# PERIPHERAL NERVE INJURIES ASSOCIATED WITH DENTAL LOCAL ANESTHESIA - A REVIEW

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## ABSTRACT

*The aim of the study is to do a short review on the peripheral nerve injuries associated with local anesthesia. Although local anesthesia remains the backbone of pain control in dentistry, there are certain adverse effects of their extensive usage. Incomplete anesthesia, hematoma formation, broken needles, trismus, infection and toxic reactions are all potential problems with dental injections.Another documented complication after injection of local anesthetic in the dental setting is prolonged and possibly permanent alteration of sensation over the areas supplied by the involved nerve known as peripheral nerve injury.*
*Nerve injury due to LA is complex. The nerve injury may be physical (needle, compression due to epineural or perineural haemorrhage) or chemical (haemorrhage or LA contents). Thus the resultant nerve injury may be a combination of peri-, epi- and intra-neural trauma causing subsequent haemorrhage, inflammation and scarring resulting in demyelination (loss of nerve lining).*
*The purpose of the review is to enlighten the practising dentists regarding the occurrence and complications of peripheral nerve injury and to bring to their notice the best possible ways of management and treatment of these injuries which would ultimately be beneficial to both the dentist and the patient.*

***KEYWORDS :*** *Local anesthesia, nerve injury, pain management, toxicity, trauma, iatrogenic*

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### Introduction

Oral health has a significant impact on the quality of life, appearance, and self-esteem of the people.(1) Oral health is a critical but an overlooked component of overall health and well-being among both children as well as adults. Oral health or hygiene problems such as dental caries, periodontitis, and oral cancers are considered as a global health problem in both industrialized and especially in developing countries where people are ignorant and most of the times not aware of such health care.
Dental surgeons and dental health workers have to play a significant role in facilitating public enlightenment that people may appreciate the need for regular dental care and make adequate and proper use of the available dental care facilities.(1)
There are reports that dental patients only visit the dentist when in pain and never bother to return for follow-up in most cases. Some of the reasons for this might be price, income, the distance a person had to travel to get care, and preference for preservation of teeth, but however the thing that tops the chart would be dental anxiety and fear.
The impressive advancement in dental technology in the past few decades have lead to the development of numerous pain management protocols with the age old one being the use of local anaesthetics for performing a painless procedure as well as managing the patient's anxiety issues.

Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage. The discomfort signals actual or potential injury to the body.(2)

A temporary depletion in sensations, particularly nociception (pain)(3,4), during dental procedures can drastically reduce anxiety in the dental clinic and make the clinical experience better and pleasant for any patient. The most common agent which aids in this process and extensively used by the dental surgeons to produce a sense of analgesia in patients during dental, procedure is Local anaesthetics. A local anaesthetic (LA) is a drug that causes reversible local anaesthesia, generally for the aim of having a local analgesic effect, that is, inducing absence of pain sensation by inhibiting nerve conduction during a variety of dental procedures (5,6).Local anaesthetics are also most commonly referred to as the backbone of painless dentistry.Yet regardless of how beneficial a health care procedure maybe , it also has its own set of drawbacks and risks.
Incomplete anesthesia, hematoma formation, broken needles, trismus, infection, toxic reactions and allergic responses, including anaphylaxis, are all potential problems with dental injections.(7,8)
Another documented complication after injection of local anesthetic in the dental setting is prolonged and possibly permanent alteration of sensation over the areas supplied by the involved nerve(s).(9,10,11) due to any peripheral nerve injuries associated with Trigeminal , inferior alveolar and lingual nerve. (12,13)

Local anesthetics used in dentistry are designed to prevent sensory impulses from being transmitted from specific intraoral and extraoral areas to the central nervous system, with minimal effect on muscular tone. Nerve injuries after either supraperiosteal or proximal block injections can affect mechanoreception (touch, pressure and position), thermoreception (hot and cold) and nociception (pain).(14,15,16)

Peripheral nerve injury is a rare complication of regional anaesthesia. Because neurological injuries after peripheral nerve blocks are so infrequent, it is extremely difficult to derive reliable and consistent data about their occurrence . Retrospective studies estimate an incidence of 0.5–1.0%, but one prospective study suggests an incidence of 10–15%
Incidence clearly depends on the definition of nerve injury.(12)Fortunately, most injuries are transient and often subclinical, or present as mild mononeuropathies.

The purpose of the review is to enlighten the practising dentists regarding the occurrence and complications of peripheral nerve injury and to bring to their notice the best possible ways of management and treatment of these injuries which would ultimately be beneficial to both the dentist and the patient.

**NEURAL ANATOMY**

In order to understand neural injury, we need to examine nerve anatomy

Each nerve is externally surrounded by a dense sheath of connective tissue, the epineurium. A layer of flat cells, the perineurium, which forms a complete sleeve around a bundle of axons is found underlying this.This perineurial layer helps to support, protect and sustain the indi- vidual nerve fibres. Perineurial septae extend into the nerve and subdivide it into several bundles of fibres.
Surrounding each such fibre is the endoneurium. This forms an unbroken tube from the surface of the spinal cord to the level where the axon synapses with its muscle fibres, or ends in sensory receptors. The endoneurium consists of an inner sleeve of material called the glycocalyx and an outer, delicate, meshwork of collagen fibres. Disruption of any of the extraneural tissues would cause a sensory disturbance due to interrupted neural transmission collectively known as nerve injuries.(17)

Moreover, Peripheral nerves seems to have a dual blood supply: one from theintrinsic exchange vessels in the endoneurium and the other from an extrinsic plexus of vessels in the epineurial space that crosses the perineurium to anastomose with the intrinsic circulation. Ischaemia has been identified as one of the causes of peripheral nerve injury.(11)

**MECHANISM OF NERVE INJURIES**

Nerve injury due to LA is complex. The nerve injury may be physical (needle, compression due to epineural or perineural haemorrhage) or chemical (haemorrhage or LA contents). Thus the resultant nerve injury may be a combination of peri-, epi- and intra-neural trauma causing subsequent haemorrhage, inflammation and scarring resulting in demyelination (loss of nerve lining)
The exact mechanism of nerve injuires are still a debated topic but numerous theories of nerve injuries have been formulated which are explained below.

**TRAUMA BY INJECTION NEEDLES**

One of the oldest and most probable theories is the direct trauma to the nerve by the injection needle.When the needle contacts the nerve directly, it results in traumatizing the nerve eventually producing prolonged change in sensation. This is the reason why the lingual nerve, which is only 3 to 5 mm from the mucosa and the intraoral landmark for mandibular nerve block, the pterygomandibular raphe, is most commonly involved (more than 70% of cases).
One suggestion is that this is more likely to be the result of trauma. There is another explanation why the lingual nerve is more likely to suffer damage. This relates to its structure. At the region of the mandibular lingula, the lingual nerve is composed of very few fascicles and, in some individuals, it is unifascicular at this point,15 unlike
the inferior alveolar nerve, which is multifascicular in this region. This structural difference may explain why the lingual nerve is more susceptible than the inferior dental nerve to injection damage.
This can be related to a study done by pogrel MA et al, 2010, which stated that Permanent nerve involvement has been reported following lingual nerve and inferior alveolar nerve blocks. This study provides an update on cases reported to one unit in the preceding six years. Lidocaine was associated with 25 percent of cases, articaine with 33 percent of cases, and prilocaine with 34 percent of cases. It does appear that inferior alveolar nerve blocks can cause permanent nerve damage to the lingual nerve as well as inferior alveolar nerve with any local anesthetic, but the incidences may vary.(9)

The correct procedure of administering a mandibular block, the practitioner contacts bone to ensure proper deposition of the local anesthetic as near as possible to the nerve before it enters the canal .(1) A long bevelled needle is often preferred to cause less trauma to the tissues ,hit the bone in the correct angulation and prevent nerve damage on insertion, but the tip of these needles is much more prone to becoming barbed when contacting the bone or when used for multiple injections.(9)

In a study done by Stacey et al 1994, 78% of the long bevelled needles used for conventional mandibular block appeared to be barbed at their tips after the procedure, regardless of bevel placement.(18) More than two-thirds of these needles displayed the more dangerous outward facing barb.(18)These barbs can rupture the perineurium, herniate the endoneurium and cause transection of multiple nerve fibres and even entire fascicles, especially on withdrawal(.19)
The Seddon and Sunderland classification systems categorize this type of injury as axonotmesis or second- or third-degree nerve injury, respectively.(20,21)

**NEUROTOXICITY OF LOCAL ANAESTHETICS**

Local anesthetics produce a variety of cytotoxic effects in cell cultures, including inhibition of cell growth, motility, and survival, and may also produce morphologic changes. The extent of these effects is directly proportionate to the duration that the cells are exposed to the local anesthetic solutions that particular site. Moreover, Moreover it has been suggested that the anesthetic itself causes localized chemical damage to the nerve, if it is injected intrafascicularly or becomes deposited within the nerve as the needle is withdrawn. Chemical trauma causes demyelination, degeneration and inflammation of the surrounding nerve fibre which would lead to the breakdown of nerve blood barrier , which causes endometrial edema. During the attempt made by the nerve to heal, this edema causes Ischaemia. During the period of regeneration and repurfusion, the free radicals present might cause cytotoxic injury to the nerve.
In some studies, the anesthetics prilocaine and articaine have caused more injuries per use than lidocaine. The studies done by Hillerup S et al 2006, included Fifty-four injection injuries in 52 patients were caused by mandibular block analgesia affecting the lingual nerve (n=42) and/or the inferior alveolar nerve (n=12). All patients were examined with a standardized test of neurosensory functions. Mandibular block analgesia causes lingual nerve injury more frequently than inferior alveolar nerve injury. Subjective complaints and neurosensory function tests showed that lingual nerve lesions are more incapacitating than inferior alveolar nerve lesions. Unlike most mechanical injuries after surgery, injection injuries were not followed by a course of spontaneous improvement of neurosensory and/or gustatory function. This indicated that neurotoxicity would be the most possible central aetiological factor.(17)

**HEMATOMA FORMATION**

Many researchers have hypothesized that the needle may possibly traumatize the intraneural blood vessels, thus paving for creation of an intraneural hematoma.(23)Hemorrhage from the epineurial blood vessels would

give rise to constrictive epineuritis, compressing the nerve fibres within the rigid tissue confines and which would eventually lead to localized neurotoxicity.(9)
The damage could be extensive for approximately 30 minutes after the injection. The release of blood and blood products from the epineurial blood vessels into the epineurium during hematoma formation would lead to reactive fibrosis and scar formation, applying pressure to and inhibiting the natural healing of the nerve.

Depending on the amount of pressure elicited by the hematoma, the injury could be classified as neurapraxia (Seddon classification) or first-degree injury (Sunderland) or as axonotmesis (Seddon) or second-degree injury (Sunderland). The first degree injury is characterized by focal block of neural impulses with maintenance of axonal and connective tissue continuity.(9) Recovery usually takes several weeks with the release of pressure and subsequent remyelinization.
The second degree injury is considered to be more severe, with variable amounts of axonal and endoneurial discontinuity and ensuing wallerian degeneration.(11) The proximal seg- ment attempts neurotization, and nerve sprouts can grow as much as 1 to 2 mm per day to span the gap created by the injury. The surviving Schwann cells and the empty endoneurial tubes attempt to guide the nerve regeneration and to provide the axon with metabolites for growth.(11)

**INCIDENCE OF PERIPHERAL NERVE INJURY**

It has become evident that the injection of local anesthetic can produce prolonged or permanent alteration of sensation along particular parts or all of the distribution of either the maxillary (V2) or mandibular (V3) branches of the trigeminal nerve.(9)These altered sensations can be categorized as anesthesias, paresthesias or dysesthesias.(9,24)

**Anesthesia** - It can be represented as the total absence of sensation, including pain. **Paresthesia** – It encompass a broader category of abnormal sensations, which may not be unpleasant.
**Dysesthesia** –It can be represented as a form of spontaneous or mechanically evoked painful neuropathy. This category can encompass hyperalgesia (a rapid and exaggerated painful response to nonpainful stimuli), hyperpathia (a delayed and prolonged pain response), sympathetic mediated pain (pain that is worsened by increasing sympathetic tone) and anesthesia dolorosa (pain in an area of anesthesia).(9,24)
Two-thirds of patients with permanent nerve involve- ment experience anesthesia or paresthesia, whereas one-third experience dysesthesias, which have much greater social and psychological impacts.

The most commonly involved nerve is the lingual nerve (tongue) and it accounts for more than two-thirds of the cases in the literature; the inferior alveolar nerve (lip and chin), including the mental nerve, accounts for less then one-third of the injuries, with the chorda tympani (taste) being involved minimally. Although extremely rare, altered sensation in the maxilla can also result from anesthetic injections.(14)

It is well known fact that an electric shock sensation is experienced by patients with subsequent immediate anesthesia, when the patient undergoes inferior alveolar, lingual or mental nerve block. This strange shock sensation is thought to occur when the needle contacts part of the nerve trunk.(11)
Numerous studies have demonstrated that an electric shock sensation is not indicative of permanent nerve injury, even though damage to the nerve may occur because of needle contact.This form of direct trauma heals within 2 weeks in 81% of patients, with no residual damage to the nerve(9).

**NERVE FUNCTIONING TESTING – SENSORY TESTING**

In most tests, the entire distribution of the affected nerve seems to be involved, rather than a small number of fascicles.(11) In one recent study, the lingual nerve of 33% of patients con- tained a single fascicle at the level of the lingula which makes it more prone for nerve injury during dental procedures. More distally, in the third molar region, the lingual nerve may contain between 7 and 39 fascicles.The inferior alveolar nerve, on the other hand,, has a minimum of 3 fascicles, which could account for its ability to regain sensations.

After the patient has been diagnosed of prolonged altered sensation caused by dental injections or any dental procedure, continued follow-up is a must. It is mandatory to to document the mechanism and the date of the initial injury, the symptom history, prior treatment and its effect, functional deficits (speech and mastication difficulties, tongue and cheek biting, taste dysfunction8,27,29) and the presence of any underlying medical disorder (e.g., psychological problems). If no improvement in function is witnessed within 2 weeks, then it becomes mandatory to refer the patient to an oral surgeon or an oral pain specialist.

Numerous tests are used to define the extent of the injury; however, these tests are qualitative and highly dependent on both the patient's subjective assessment and the practitioner's expertise.(25) Pinprick testing, which represents pain, is used to map out the area of altered sensation. Von Frey's hairs are then used to evaluate touch and pressure sensation. Directional sense is determined using a fine paintbrush, and positional sense using a blunt point. Static and moving 2-point discrimination can be useful, as can testing of temperature sensation using Minnesota thermal disks. The taste sensations of sweet, salt, sour and bitter can also be subjectively analyzed.

**PROGNOSIS**

Regardless of the presence or absence of electric shock sensation, patients with nerve injury after dental injection, have a good prognosis. Spontaneous complete recovery from the altered sensation occurs within 8 weeks in approximately 85% of the cases..9(,11) The inferior alveolar nerve often carries a more favourable prospect of recovery because it lacks mobility and confined to the inferior alveolar canal unlike lingual nerve.

**PREVENTION**

As all would know, prevention is always better than cure, thus it is best to know the methods of prevention rather than waiting for the problem to resolve on its own or searching for the best treatment possible. Prevention of LA nerve injuries is possible and some simple steps may minimize LA-related nerve injuries:

-Avoid high concentration LA for IDBs (use 2% Lidocaine as standard);

-Avoid multiple blocks where possible;

-Avoid IAN blocks by using high concentration agents (Articaine) infiltrations.

There are several advancements in administration of local anesthesia in the past one decade which could replace the use of needles as these are a major cause of traumatic injury to the nerve. Some of the most effective methods would be the use of jet injections , eutectic mixture of local anaesthetics and computer controlled local anaesthetic delivery.

A jet injector is nothing but a type of medical injecting syringe that uses a high-pressure narrow jet of the injection liquid instead of the use of a long syringe/needle from a reservoir. A small amount of local anesthetic is pushed as a jet into the submucosa. It is powered by compressed air or gas, either by a pressure hose from a large cylinder, a built-in gas cartridge or small cylinder. This takes place when the knob is pressed to release air pressure which produces a fine jet of solution which penetrates the mucosa through a small puncture wound to produce surface anesthesia.(2)

Other effective methods would be the eutectic mixture of local anaesthetic commonly abbreviated as EMLA. It contains a mixture of lignocaine 2.5% and prilocaine 2.5%, which forms an oily phase and diffuses through the intact skin. In a study done by Clarke et al , it was reported that the use of EMLA cream for anesthetizing the skin prior to needle insertion is beneficial as this reduces the incidence of injection pain.
Lidocaine and prilocaine separately are solid bases but when mixed in equal quantities by weight, they form a eutectic mixture. It is formulated in to a preparations without any use of non-aqueous solvent, thus this ensures that a higher concentrations of anaesthetic be formulated into the preparation and maintained during application. It primarily works by blocking nerve signals to achieve local anaesthetic effect.

The other alternative which can be used is the computer controlled delivery of local anesthesia commonly abbreviated as CCLAD. CCLAD system enabled an accurate manipulation of needle placement with fingertip accuracy and delivers the LA with a foot-activated control. The lightweight handpiece is held in a pen-like grasp, it provides the user with greater tactile sensation and control. The available flow rates of LA delivery are controlled by a computer and thus remain consistent from one injection to the next. The pain perception was significantly reduced two to threefold when compared to the standard manual syringe.

These are only some of the advancements made in the delivery of local anesthesia, as there are are many more newer method developed and currently being developed. Some of the other methods would be Electronic Dental Anesthesia (EDA), Intra-oral Lidocaine Patch (DentiPatch), Iontophoresis and Intra-osseous Systems (IO Systems).

Intra-operatively, all clinicians should document unusual patient reactions occurring during application of local analgesic blocks (such as sharp pain or an electrical shock–like sensation).(23)

**TREATMENT**

Few studies have specifically addressed treatment for this type of nerve injury. Both surgical and pharmaceutical management have been used, with varying success.
most results in the literature reflect treatment for nerve injuries related to surgical trauma.(26-30) Only one study has published results directly related to a microneurosurgical approach to nerve injuries caused by dental injection; in that study, the overall treatment outcome with exploration and neurolysis was poor.
Long-term pharmacologic therapy has also been found to be effective in some patients. Medications such as anticonvulsants (carbamazepine, phenytoin, gabapentin, topiramate), benzodiazepines, tricyclic antidepressants, antispasmodics (e.g., baclofen) and anesthetics (e.g., lidocaine)have been shown to benefit patients suffering from dysesthesias.

To achieve the goal of absolute pain-free and injury free practice dentistry, more efforts are required to be put in to discover the best method. It is very important for all the dentists to adapt the newer and less traumatic methods of delivery of LA. It is necessary in the current evidence- based era of dental practice for dentists to constantly update, evaluate and incorporate newer drugs and methods into daily practice to provide our patients the best care possible at all times.(2)

**CONCLUSION**

Although local anesthesia remains the backbone of pain control in dentistry, there are certain adverse effects of their extensive usage. Incomplete anesthesia, hematoma formation, broken needles, trismus, infection and toxic reactions are all potential problems with dental injections.Another documented complication after injection of local anesthetic in the dental setting is prolonged and possibly permanent alteration of sensation over the areas supplied by the involved nerve known as peripheral nerve injury.

Nerve injuries after dental injection are of major concern to dentists, as injection of local anesthetic is one of the procedures that dentists perform most frequently on most of the patients . Although the occurrence of this injury is very rare, many practitioners will see this form of nerve injury during their careers. The exact mechanism of the injury has yet to be determined, and little can be done to prevent its occurrence. The prognosis is found be quite good . However, the longer the symptoms exist, the difficult it becomes to treat these, and lesser is the prognosis.
This type of injury carries with it many functional and psychological implications, and referral to both dental and medical specialists may be necessary for continued follow-up and possible treatment.
Increased awareness of this form of complication will allow the practising dentists to effectively communicate the implications and prognosis of the altered sensation to affected patients and thus reducing the incidences of iatrogenic nerve injuries during the course of the treatment.

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