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Nerve Injuries During Root Canal Treatment: A Review

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ABSTRACT

Nerve injury during root canal treatment is not a frequent complication, but when it occurs it needs immediate attention and prompt treatment. The symptoms of nerve injury may range from paraesthesia to hyperaesthesia or even dysaesthesia. Inferior alveolar nerve and its branches are commonly affected. Aetiology is over instrumentation, irritant irrigants and canal medicaments, loss of apical constriction and extruded sealants and obturation materials. Depending on the symptoms and the time of reporting, treatment options may vary. Continuous observation, surgical/ non-surgical retreatment, systemic prednisone, decompression surgery, intentional replantation of the tooth are the various treatment options available. Prevention of such injuries is by attention to detail. Adherence to canal working length throughout the instrumentation procedure and taking a radiograph during the initial phases of the obturation can help to prevent such nerve injuries.

Key words: Nerve injury, Paraesthesia, Endodontics, Decompression.

INTRODUCTION

Nerve injury during root canal treatment is not a frequent complication, but when it occurs it needs immediate attention and prompt treatment. The symptoms of nerve injury may range from paraesthesia to hyperaesthesia or even dysaesthesia. Inferior alveolar nerve and its branches are commonly affected. This article reviews the literature about the aetiology, risk factors, treatment options, prognosis and preventive methods for nerve injuries during root canal treatment.

Nerve Injury during root canal treatment

The risk factors for endodontic nerve injury include;

- Proximity of the tooth to the nerve
- Over instrumentation
- Overfill
- Chemical nerve injury (including sodium hypochlorite)

According to Seddon *et al*. (1943) neural injuries can be classifiedbased on the severity of the tissue injury and the prognosis. They suggested three levels of injury. (1-3)

1. Neuropraxia – It is characterized by local myelin damage, with axon continuity and no distal wallerian degeneration. This form of injury occurs most commonly due to nerve compression. Recovery is usually complete and takes from a few hours to days.
2. Axonotmesis – This type of damage usually occurs in crush injuries. It is defined as loss of continuity of the axon, with preservation of the neural connective tissue sheath, which can support axonal regeneration. Distal wallerian degeneration of the axons occurs. Axons regenerate at a rate of approximately 1 mm per day. But recovery is incomplete and takes several months.
3. Neurotmesis - It is the most severe of all peripheral nerve injuries. Nerve severance occurs and there is anesthesia in the areas

of nerve distribution. There is no chance for sensory recovery.

Paraesthesia is the most common symptom of a nerve injury and is defined as 'a burning or prickling sensation or partial numbness caused by neural injury and it is usually a result of neuropraxia (3). Each patient has a different description for paraesthesia as warm, cold, burning sensation, prickling sensation,aching, tingling sensation, pins and needles, numbness, and itching sensation without any stimuli(4-5).

Other symptoms of nerve injury could be anesthesia, hypoesthesia, hyperesthesia and dysesthesia.

Aetiology

Various studies have shown that, in addition to the effects of the material, the sequelae and untoward effects of nerve injury are location related. The risk of this occurrence rises in the root canal wherein the apical stop is inadequately prepared. Rowe (6) stated that, in teeth with apices approximating the inferior alveolar canal, frequent cause of damage is excess filling material which has passed through the apices and either caused pressure on the neurovascular bundle in inferior dental canal or produced a neurotoxic effect on the nerve trunk. Overextension of materials into the alveolar cancellous bone near other teeth that are not close to a sensory nerve can also be expected to produce mild, to moderate, to severe discomfort until the initial inflammatory response subsides.

The probability of an inferior alveolar nerve injury occurring from endodontic procedures is very less, but when it occurs, it is a serious treatment complication (7). Inferior alveolar nerve injury during endodontic procedurescan result from periapical surgery, over-instrumentation, irritant root canal medicaments and irrigants and overextension by root canal obturation materials (8). Majority of the nerve injuries have been reported in the lower second molars, but may also occur in the first molars and premolars (9).

Three different etiological mechanisms have been suggested for nerve injuries (9)

(1) mechanical trauma due to over-instrumentation
(2) pressure due to the presence of the endodontic point or sealant within the inferior alveolar canal
(3) a neurotoxic effect of the endodontic medicaments/irrigants or sealant materials.

The mandibular canal is a closed structure, which predisposes the enclosed nerve to compartment syndrome due to pressure injury.Due to increase in pressure, the arterial blood supply of the nerve is compressed, which results in an acute phase of inflammation. In the acute phase there is increased vascular permeability, edema, and ischemia, which leads to decreased oxygen delivery to the nerve. Prolonged periods of compression and stretching forces to the nerve can cause fibroblast invasion, scarring, and fiber degeneration all of which lead to irreversible changes in the neural structure. Factors which affect the recovery from the injury are the duration of the trauma and the severity of the lesion. Decompression of the nerve compartment to relieve the pressure may be done in indicated cases to prevent irreversible nerve damage (3).

Endodontic materials which are extruded beyond the apical foramen can lead to chemical neurotoxicity (10-13).The most common endodontic materials which can cause neurotoxicity are paraformaldehyde-containing pastes like Sargenti N2 paste and AH26. Paraformaldehyde is a polymeric hydrate of formaldehydewhich releases formaldehyde gas on contact with water and may cause permanent neural damage (12-13). AH26 is a synthetic resin which releases formaldehyde formed from hexa methylene tetramine and causes neural damage(11,13).

Eugenol-containing cements like Zinc Oxide Eugenol(ZOE) have the potential for long lasting nerve damage.This is because eugenol is a phenol it can penetrate the nerve and coagulate the proteins, destroying the axon of the nerve (3).

AH-26,Hydron, Diaket, Iodoform, Calasept, Endoseal and Chloropercha are the other endodontic materials that have been found to cause serious neurotoxic complications when extruded into the mandibular canal.

Treatment Options

Treatment options for inferior alveolar nerve injury due to endodontic treatment can be divided into two types – surgical and non-surgical. These treatment modalities are based on case reports and studies.

Recognition that a nerve injury has occurred is the first and most important step. Recognition of an inaccurately placed root canal filling usually takes place when a post-treatment radiograph is examined.

Whenever possible, treatment should begin with removal of the causative factor. Inflammation, edema, hematoma or infection should be controlled (14) so as to prevent irreversible changes of the neural structure (3,7,14,15).

Correction of an overextended filling is more difficult than that of an underextended filling. An attempt to remove the overextension is sometimes successful if the entire point can be removed with one tug. Many times, however, the point will break off, leaving a fragment loose in the periradicular tissue. Attempts at removing a laterally condensed overextension, by using chloroform and a Hedstroem file, will usually produce the same results as trying to retrieve an overextended thermoplastic filling material; it may be pushed further into the periradicular tissue. If the overextended filling cannot be removed through the canal, it will be necessary to remove the excess surgically.

Root canal filling materials such as gutta-percha and many sealers are generally well tolerated by the surrounding tissues, and overextended fillings do not automatically require surgical removal if asymptomatic and not associated with lesions. If symptoms persist from a tooth with an overextended gutta-percha filling, surgical removal of the excess material is usually a relatively minor procedure. If the root canal has been adequately cleaned and filled, a retro- filling is not necessary.

In re-treatments, the material being removed and the method of removal both affect the potential for overextension and extent of damage to the surrounding tissues. Spangberg (16) studied the effect of various root canal filling materials on HeLa cells and found that amalgam, gutta-percha, and zinc phosphate had the least toxic effect followed by calcium hydroxide paste, AH26 and Tubliseal . Chloropercha, Diaket, and N2 had the strongest toxicity.

The severity of nerve damage increases with duration of injury, so early intervention is better. If the post treatment radiograph shows signs of endodontic material inside the inferior alveolar canal, the patient should be carefully monitored during the post operative period.Most minor overextensions do not require anything more than periodic observation. If nerve injury-related symptoms appear, aggressive treatment, may be required, which includes decompression, debridement, irrigation and cleaning of the nerve canal (9).

The various drugs that have advised for a nerve injury include antibiotics, nonsteroidal anti-inflammatory drugs and corticosteroids, proteolytic enzymes to disintegrate any coagulum and vitamin C for its antioxidative action (17).

Gatot and Tovi (18) suggested the use of systemic prednisone to shorten the course of the condition, prevent secondary fibrosis and lessen the severity of sequelae.Decompression surgery may result in complete resolution of the anesthesia or paresthesia.The prolonged presence of a root canal sealer on the nerve can prevent resolution of the ischemia to the nerve, due to epineural edema, which can further press on the nerve, connective tissue proliferation and epineural fibrosis. Chances are there for complete recovery from anesthesia when the decompression surgery is done at the earliest.

Surgical therapy is indicated in cases where the nerve has been sectioned, where there is a compression of nerve by a foreign body, neural neoplasia, and persistent anesthesia or paresthesia (17). The most important advantage of surgical intervention in the early stages of paresthesia is restoration of the neural microvasculature, which makes recovery of the nerve possible. Buthe results

of surgical decompression are not always predictable and there are some risks associated with the procedure like sectioning of the nerve or further damage that can cause complete anesthesia (15). Girard (19) has advised to approach with caution any procedure with the potential to cause nerve damage.

Intentional replantation is defined as the removal of a tooth and its re-insertion into the socket after endodontic manipulation or obturation of the canal, or both and was introduce by Grossman (20). It is a relatively conservative procedure for treating paraesthesia due to nerve injury caused by root canal treatment.If the case selection is proper this method of treatment yields a predictable outcome. Bender and Rossman (21) have recommended intentional replantation for paraesthesia due to RCTas a useful treatment option and not a last resort. They recommended this method as the treatment of choice for lower second molars, single-rooted teeth and lower first molars ,when periapical surgery is not feasible, when a patient is not willing for periapical surgery or a when a previous periapical surgery has failed. But this method should be considered only when retreatment is not feasible. Modern endodontics offers many opportunities to diagnose and treat cases that traditionally presented a tremendous clinical challenge (20,22-25).

Various drugs which promote nerve recovery after an injury have been evaluated which include vitamins B_1, B_6 and B_{12} and the neuro transmitter GABA or its analogues (26-29).These drugs have found to improve the regeneration of peripheral nerves in animal studies and their effects in humans do not have much evidence in the literature.

Prognosis

Apparently a correlation exists the duration, origin and significance of the injury and the prognosis for the paresthesia. The longer the mechanical or chemical irritation persists, the more degeneration of the nerve fibre that will occur and the greater the risk that the paresthesia will become permanent (30).

Prevention

Attention to detail is the best form of prevention. Accurate working lengths and care to maintain them will help prevent overextensions. Modifying the obturation technique may also be preventive. In younger patients with wider root canal systems or in teeth with apical resorption the apical stop may not be adequate to prevent gutta-percha from being extruded. Techniques that create apical barriers with calcium hydroxide, dentin chips, or MTA maybe useful in these cases.

Incorporation of two simple steps into one's root canal treatment technique can significantly decrease the chance of aberrant fillings; first, confirmation and adherence to canal working length throughout the instrumentation procedure and, second, taking a radiograph during the initial phases of the obturation to allow for corrective action.

Roane *et al* have attempted to minimize apical canal transportation, a frequent cause of overextrusion of root canal filling by use of the "balance forced" approach (31).

CONCLUSION

This review reveals the need to exercise great care in all steps of root canal treatment of nonsurgical endodontic therapy, especially when the root apices are in close proximity to vital anatomic structures such as the inferior alveolar canal. Attention to detail is vital to prevention of nerve injuries during endodontic therapy. If injury has occurred early and prompt intervention must be done to relieve the patent of the symptoms and for better recovery.

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