheek, lower lip, and chin. The mandibular nerve contains both sensory and motor fibers. It runs from the trigeminal ganglion through the foramen ovale and gives off 2 branches from its main trunk (meningeal branch and nerve to the medial pterygoid muscle). Then it divides into anterior and posterior divisions. The anterior branch emits 1 sensory nerve, the buccal nerve, and 3 motor branches to supply the masseter, the temporalis, and the lateral pterygoid muscles. The posterior branch of the mandibular nerve is larger than the anterior branch. It gives off 2 sensory branches, the auriculotemporal and lingual nerves. Just before the posterior branch enters the mandibular foramen as the inferior alveolar nerve, it gives off the mylohyoid nerve, which supplies the mylohyoid and the anterior belly of the digastric muscles.²⁶

The IAN is a branch of the posterior division of the mandibular nerve that contains both sensory and motor fibers. It enters the mandibular foramen, runs in the mandibular canal, and supplies the mandibular teeth. It leaves the mandibular canal through the mental foramen as the mental nerve. Within the canal, the nerve is about 3 mm in diameter, and its course varies. It can run with a gentle curve toward the mental foramen, or it can have an ascending or descending pathway. A bifid IAN canal has been reported to occur very infrequently. Nortjé et al found an occurrence of 0.9%. Grover et al were able to find only 0.08% of radiographs suggestive of bifurcation of the IAN.²⁷ Langlais et al found 0.95% of cases to have bifid IAN canals. Despite the rare occurrence of the bifid IAN canal, the clinician must be on the lookout for these cases when planning for dental implants.²⁸

3.Treatment planning for implant placement

Several methods are used to localize the IAN during treatment planning. These include conventional radiography, tomography, and computerized tomography (CT). Another method is surgical exposure of the mental nerve by blunt dissection to allow direct vision of the nerve and to estimate the distance between the mandibular ridge crest and the IAN, but the irregular intraosseous course of the nerve limits the value of this surgical technique. CT provides the most accurate and precise method for localization of the IAN. Also, the image can be reconstructed into a 3-dimensional model that can be used as an accurate surgical guide. This 3-dimensional image is very useful in determining the buccolingual width of the bone, as well as the buccolingual position of the nerve.²⁹ This allows positioning of the implant to the lingual or buccal of the nerve to avoid its injury in cases of limited bone height. Although CT is very useful in dental implantology, its high cost and level of radiation prevent it from becoming the standard of care. To localize the IAN, most clinicians use conventional radiography (eg, panoramic views, periapicals), which is sufficient for most cases. Panoramic radiographs can be used safely for most cases but with some limitations.³⁰

4.Classifications of inferior alveolar nerve injury

In 1943, Seddon described a triple classification of mechanical nerve injuries to characterize the morphophysiological types of mechanical nerve injuries. Seddon's classification (neuropraxia, axonotmesis and neurotmesis) is based on the time course and completeness of sensory recovery.³¹

Neuropraxia is characterized by a conduction block, the rapid and virtually complete return of sensation or function, and no degeneration of the axon. It may be the result of nerve trunk manipulation, traction, or compression of a nerve.³² Normal sensation or function returns within 1 to 2 days following the resolution of intrafascicular oedema, generally within 1 week following the nerve injury. An axonotmesis is characterized by axonal injury with subsequent degeneration or regeneration. Traction and compression are the usual mechanisms of this type of injury. These may cause severe ischemia, intrafascicular oedema, or demyelination. Even though the axons are damaged, there is no disruption of the endoneurial sheath, perineurium, or epineurium. Complete recovery can occur in 2 to 4 months, but improvement leading to complete recovery may take up as long as 12 months. A neurotmesis is characterized by severe disruption of the connective tissue components of the nerve trunk with compromised sensory and functional recovery. The aetiology of nerve injury is traction, compression, injection injury, chemical injury or in a complete disruption of the nerve trunk laceration and avulsion.³³ With this type of nerve injury there is a poor prognosis for recovery. For example, sensory and functional recovery is never complete and has a high probability of development of a central neuroma

5.Aetiological factors of traumatic inferior alveolar nerve injury

Aetiological factors of IAN injury depending on the time of incident can be classified into intraoperative and postoperative. Depending on traumatic mechanisms intraoperative aetiological factors may be further sub-grouped into - mechanical, thermal and chemical and postoperative indirect - to thermal stimuli, peri implant infection and hematoma with subsequent scarring and ischemia.

A. Inferior alveolar nerve injury during traumatic local anaesthesia injection

Profound local anaesthesia during the dental implant surgery can drastically reduce patient anxiety during the surgery. Local anaesthetics are designed to prevent sensory impulses being transmitted from intraoral and extraoral areas to the central nervous system with minimal effect on muscular tone. Unfortunately, the injury of an IAN can occur during a traumatic local anaesthesia injection. Although very rare, nerve injury after administration of an IAN block was well documented. The exact mechanism of the injury has yet to be determined, nevertheless. Three main theories were proposed. These include direct trauma from the injection needle, hematoma formation and neurotoxicity of the local anaesthetic.^{3,34}

B. Inferior alveolar nerve injury by implant drill

The most severe types of injuries are caused by implant drills and implants themselves. Sensory IAN injuries made by implant drills may be caused by direct intraoperative (mechanical and chemical) and indirect post operative trauma (ischemia and thermal stimuli).³⁵ Many implant drills are slightly longer, for drilling efficiency, than their corresponding implants. Implant drill length varies and must be understood by the surgeon because the specified length may not reflect an additional millimetre so called "y" dimension. Lack of knowledge about this may cause avoidable complications. Damage to the IAN can occur when the twist drill or implant encroaches, transects, or lacerates the nerve.³⁶

C. Inferior alveolar nerve injury by dental implant

Sensory IAN injuries made by dental implant may be caused by direct intraoperative (mechanical) and indirect post operative trauma (ischemia) or peri implant infection. Direct mechanical injury i.e. encroach, transection, or laceration of the nerve is related to implant intrusion into the canal. After direct trauma, when the implant is placed through the bony canal, the nerve ending may get retrograde degeneration in most of the cases, because the nerve running in the canal is a terminal ending of the nerve and the size is quite small.³⁷ Otherwise partial implant intrusion into mandibular canal can evoke IAN injury due to compression and secondary ischemia of corresponding neurovascular bundle

D. Inferior alveolar nerve injury using wrong operation technique

Injury of the final part of the IAN - mental nerve can occur in those cases when an extreme degree of alveolar process resorption exists. In such cases, the mental foramen was found in the surface of alveolar bone and directly under the gums. To avoid direct injury with scalpel, the initial incision should be made more lingually and a full-thickness flap is elevated until the mental foramen is identified. In addition, flap reflection or retraction, suturing, soft tissue swelling and pressure on the mental nerve area can also cause injury to that nerve, resulting in altered sensation after surgery

6.Diagnosis of IAN injury

A.Diagnosis of IAN injury according to early signs and symptoms reported by patients

Signs and symptoms, any sensation described by the patient, should be taken into consideration since radiography is not always helpful. There are cases where the implant does not seem to damage the nerve, but in fact, it does.

One of the most important things the practitioner should check after the operation is completed is whether the patient experienced a return of normal sensation. Six hours after operation (after the local anaesthesia effect wears off), the patient should be contacted. In cases of the patient reporting persistent numbness or anaesthesia, it would be the first sign for the surgeon that something went wrong and nerve damage probably occurred . Numbness usually will be felt on the side of implant placement, including the lower lip and chin. Another symptom that may indicate nerve damage is the feeling of tingling, tickling, or burning skin in other words, paraesthesia. In some cases, numbness may not appear immediately but later on. The patient does feel improvement in sensation in the beginning, although some discomfort is present, and later numbness appears. A case study of 4 females, which recorded their sensations following implant-associated IAN damage, concluded that all patients suffered from numbness of the affected inferior alveolar dermatome.^{3,38-40}

B.Diagnosis of IAN injury based on subjective sensory tests

A study in the year 2009 by Poort et al. reveals an interesting fact - subjective evaluation has been found to be the most commonly used method (64% of all methods used) to detect implant-associated IAN injury.⁴¹

Every alteration in sensation reported by the patient should be carefully taken into consideration, both intra- and postoperatively. That is because the patient's own feeling is the best evaluation for change in sensation, as sometimes the alteration may be not big enough to be detected by any diagnostic tools, which are less sensitive than the human himself/herself . Some patients get an "electric-shock-type" sensation during administration of local anaesthetic, which can give a hint about further nerve injury, but it is not a definitive sign since injuries can occur without any intraoperative demonstration. After the fading of the local anaesthetic effect, the doctor should ascertain with the patient if any changes occurred and if some suspicion for neuropathy is present. A basic neurosensory examination should be performed. Basically, subjective sensory tests are divided into 2 major categories: mechanoreceptive and nociceptive.⁴²

C.Diagnosis of IAN injury using alternative methods

Several researches have proposed that early implant removal may lead to better healing with the return of sensation.⁴³ However, in most cases, by the time diagnosis is made, it may lose its efficiency. The problem in making an immediate diagnosis is that usually, by the end of the surgery, the patient is still found under the effect of local anaesthetics. That occurs especially when surgeons use long-acting anaesthetics in order to delay the pain as much as possible.

Phentolamine mesylate (PM) is an anti-hypertensive reversal agent of local anaesthesia. A study conducted by Froum et al. in 2010 checked the possibility of its utilisation immediately after implant placement.⁴⁴

Without using PM, the local anaesthetic effect fades away in the range of 3 to 5 hours after injection. Thus, using a reversing agent will significantly increase the chances of full recovery, as its application permits making the earliest detection of nerve damage currently available.

7.Prevention of IAN Injury

Accurate measurement of the bone available for implant support coronal to the IAN canal is the only way to avoid IAN injuries.⁴⁵ The use of CT-based surgical stents or navigation systems may also help prevent nerve injury. Some practitioners recommend the use of “drill guards” provided by some implant systems. These guards are attached to the drill close to the handpiece to prevent over penetration of the drill into the bone.⁴⁶ Many clinicians prefer the use of transverse alveolar implant techniques to slant the implant laterally to engage the cortical buccal bone, in an attempt to avoid IAN injury.⁴⁷ Heller et al advocate the practice of using infiltration for local anesthesia instead of an IAN block, because without complete lack of sensation, the patient will feel pain if the drill approaches the IAN canal—a significant indication to stop drilling.⁴⁸ At the same time, an intraoperative radiograph with the presence of the drill or other gauge in the osteotomy site is of great value, especially if nerve approximation is expected.

8.Management of IAN Injury

If intraoperative nerve injury is suspected, it must be recorded, and a thorough neurosensory examination should be performed as soon as the local anesthesia effect is lost.⁴⁵ Results of the examination, as well as the patient's description of the altered sensation, must be recorded throughout follow-up visits. Events that can lead clinicians to suspect nerve injury include pain or altered sensation during drilling or implant placement, slippage of the drill or implant deeper than planned, and the presence of excessive bleeding, especially if nerve proximity is suspected.

Patients may complain of altered sensation even though clinical procedures were uneventful. Management of the problem will depend on the cause of the IAN injury. As mentioned earlier, nerve injury can occur for many reasons. Radiographs must be taken to confirm whether it has been caused by the implant. If the implant is impinging on the nerve, it should be removed or at least unscrewed a few threads to relieve the pressure on the nerve; this is why we recommend using an implant that can be “unscrewed” after placement. Whichever the clinician decides to do, he or she must do it as soon as possible to prevent or minimize permanent nerve damage.⁴⁰ If the implant causing the problem is already osseointegrated, it can be removed by a trephine drill. As an alternative, an apicoectomy of the implant can be done, if feasible.⁴⁹

Clinicians might face some instances of altered sensation wherein the implant does not appear to be impinging on the nerve. In such a case, nerve injury may have occurred during drilling. Such a scenario should be strongly suspected if the implant is very close to the IAN canal. Other less frequent causes include local anesthesia or aggressive retraction of the buccal flap. To control inflammatory reactions in the injured nerve, a course of steroids can be prescribed. An alternative would be a large dose of nonsteroidal anti-inflammatory drugs (eg, 800 mg ibuprofen) 3 times daily for 3 weeks. If the situation improves, the clinician can prescribe another course of anti-inflammatory drugs.⁴⁵ Perceptions of pain and temperature are usually the first 2 sensations to recover, whereas other sensations may take longer⁵⁰⁻⁵²

.Many patients respond well to this line of treatment. Any improvement in the patient's condition should be recorded, along with results of a neurosensory examination and the patient's description. If the condition fails to improve within 2 months, referral to a microneurosurgeon is indicated. Early referral will allow for early management before distant degeneration of the nerve takes place. This degeneration usually occurs within 4–6 months of nerve injury. This is the reason why many authors recommend that microsurgery be performed within the first months after injury. Strauss et al concluded that 50% of the patients who underwent microsurgical repair of the IAN reported significant improvement, 42.9% reported slight improvement, and only 7.1% reported no improvement.⁵⁰ They also reported that highly significant improvements were achieved after 1 year of microsurgical intervention.

9. Conclusion

Various diagnostic methods, as well as treatment strategies, have been developed throughout the years for dealing with one quite prevalent complication in the implantology field - inferior alveolar nerve injury. Concurrently, the importance of early diagnosis and treatment was proved. Proper understanding of the involved anatomy, the surgical procedures, and implant systems—along with proper treatment planning—will reduce the chances of such an unpleasant complication. If nerve injury occurs, early and proper management is the key to maximizing the chances of recovery.

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11. Authors Contribution

Author 1 (Amina Mehrin Bano) carried out the review by data curation and drafting the manuscript after performing the necessary formal analysis . Author 2(Dr. Dhanraj Ganapathy) aided in conception and visualization of the topic and has supervised in preparation of the manuscript . Author 3 (Dr. kiran kumar)has supervised in preparation, reviewing and editing of the manuscript All authors discussed the results and contributed to the final manuscript.

12. Conflict Of Interest

The researcher claims no conflict of interest.

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