Traumatic Injury of the Inferior Alveolar Nerve after Dental Implant Surgery; a Literature Review

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Abstract

Osseointegration was the hallmark of success in implant dentistry in the 1980s. However, implant success in the 21st century involves other factors including: stability of the implant, adequate radiographic bone levels, lack of symptoms or evidence of infection, minimal probing depths around the implant, and the ability of the patient to keep the area clean.

Although implant dentistry is a very dynamic and exciting area of oral treatment, it does not guarantee results, nor is it without temporary and/or permanent post-operative complications (e.g. neurosensory disturbances).

In this paper, a literature review considering cases of altered sensation due to traumatic injury of the inferior alveolar nerve after dental implant surgery was conducted. Other related points like pre-, and post-operative diagnostic methods for neurosensory disturbances were also discussed.

Such cases have been shown to range between 0.13% and 43.5% among past studies. The extreme variation in the reported prevalence of neurosensory disturbances suggests that such problems have not been adequately evaluated.

If sensory disturbance appears after dental implant placement, a nerve injury should be suspected, the patient should be carefully examined, the findings documented, and progress or return of sensation should be monitored diligently.

Success rates of dental implants

In the past 25 years, the replacement of missing teeth with implant-supported prostheses has become a widely accepted treatment modality for the rehabilitation of fully and partially edentulous patients. This breakthrough in oral rehabilitation is based on the concept of osseointegration first described by the two research groups of Brånemark et al. (1977) (1) and Schroeder et al. (1981) (2). Both groups described this biologic phenomenon as direct contact between living bone and the surfaces of commercially pure titanium implants. Over the years, clinical guidelines were established for the predictable achievement of osseointegration in patients.

The cumulative success rate of implants according to treatment compiled from controlled, long-term, prospective multicentered trials with Brånemark osseointegrated implants has been reported for single-tooth restorations (3), partially edentulous bridgework (4), overdentures (5), and fully edentulous jaw bridgework (6). The results are based on a minimal follow-up of 5 years. Short- to mid-term data have also been reported for a number of other implant systems, such as Astra® implants (7), IMZ® and TMS® implants (8), 3i® implants (9), and ITI® implants (10).

In general, studies have demonstrated success rates ranging from 80-92% success for the maxilla over 5 to 10 years (11, 12). Other studies have reported long-term success rates for the maxilla at 92% and the mandible at 94% in 5 years (13) with up to 78% success in the maxilla and 86% success in the mandible in a 15-year time period (4). These results agree with more recent studies which reported implant survival rates of 97.3% for ITI® and Brånemark® systems (14), 90.9% for implants supporting fixed prostheses in the edentulous upper jaw (15), 82% to 94% after 10 years of observation (16), 99.2% for implant treatment with fixed prostheses in edentulous jaws after 20 years (17), and 91% and 97.81% for maxillary and mandibular implants respectively of ITI® implants after a 5-year period (18).

However, although implant dentistry is a very dynamic and exciting area of oral treatment, it does not guarantee results, nor is it without complications.

Sensory disturbances in dental surgery

Sensory disturbances are well known complications of dental and maxillofacial surgery and have been well documented in the long term evaluation of patients after maxillofacial trauma, third molar and orthognathic surgery, vestibuloplasty and ridge augmentation (19-23). Sensory disturbances can also be caused by diverse factors such as pressure on the mental nerve from a denture, or partial denture, an implant impinging on the nerve, pressure caused by an edema, hematomas, scars, or dental injections (24, 25). Nerve damage can result from the nerve being stretched, compressed, and partially or totally transected. Violation of the mandibular canal or mental foramen during an osteotomy can result in injury of the inferior alveolar nerve, mental nerve, or adjacent blood vessels.

According to Seddon (1943) (26), nerve injuries can be classified as follows:

- Neurapraxia: there is no loss of continuity of the nerve, it has been stretched or has undergone blunt trauma. The paraesthesia will subside, and feeling will return in days to weeks.

- Axonotmesis: nerve damaged but not severed and feeling returns within 2 to 6 months.

- Neurotmesis: severed nerve with poor prognosis for resolution of paraesthesia.

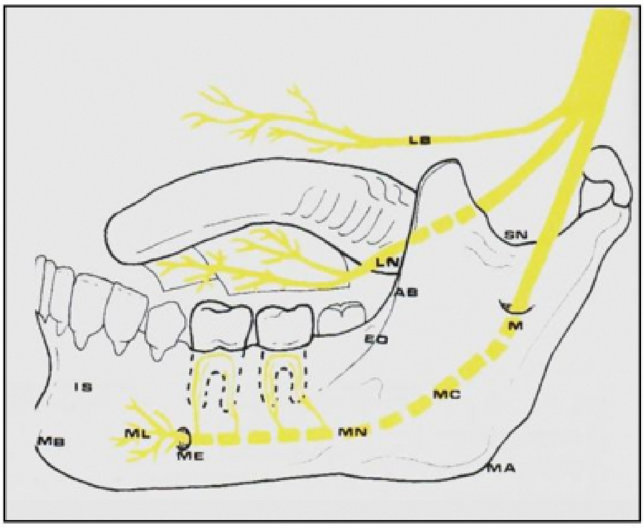
Patients with such nerve injuries may experience unexpected, unpleasant sensations and have difficulty performing common activities with the face and mouth. Such adverse effect can be unacceptable to patients and negatively impact their physiology and psychology.

Prevalence of sensory disorders associated with implant surgery in the mandible

Altered sensation is a recognized complication that may follow surgical procedures of the mandible, and the risk of nerve injury is an important and inherent complication associated with oral implants placement. It is important to recognize such a risk and be aware of the treatment of such injuries should they occur.

Figure 1

Demonstration of nerve supply in the mandible (LB, long buccal nerve; LN, lingual nerve; SN, sigmoid notch; AB, anterior border , mandibular ramus; M, mandibular foramen; EO, external oblique ridge mandible; IS, incisive fossa; MB, mental protuberance; ML, mental neurovascular bundle; ME, mental foramen; MN, mandibular neurovascular bundle; MC, mandibular canal; MA, mandibular angle) From: Cranin N. Atlas of Oral Implantology, 2nd Edition, Mosby, Inc., St. Louis



Cases of altered sensation due to traumatic injury of the inferior alveolar nerve after implant surgery differ widely among past studies.

A retrospective questionnaire study conducted by Ellies (1992) showed that of the responding patients (80%), 37% reported altered sensation following implant surgery, with long-term changes occurring in 13% of patients (27). The most frequently involved parts of oral-facial complex were the lip and chin, and the prevalence of altered sensation was significantly higher in women compared to men. A similar study of Ellies and Hawker (1993) also showed consistent results in which 36 % of the patients reported altered sensation following implant surgery (28).

In a prospective questionnaire study, Kiyak et al. (1990) found that 43.5% of subjects experienced facial numbness, although only 4.3% of them had anticipated it (29).

In a prospective study of 110 patients conducted by Wismeijer et al. (1997) to present the results of the patients' perception of the sensation of their lower lip before, 10 days after and 16 months after implant surgery in the mandible, it was shown that 25% of the patients described a sensory disturbance before treatment, 11% of the patients reported a sensory disturbance in the lower lip 10 days after surgery, and 10% reported a sensory disturbance 16 months after surgery (30).

Bartling et al. (1999) designed a study to determine the incidence of altered sensation in patients who had underwent mandibular endosseous implant placement, and it was shown that 8.5% of the patients reported altered nerve sensation at their first post-implant visit. None of the patients experienced hyperesthesia or dysesthesia, and one patient remained totally anesthetic for 2 months, but reported return to normal function in 4 months (31).

Altered sensation associated with implants in the anterior mandible was followed up in a prospective study by Walton (2000), who found that approximately 24% of subjects might report transient altered sensation in the short-term after implant surgery, and that only about 1% experienced sensation changes 1 year after implant surgery (32).

Traumatic injury of the inferior alveolar nerve following dental implantation was found in 17.75% of cases in a study by Kubilius et al. (2004); mild nerve damage was found in 9.92% of patients, moderate damage in 7.05%, and severe damage in 0.78% of cases (33).

In a study of Ferrigno et al. (2005), it was shown that 21.1% of patients who had undergone dental implant placement experienced neurosensory disturbances registered by light touch, pain, and 2-point discrimination techniques (34).

In an initial questionnaire approach conducted by Abarca et al. (2006), cases of neurosensory disturbances after immediate loading of implants in the anterior mandible were detected in 33% of patients (35). Some of these patients were also subjected to psychophysical assessment and have been found to present a more frequent reduction of tactility.

A prospective study conducted by Vazquez et al. (2008) to determine the incidence of altered mental nerve sensation after implant placement in the posterior segment of the mandible showed that no permanent sensory disturbances were observed (36). There were 2 cases of post-operative paraesthesia (0.13% of patients). These sensory disturbances were minor, lasted from 3 to 6 weeks and resolved spontaneously.

More recently, Dannan et al. (2013) conducted a retrospective study in a sample of German patients that showed that the prevalence of altered sensation due to injury of the inferior alveolar nerve after dental implant surgery was 2.95% (37).

Longitudinal studies of oral implants in completely edentulous subjects when implants were placed anterior to the mental foramina, suggest a very low incidence of altered sensation (38, 39), leading to the common clinical comparison of the risk for altered sensation after implant placement to that associated with third molar surgery (1% to 5%) (27). However, when implants were placed both anterior and posterior to the mental foramina, the incidence of altered sensation was reported as 10% (40).

It has been suggested that the prevalence of sensory disturbances depends on several factors: the site of implant placement, the type of surgical procedures adopted, the design of the studies, the sensitivity of the testing methods, the choice of the outcomes measures, and the terminology used to describe sensory disturbances.

Table (1) demonstrates cases of altered sensation due to traumatic injury of the inferior alveolar nerve after implant surgery among past studies.

It seems to be that the extreme variation in the reported prevalence of neurosensory disturbances suggests that such problems have not been adequately evaluated.

Diagnostic methods in sensory disturbances

Neurosensory testing can be divided into 2 basic categories: mechanoceptive and nociceptive testing based on the specific receptors stimulated through cutaneous contact. Mechanoceptive testing can be divided based on 2-point discrimination (TPD), static light touch and brush directional stroke. Nociceptive testing is subdivided into pinprick and thermal discrimination.

The most used method for the interpretation of the neurosensory deficit was subjective evaluation. Patients tend to adapt to a deficit and report a normal sensation, whereas the clinical investigation shows a deficit (41). In contrast, patients may still complain of neurosensory alterations, whereas clinical tests are normal (42).

The second method is a list of questions concerning various aspects of the symptoms and function (questionnaire). Answers can be given as yes or no, via multiple-choice options, or by use of a visual analog scale (VAS). The third method described is the light touch (LT) test, which is used to test tactile stimulation by gently touching the skin and to evaluate the detecting threshold of the patient (43).

The fourth method is the TPD test. The TPD test measures the minimal distance a patient can discriminate between 2 separate points. This test is accurate and also offers grading (44).

The fifth method is pinprick pain perception tests. Methods used are touching or pinching the skin with a sharp dental probe, forceps, or needle. The patient should feel a sharp pain (45).

The sixth method is temperature sensation. This method tests the differentiation between hot and cold. The sensation is tested with ice cubes, heated mirror handles, water-filled test tubes that have a temperature of 15°C and 50°C (44).

The seventh method is direction discrimination. Direction discrimination is tested by using cotton swab, a soft brush, or Semmes-Weinstein monofilament. It is recommended to swipe a soft brush from left to right, as well as in the reverse direction, over a 1-cm area, asking the patient the direction of the stimulus (44).

The eighth test is sharp/blunt discrimination. This is mostly tested by use of a dental probe, using the sharp tip and the blunt handle, asking the patient whether the stimulus is sharp or blunts (46).

According to a review conducted by Poort et al. (2009), few studies reported the use of a control site for clinical sensory testing (47).

Clearly, more information are required before the clinician can reliably counsel the patient on the probability of experiencing altered sensation after implant surgery.

Pre-operative diagnostic methods to avoid neurosensory complications

In general, assessment of available alveolar bone and bone morphology, with clinical examination and palpation of the bone ridge at the implant site, is essential in pre-operative implant planing. Various pre-surgical imaging techniques, including conventional radiographs (intraoral and panoramic radiographs, tomography, and cephalometry) and computed tomography (CT), are proposed to localize the mandibular canal. However, Hassfeld et al. (1998) suggested that CT should be reserved for the planning of complex implant treatment in the direct vicinity of the maxillary sinus and nerves and for multiple implant insertion. Other techniques include the use of magnetic resonance imaging (MRI) of the jaw as a diagnostic imaging method before inserting dental implants (48, 49).

More recently, Cone Beam Computed Tomography (CBCT) has gained broad acceptance in dentistry in the last 5 years (50). It has been shown that, with CBCT modality, the visibility of the mandibular canal and the marginal crest, as well as the observer agreement of the location of these structures, was high (51), and that preoperative CBCT measurement could provide important information to avoid nerve damage when installing endosseous implants in the interforaminal region (52).

Although the need for cross-sectional imaging has been strongly recommended (53-55), panoramic radiography is considered to be the standard radiographic examination for implant treatment planing as it imparts a low radiation dose and gives the best radiographic survey (56, 57). On the other side, other researchers (58) evaluated the accuracy of radiological examination methods in quantitative preimplantar bone assessment, and found that panoramic radiography represents an insufficient method for appreciating the preimplantar bone status. That's why it has to be supplemented with other radiological examinations, especially in the cases of alveolar crest atrophy, to avoid accidental penetration of adjacent structures.

CONCLUSION

Injuries of the trigeminal nerve branches remain relatively uncommon events after mandibular implant placement. However, given the frequency of dental and surgical procedures in the mandibular area and the growing field of implant dentistry, it is likely that this complication may occur in a dental professional's practice. If sensory disturbance appears after implant placement, a nerve injury should be suspected. The patient should be carefully examined, the findings documented, and progress or return of sensation monitored diligently.

Although using questionnaires to determine the presence or absence of a problem after a dental procedure is easy and inexpensive, the use of objective methods (i.e. physiological methods) in the evaluation of a population affected by any sensory disturbance, when complaints are detected, is highly recommended to clarify the type, magnitude, extension, and eventual persistence of the neurosensory disturbance.

By using proper treatment planning and modern pre-operative radiographic techniques, one can offer endosseous implants with minimal risk of injury to the trigeminal nerve.

Table 1

Prevalences of inferior alveolar nerve altered sensation due to mandibular dental surgery mentioned in past studies

Study	Type of study	The use of questionnaire?	Number of patients	Prevalence of inferior alveolar nerve altered sensation	Physical examination used?	Special remarks
Vazquez et al., 2007	Prospective	No	1527	0.13%	No	Efficacy of panoramic radiograph in the pre-operative planning was assessed
Abarca et al., 2006	Prospective	yes	85	35%	Yes	Immediate loading implant system was used
Ferrigno et al., 2005	Prospective	Yes	15	21.3%	Yes	Inferior alveolar nerve transposition with implant placement achieved
[illegible] et al., 2004	Prospective	No	340	17.33%	Yes	Medical treatment used to relief neurosensory disorders
Walton, 2000	Prospective	Yes	80	24%	Yes	Pre-surgical and postsurgical assessment of sensation was accomplished
Bartling et al., 1999	Prospective	No	94	8.5%	Yes	-
Wismeijer et al., 1997	Prospective	Yes	110	11%	Yes	-
Ellies and Hawker, 1993	Retrospective	Yes	Not mentioned	36%	No	-
Ellies, 1992	Retrospective	Yes	266	37%	No	Altered sensation in women was higher than men and in patients with history of diabetes
Kiyak et al., 1990	Prospective	Yes	39	43.5%	No	-

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