



Paresthesia and Dysesthesia after Root Canal Therapy of a Mandibular Molar: Diagnosis and Management in a Clinical Case Report

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Abstract

Inferior alveolar nerve (IAN) injury is a rare but serious complication of root canal treatment (RCT), typically caused by mechanical over-instrumentation, chemical irritation from extruded sealers, or thermal damage. We report the case of a 42-year-old woman who developed persistent burning pain, numbness, and dysesthesia of the right lower lip and gingiva after RCT of the right mandibular second molar. Initial management by a general dentist involved retreatment and calcium hydroxide medicament; however, early CBCT was misinterpreted, and referral was delayed. High-quality CBCT and clinical testing later revealed obturation material within the IAN canal and a horizontal fracture of the distal root. Endodontic retreatment, followed by maxillofacial microsurgery for removal of extruded gutta-percha/sealer, combined with neuroprotective therapy (dexamethasone, vitamin B, and adjunctive low-level laser therapy). The patient achieved complete resolution of pain and sensory disturbances within one month, and remained asymptomatic with radiographic periapical healing at 12-month follow-up. Comprehensive preoperative imaging, cautious canal instrumentation, independent CBCT interpretation by the endodontist, and timely specialist referral are essential to minimize the risk of IAN injury. Even with delayed intervention, targeted microsurgical removal of extruded material can result in favorable neurological recovery.

Keywords: Dysesthesia; Extrusion; Mandibular Second Molar; Neuropathy; Neurotoxicity; Paresthesia; Root Canal Treatment; Sealer Extrusion

Introduction

The inferior alveolar nerve (IAN) is a division of the mandibular branch from trigeminal nerve, which is responsible for sensory innervation of the facial skin and the corner of the lip, in addition to supplying sensation to the pulps of the mandibular teeth [1]. IAN runs through the mandibular canal within the lower jaw, and its proximity to the roots of mandibular teeth, particularly the third molars in the first place and mandibular second molars (MSM) next, is a critical consideration in dental procedures like extractions and implant placement. Understanding this proximity is essential for minimizing the risk of nerve damage during these procedures [2]. The apices of the second and third molars in the mandible typically lie within 1 mm of the canal roof, and a wall of low-density, extremely porous spongy bone protects the neurovascular bundle within the canal [3].

The predominant cause of injury to this nerve is the surgical extraction of the mandibular wisdom tooth. Moreover, the

administration of local anesthetic, implant surgery, orthognathic procedures, mandibular fractures, and root canal therapy (RCT) all contribute to canal damage and IAN injury [4]. The incidence of nerve damage differs throughout various publications and is contingent upon the underlying cause. The rate of nerve injury after wisdom tooth extraction varies from 0.4% to 13.4%, while non-iatrogenic complications, such as mandibular fractures, range from 46% to 81% [5]. Despite being rare, iatrogenic IAN damage resulting from RCT is a serious complication. This can lead to altered sensation, pain, or even permanent nerve damage in the lower lip, chin, and surrounding areas [2].

Overextension/overfilling of the root canal filling materials in mandibular premolars and molars can damage the IAN bundle due to the proximity of the related roots [6]. The rate of IAN damage associated with RCT remains ambiguous due to the spontaneous healing of several cases that go unreported. The predicted incidence of nerve injury resulting from RCT ranges from 0.96% to 7.5% [7, 8]. Iatrogenic nerve damage during



different stages of RCT from preparation and over-instrumentation to over-obturation can occur due to several factors, including: mechanical injury; excessive instrumentation and the extension of gutta-percha beyond the foramen, chemical damage; due to the discharge of sealers, disinfection agents, and medicaments [9], and thermal injury; extrusion of warm softened gutta-percha with/without sealer during vertical compaction method used for canal obturation [10]. Moreover, inflammation and infection resulting from a necrotic tooth or unsuccessful prior RCT may potentially induce sensory nerve abnormalities [9].

RCT may cause IAN injuries in about 1% of mandibular premolars (7) and 10% of mandibular second molars [11]. The risk of IAN injury is greater with the mandibular second molars compared with the mandibular first molar and premolars [6]. During RCT, several factors influence the probability of nerve damage, such as tooth angulation, configuration of the canal, naming position of the apical foramen, the presence of accessory foramina, the presence/absence of cementum around the periapex, quality and density of the trabecular bone, the degree of cortication of the IAN [11, 12], the nerve's trajectory relative to the tooth root, technical specifications, and the selection of the root canal filling system and sealer type [13]. In the periradicular space, a substance like sealer can move through four possible routes: the mandibular canal, drainage through lymphatic veins, dissemination through the veins of the periapical region, and diffusion through the soft tissue between the bone and mucosa [14]. Endodontic sealers can exhibit cytotoxicity, especially when fresh or in the initial setting phase. The degree of cytotoxicity varies depending on the specific sealer material, its composition, and the duration of exposure. Sealers based on epoxy resins release formaldehyde and other potentially toxic components during the initial setting process [15]. Extrusion of the sealers has been shown to have cytotoxic, genotoxic, and neurotoxic effects on the periradicular or close anatomical tissues [16]. When the root canal sealers contacted a nerve, it has been reported that the sealers affect nerve transmission [17].

These nerve damages may result in adverse sensory disruptions, including pain, paresthesia (an abnormal sensation that is not unpleasant), dysesthesia (an abnormal sensation that is unpleasant or painful), or anesthesia [18, 19]. The alteration in sensation and discomfort resulting from nerve damage may hinder speaking, eating, drinking, and dental hygiene, significantly diminishing the patient's quality of life and potentially causing profound psychological repercussions [20, 21].

Research indicates that roughly three months post-nerve damage, both central and peripheral alterations transpire within the neurological system, which are likely unresponsive to surgical interventions. This highlights the imperative for prompt

treatments and requisite therapeutic measures in instances of nerve injury [22]. In-time intervention/treatment can lead to recovery/restoration of function with various degrees from significant to optimal. In cases where nerve damage is caused by a foreign body, such as a dental implant or an overstuffed root canal filling, prompt action is essential [23].

The way to successful treatment goes through exact history taking, thorough objective testing, meticulous radiographic examination, and precise operation.

This case report presents the critical error of a general practitioner in terms of endodontic treatment of MSM without proper imaging (using bitewings instead of periapical radiography), ongoing post treatment pain that was misdiagnosed by relying on low quality biased cone-beam computed tomography (CBCT), rather late referral of the patient to Endodontist and at last, diagnostic issues associated with chronic and severe pain succeeding RCT of a MSM, characterized by signs of nerve injury. The readers are strongly invited to pay attention to all the procedures and common pitfalls in radiographic evaluation, which will be discussed in detail.

Case Report

This case report has been written according to the Preferred Reporting Items for Case reports in Endodontics (PRICE) 2020 guidelines [24]. The patient provided oral and written consent for the treatment and approved the use of data in this report.

A 42-year-old woman was referred from a general practitioner to the Department of Endodontics at the Faculty of Dentistry. The Medical history revealed no history of systemic illness. Her chief complaint was persistent right-sided pain after undergoing root canal treatment (RCT) of the right mandibular second molar (RMSM), which was conducted five months earlier. Upon communication with the dentist, the details of the intervention were revealed. The history of present illness and dental history is as follows.

According to the general practitioner and the patient herself, the patient had presented with bite-wing radiographies that showed a class II cavity on the right MSM. The general practitioner started cavity preparation, and after pinpoint pulp exposure, she decided to perform RCT. RCT was done without taking a periapical radiograph or rubber dam isolation. Root canal preparation was done with Denco Blue rotary files (Shenzhen Denco Medical Instruments, Shenzhen, China). Canals were obturated with lateral condensation of 4% taper master gutta-percha cones and Beta RCS sealer (Betadent, Tehran, Iran), and the tooth was restored within the same session (Fig. 1A-1D).

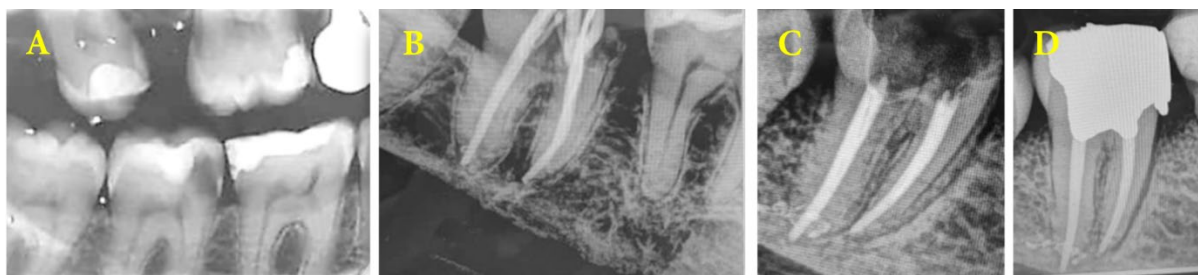


Figure 1. Primary root canal treatment by a general practitioner; A) Bite-wing radiography as the pre-operative image, note the class II cavity on the mandibular second molar; B-D) RCT/over-obturation of the canals, and coronal restoration

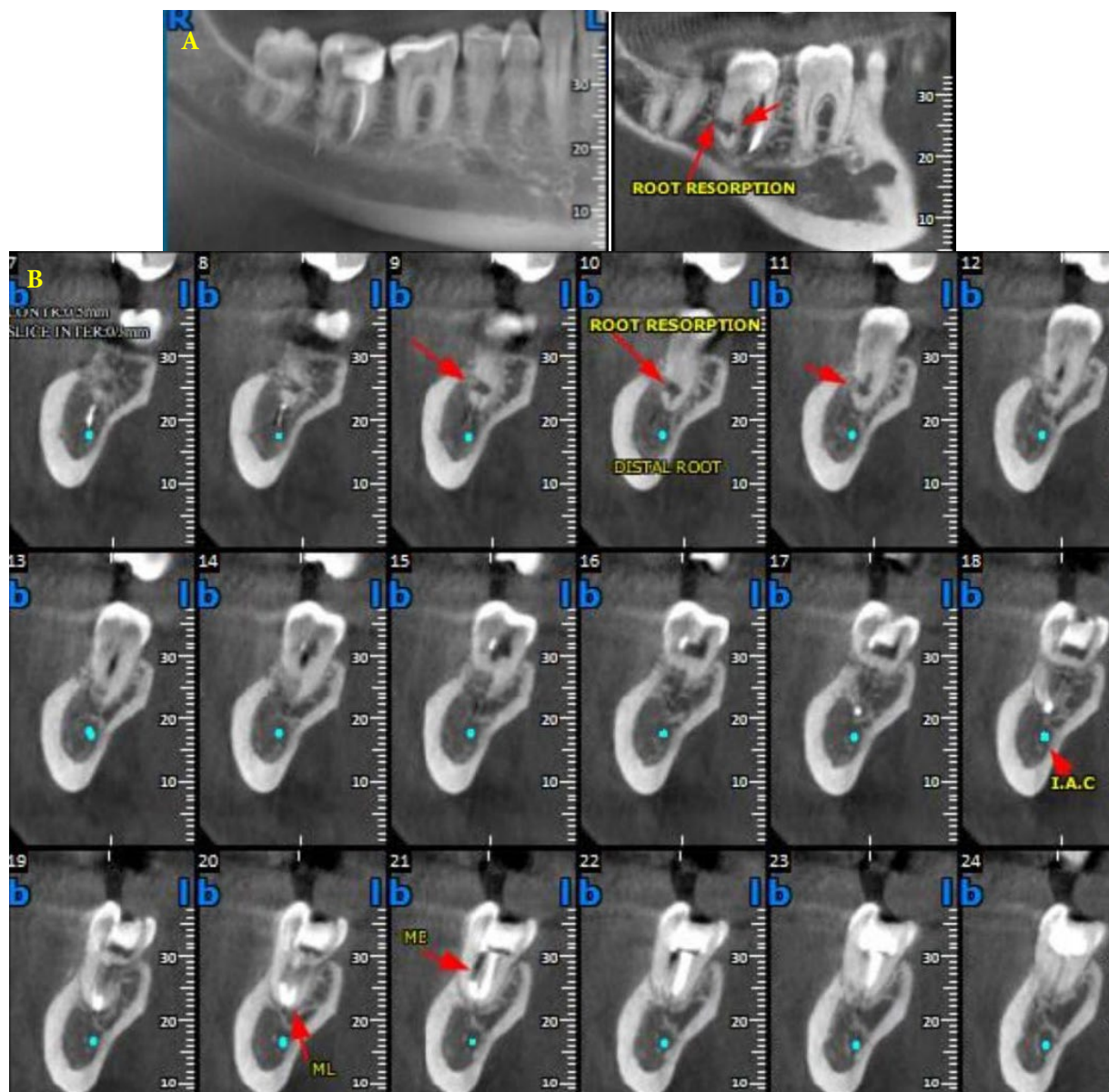


Figure 2. CBCT images taken after RCT of the right mandibular second molar and placement of CH in the distal canal due to the patient's pain; A) Frontal sections and B) Axial sections of the right mandibular second molar, prescribed by the general practitioner upon continuous pain after RCT. Note the distal canal, which is medicated with calcium hydroxide paste and red flash, pointing to a radiolucency diagnosed as resorption



Figure 3. Treatments done by endodontist: A) Pre-operative radiograph; B) Retreatment and placement of CH; note the remaining gutta-percha pieces in the periradicular area; C) Obturation of the canals; D) CEM plug in distal canal up to the fractured piece of apical section and crown filling with glass ionomer

According to the general practitioner and the patient herself, after the patient's dismissal, she complained of continuous pain, which was worsened upon chewing, for weeks. The patient presented to the general practitioner's dental office again four weeks after the primary treatment. The dentist suspected overfilling of the distal canal and started retreatment and gutta-percha retrieval. According to the patient and confirmed by the dentist, she used excessive force to extirpate the 1-2 mm gutta-percha section, which was extruded beyond the apex. The dentist even mentioned trying to use a cotton pellet soaked with chloroform, which was wrapped around a #30 H-file to forcefully grasp the gutta-percha piece. After an unsuccessful effort, she filled the canal with calcium hydroxide (CH) paste (Vitapex, Neo Dental International Inc., Federal Way, WA, USA) and sent the patient for a CBCT. The CBCT images (which were not high quality for endodontic purposes and lacked much data) emphasized the presence of a radiolucency in the apical section of the distal root that was labeled as resorption by a radiologist, which is now proven to be wrong (Fig. 2). Afterwards, the patient's complaint of pain continued for another four weeks. Finally, the dentist decided to refer the patient to an Endodontist, suspecting "painful tooth after RCT with internal resorption" almost two months after primary treatment.

After the patient visited the Endodontist, a thorough history was taken, and a new periapical radiograph was taken (Fig. 3A). All radiographies and images were displayed on a liquid crystal display monitor (LG 17MB15, Seoul, Korea) with a resolution of 1280×1024 pixels and a refresh rate of 370 to 380 MHz. Based on the CBCT images and history of treatment from the dentist, the horizontal line on the distal root was diagnosed as a horizontal root fracture, which occurred after forceful retreatment of the root canal by the dentist (Fig. 3A).

Endodontic retreatment of the MSM was conducted (Fig. 3B), and the three canals were medicated with pure CH (Prevest Denpro, Golchai, Iran) for one week. Two pieces of extruded gutta-percha, the lengths of which were about 2-3 mm, were not extirpated, and no effort was made to do so due to proximity to

the IAN canal. During this time, the patient's pain continued, although to a lesser degree. After one week, the mesial canals were obturated with lateral condensation of gutta-percha and sealer (AH-Plus, Dentsply DeTrey, Konstanz, Germany). The distal canal was bio-obturated with calcium-enriched mixture (CEM) cement (BioniquDent, Tehran, Iran) up to the fracture site and the separated root piece (Fig. 3C & 3D) [25, 26]. The tooth was provisionally restored with light-cured glass ionomer (Fuji II LC; GC, Tokyo, Japan) (Fig. 3E).

One week after the Endodontist's visit and retreatment, the patient's pain and discomfort continued. This type of pain continued after the primary endodontic treatment session done three months earlier. This pain had a burning nature and conflicted with the patient's tooth brushing routine. Soft touching of the alveolar mucosa triggered the burning, painful sensation. The patient would give a score 6 of visual analogue scale (VAS) on a 10-centimeter ruler to this pain. However, a mucosal numbness was present at the time of the visit by the endodontist. Also, she mentioned a tingling sensation near the lower lip corner. All these revealed paresthesia and dysesthesia. Taken together with the history of treatments taken from the dentist, a new high-quality CBCT was ordered, suspecting chemical and mechanical trauma to the IAN. Considering the delayed manifestation of paresthesia and tingling symptoms, the possibility of chemical nerve damage was also considered. The new CBCT images revealed gross violation of the IAN canal by the endodontic obturation material. Moreover, the fracture of the distal root due to excessive pressure during the dentist's retreatment was confirmed (Fig. 4).

To sum up, all these procedures done by the GP could have led to injury of the IAN:

- 1-Not taking a proper radiographic image before starting RCT of the MSM to estimate the distance of the IAN canal from the tooth apex, and considering referral for RCT.
- 2-Probably some IAN canal injury after (over?)-instrumentation and over-obturation of the root canals. Especially considering the resin-based sealer (Beta RCS) to be neurotoxic, apart from the mechanical trauma on the IAN and canal.

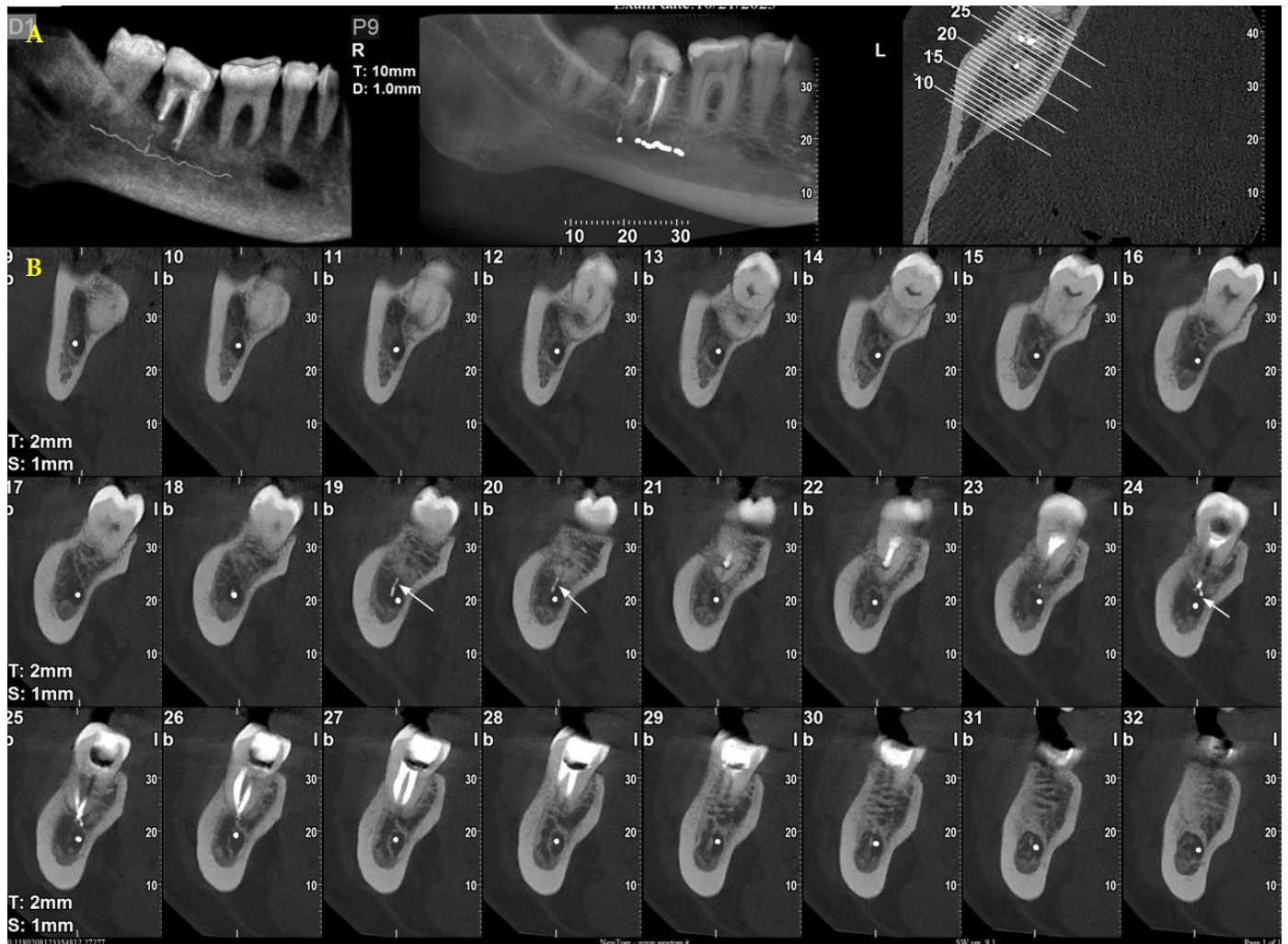


Figure 4. Post-retreatment CBCT images taken for the second time after IAN trauma was suspected; A) Frontal view indicating the obvious presence of obturating materials inside the IAN canal; B) Axial sections revealing the oblique horizontal root fracture in the distal root, although again interpreted as resorption by the radiologist

- 3-An effort to forcefully extirpate the gutta-percha pieces by using an H-file wrapped by a pellet soaked with chloroform (which is highly neurotoxic) in the extra-radicular area, which led to a horizontal fracture of the distal apex. This fractured piece could have worsened pain and changed its pattern to a more odontogenic type rather than neuropathic.
- 4-Relying on the primary CBCT report indicating root resorption and not considering in-time referral of the patient to an Endodontist.

This was how IAN's injury was diagnosed after ten days of patient referral to an Endodontist. Because it took two months for the GP to consider referral, in-time treatment was of utmost importance.

As it is important to regularly evaluate patients with nerve injury, during the initial 72 h after the accident, the golden

evaluation time had passed. It is stated that if the symptoms of moderate/severe nerve injury do not improve or even worsen two months after the injury, surgical interventions are necessary [34-36]. The patient was referred to the oral and maxillofacial surgeon for evaluation of the possibility of surgical intervention and for extracting the gutta-percha and sealer from the IAN canal. If our doubt were to turn into certainty, tooth extraction would not be beneficial, as the IAN damage would not be addressed, since the extruded obturating material was still present inside the mandibular canal.

Based on this diagnosis, the surgeon conducted a microsurgery to excise the displaced gutta-percha from the IAN canal roof. Under magnification of the dental operating microscope OPMI 1 (Carl Zeiss, Oberkochen, Germany) with a 10 to 40.5 cm of working distance and halogen light at 12 V, a

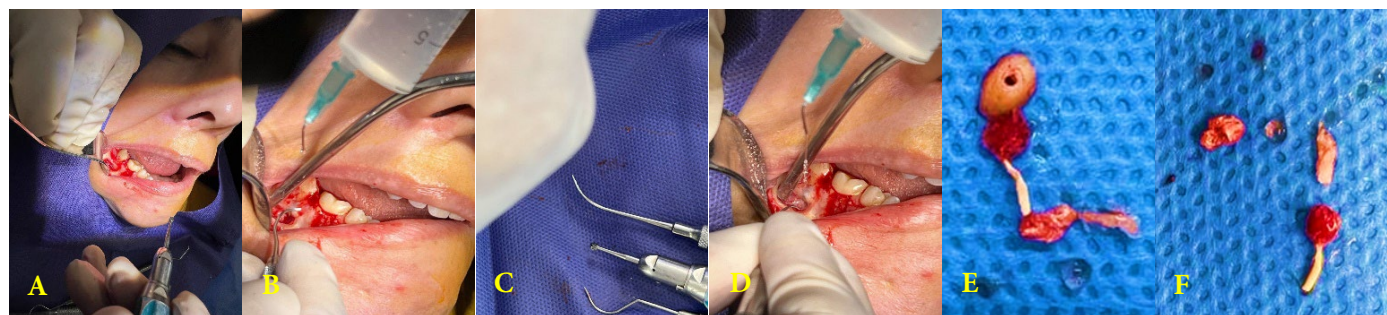


Figure 5. Surgery of IAN canal for extirpation obturating materials: A) Preparation of bony window and IAN canal roof removal; B) Canal exposure; C) Nerve lateralization device; D) IAN canal irrigation; E) Removal of the separated apex and obturating material from the IAN canal; F) Extruded obturating material taken out of the canal



Figure 5. A) Pre-surgical radiography; B) Post-surgery radiography; C) One week after surgery and suture removal day, the tooth was restored; D) Twelve-month follow-up radiography

nerve retractor instrument was used to protect the IAN during removal of the cortical layer in the close vicinity to the neurovascular bundle by means of a surgical bur. The surgeon removed the buccal cortex surrounding the IAN canal and removed the canal roof. With nerve lateralization, the IAN was exposed, and traction was used to deflect it laterally while the canal irrigation was being administered with a solution of dexamethasone and normal saline, and the obturation materials were curetted (Fig. 5).

After the surgical treatment (Fig. 6B), the patient's prescription comprised 0.5 mg dexamethasone tablet (AbuRaihan Pharmaceutical, Tehran, Iran) and 100 mg of vitamin B1 tablet (Jalinous Pharmaceutical, Tehran, Iran), each one once daily, while low-level laser therapy using the Doctor Smile Wiser diode laser was applied as part of the post-operative management after nerve injury. The treatment protocol included 980 nm, 100 J/cm², 70 mW, 0.028-cm² beam, for three sessions, according to current clinical recommendations [27].

After the treatment, the patient's acute symptoms subsided, and within a month, the pain and discomfort resolved. Sensory testing, including a light touch of the lower mandibular area and lip corner, revealed no abnormal sensation or pain, and two-point discrimination was indicative of the patient's sensory reconstruction. After that, the patient was referred for the final crown restoration. One week after surgery, the sutures were

removed, and the tooth went under permanent restoration (Fig. 6C). During the 6-month follow-up, the patient reported the absence of pain/discomfort, and all signs of paresthesia had entirely subsided. The one-year follow-up indicated healing of the periapex and absence of symptoms (Fig. 6D & Fig. 7).

Discussion

This case analyzed the patient's complaints following a root canal treatment and underscored the necessity of a comprehensive clinical assessment, along with a meticulous evaluation of three-dimensional scan pictures and pretreatment radiographs. A significant aspect of this case was that the general dentist commenced the root canal treatment of the second mandibular tooth utilizing a bite-wing radiograph. This rendered it infeasible to precisely evaluate the length of the roots and their proximity to the nerve tissue. Furthermore, in the preliminary post-treatment CBCT, the slice intervals made by the radiologist on the image precluded the observation of the gutta-percha beyond the canal.

This issue is most likely due to the imaging factors, such as voxel size limitations and anatomical factors [2]. From the authors' point of view, the radiologist faced a lack of information regarding the nature of radiolucency of horizontal root fracture on the distal root, which was interpreted as root resorption. This emphasizes the

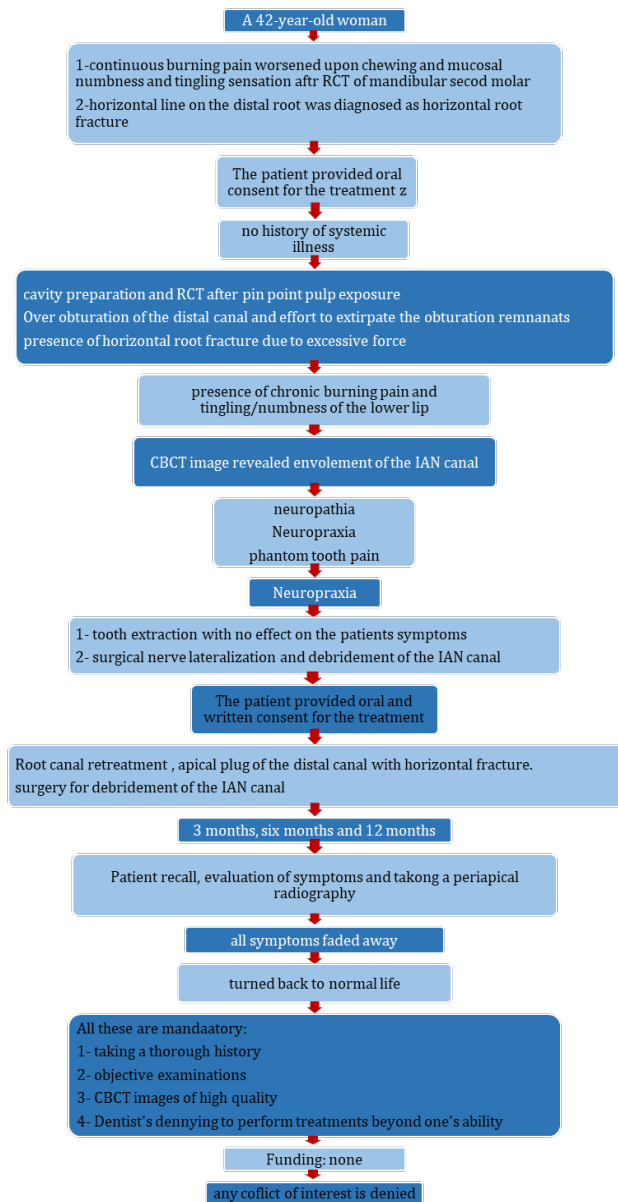


Figure 6. PRICE 2020 Flowchart [24]

importance of the endodontist critically reviewing CBCT scans [28–31], and obtaining compressed discs directly from the radiologist, rather than relying solely on the radiology report. As is obviously seen, the primary CBCT did not point out the IAN canal involvement, and a misdiagnosis made by the radiologist distracted the dentist's mind. Moreover, the importance throughout history, both for the patient and dentist, cannot be overlooked.

A lot of research shows that IAN injuries happen more often in women. This is because, first, women go to the dentist more often [32–34], and second, there is less space between the nerve and the root apex of the mandibular molars, which makes this risk higher [32, 35]. Although the probability of

total nerve recovery is identical for both genders, the patient's demographic status appears to have no impact on the prognosis of nerve healing [36].

An investigation by Lampert *et al.* [19] showed that surgical procedures for nerve damage resulting from endodontic treatments can enhance nerve sensory function, corroborating the findings of the current study. Several studies suggest that surgical intervention is necessary if a patient's symptoms persist and show no improvement 90 days after a nerve injury. However, postponing intervention for six months is advisable if there are evident indications of neurological enhancement, allowing for consistent monitoring and assessment of the patient's improvement [1].

Castro *et al.* [4] conducted a study on endodontic injuries to the inferior alveolar nerve, and found that the best results happen when extruded materials are removed from the nerve space within the first 72 h after the injury. Delays increase the chance of nerve damage that cannot be fixed. Furthermore, it underscores the importance of a comprehensive assessment of pre-operative radiographs and meticulous regulation of working length with an apex finder and radiographs.

In this report, the patient had pain for two months and exhibited paresthesia after a delay of several weeks, thereby increasing the probability of a chemical nerve injury. Paresthesia is a sense of warmth, cold, burning, aching, prickling, tingling, numbness, or itching in the absence of stimuli and is caused by local interventions such as application of local anesthesia, trauma, complicated RCT, third molar surgery, orthognathic surgery and implants are among the local/systemic factors naming microbial infections, multiple sclerosis, lymphoma, and diabetes mellitus [37].

Despite the postponement of surgical intervention relative to the emergence of the patient's symptoms, the outcomes of nerve regeneration from the injury were entirely good. Nerve injury was probably neuropraxia, which was caused by mechanical damage from using too many instruments and chemical damage from sealers and canal-filling products getting into the foramina. Neuropraxia is the mildest form of peripheral nerve injury, characterized by a temporary disruption of nerve function without structural damage to the nerve itself. It involves a blockage of nerve impulses, leading to symptoms like numbness, tingling, or weakness in the affected area. Recovery is typically spontaneous and complete, usually occurring within weeks or months [38, 39]. Neuropraxia is the least severe type of peripheral nerve injury, according to classifications like Seddon's classification. The nerve damage is usually reversible, and the nerve can recover its function [39, 40].

Due to the potential for delayed nerve damage after RCT, it is advisable to regularly evaluate patients at risk of nerve injury, particularly during the initial 72 h after the procedure, to provide timely intervention if symptoms develop. Treatments for mild to moderate nerve injuries typically encompass non-surgical approaches, including pharmacotherapy, laser therapy, and psychological interventions [41]. In cases of moderate to severe nerve damage or when the patient's symptoms don't improve two months after the injury, surgical interventions are necessary [42-44]. As corticosteroids, prednisone and dexamethasone were used, along with pregabalin, which is used to treat seizures and depression. These drugs have provided positive and useful results in most studies about nerve damage. You must take them promptly after the onset of nerve injury to achieve optimal results. Concerning vitamin B supplements, research findings on peripheral nerve injuries have been encouraging, although their efficacy on inferior alveolar nerve injuries remains uncertain. Furthermore, there exists no established protocol for the administration of drugs [45]. Research indicates that the diode laser, operating at a power below 500 mW and a wavelength of 810-830 nm, produces optimal outcomes for nerve regeneration. Employing lasers instead of pharmaceuticals mitigates the adverse effects associated with medications on the body. At the same time, using lasers instead of surgical techniques reduces the risk of morbidity associated with surgery [45].

The surgical intervention can include different modalities, depending on the situation, such as extraction of the tooth, apicoectomy, osteotomy, removing extra sealant and gutta-percha from the canal, and microsurgery for nerve end-to-end anastomosis [4]. The outcome is contingent upon the kind and severity of the injury, its etiology, the patient's symptoms, and the timing of the intervention. The younger the patient, the shorter the gap between injury and surgical intervention, and the less strain during wound repair, the greater the probability of surgical success [45].

In this case, after the onset of neurological injury symptoms, the patient underwent a combination of medicinal and surgical interventions to improve their condition. This case shows how important it is to do thorough clinical and radiographic exams to get a good idea of the tooth's anatomy, the connection between the root of the tooth and the nerve canal, and the need to carefully look at pre- and post-operative x-rays and correctly interpret CBCT scans. The most efficacious method for addressing nerve

damage is to avert its occurrence initially. Moreover, it is crucial to promptly refer the patient to the appropriate specialist when they exhibit symptoms of nerve injury.

In retrospect, this case also underscores the importance of considering vital pulp therapy (VPT) as a conservative alternative to RCT when the pulp is only mechanically or cariously exposed [46, 47]. VPT procedures such as pulpotomy or pulp capping have shown favorable long-term outcomes, particularly in cases where adequate isolation, biomaterials with bioactive properties, and proper diagnosis are employed. If VPT had been selected instead of RCT in this case, the risks associated with canal over-instrumentation near the IAN could have been entirely avoided. Therefore, careful case selection and adherence to current evidence-based guidelines for VPT may help preserve pulp vitality and reduce the likelihood of iatrogenic complications.

Conclusion

Inferior alveolar nerve injury is a potential complication of endodontic treatment, often due to mechanical over-instrumentation or chemical irritation. This case highlights the importance of taking a complete radiographic examination and not relying solely on limited images like bite-wings. Furthermore, it is important to enhance our knowledge to interpret CBCT scans correctly and not rely solely on the radiologist's report. Last but not least is to remember that the primary decay on this tooth could have been treated through VPT rather than a complicated RCT by a general dentist without enough equipment and eligible pre-operative data.

Key learning points:

- 1-Always take a complete history and perform a thorough clinical examination;
- 2-Utilize three-dimensional imaging (CBCT) and pretreatment radiographs carefully;
- 3-Limited images like bite-wings may be misleading. Never initiate root canal treatment based only on bite-wing radiography, as they fail to show full canal length, and do not indicate the proximity of root apices to the inferior alveolar nerve (IAN).
- 4-Endodontists should review CBCT scans personally. Do not rely exclusively on the radiologist's report, as their misinterpretation may distract the clinician's focus and delay proper diagnosis.
- 5-General practitioners should be aware of their root canal treatment abilities. Delayed or incorrect diagnosis can lead to neuropathic complications.

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Conflict of interest

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Authors' contributions

Conceptualization: MF; Methodology: MF/AH; Formal Analysis and Investigation: MF/SK; Writing-Original draft preparation: SK; Writing-review and editing: MF; Supervision: MF. All authors read and approved the final manuscript

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