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CLINICAL ARTICLE

TREATMENT OF YATROGENIC POST-TRAUMATIC NEUROPATHY ASSOCIATED WITH ENDODONTIC THERAPY USING 3D TECHNOLOGIES

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Abstract

Post-traumatic neuropathy is one of the complications of endodontic treatment, represents a serious problem, manifested by sensory disturbances and has a significant negative impact on the quality of life of patients. Mechanical pressure on the filler causes swelling and hematoma and, due to the chemical action of the substance, neurotoxicity. The decision to treat a patient with trigeminal neuropathy requires complex treatment. Early surgical removal of excess endodontic material resulting from endodontic treatment provides the best prognosis for recovery. With the development of modern digital technologies, advances have been made in the endodontic treatment process.

The presented clinical case describes original method for the treatment of endodontic inferior alveolar nerve injuries associated with endodontic therapy using surgical template obtained by three-dimensional software modeling. Using computed tomography software, a template was developed for drilling the bone in the projection of the localization of the material. The surgical template is printed with a 3D printer, after installation in the oral cavity, osteotomies are made under X-ray and excess material is removed, after which the patient is prescribed complex treatment.

Results: After 2 weeks, the patient's complaints disappeared. Sensory impairments were restored and had a positive impact on the patient's quality of life. A control X-ray examination revealed regeneration of young bone tissue at the osteotomy site.

Conclusion: The introduction of digital planning software and the use of 3D printed surgical guides in endodontic microsurgery have significantly improved treatment planning as well as operative and psychological comfort for patients.

Keywords: *endodontic therapy; traumatic trigeminal nerve injury; neuropathic pain; post-traumatic trigeminal neuropathy; 3D technologies.*

Introduction

"Post-traumatic neuropathic trigeminal pain" as described in the International Classification of Orofacial Pain (ICOP) criteria[1] may be the cause of various dental interventions (removal of third molars, local anesthetic injection, dental implant surgery, endodontic treatment, ablative surgery, trauma, orthognathic surgery and several other interventions).[2-10]

Yatrogenic trigeminal nerve injuries remain a

serious problem and is manifested by sensory disturbances such as anesthesia, hypoesthesia, hyperesthesia and paresthesia.[11-13]

Altered sensation and pain in the orofacial area lead to significant psychological consequences, can interfere with talking, eating, kissing, shaving, applying makeup, brushing teeth, and drinking alcohol just about every social interaction, have a significant negative effect on the patient's self-image, quality of life.[14] In endodontic procedures the most common nerve affected is the inferior alveolar nerve (IAN) and as a result patients suffer from neuropathic pain. Psychological assessment requires the use of validated questionnaires exploring anxiety, depression, post-traumatic stress disorder, catastrophizing and somatization.[15] Iatrogenic trigeminal neuropathy is caused by nerve injury from an endodontic instrument and extrusion of material into the inferior alveolar canal, resulting in result of their physical and chemical damage to the IAN.[16-19] The average post-endodontic pain is 7.2 on a visual analogue scale (where zero is no pain and 10 is as much pain as possible).

Mechanism of nerve injury related to endodontic treatment is explained by mechanical, chemical and hemorrhagic damage to the peripheral sensory nerve and compression of nerve fibers[20]. Chemical toxicity and mechanical pressure created by leakage of sealers into areas close to the mandibular canal.[21,22] The decision to treat a patient with nerve damage requires complex treatment and may include: sedation, medication, surgery, and psychological treatment. Pharmacological treatment consists of analgesics, opioids and atypical painkillers, antidepressants and benzodiazepines.[23-24]

Urgent surgery should be recommended for nerve injury caused by endodontic procedures or implants.[25] If the removal of excess endodontic material is delayed, irreversible nerve damage occurs and the prognosis for recovery remains difficult to predict.[26-29] In those clinical cases where the cause of damage to the mandibular nerve was a broken endodontic instrument that came out from the apex of the tooth root into the nerve canal, in this case the broken endodontic. In those clinical cases when the filling material has come out of the tooth canal, it is removed surgically. Based on X-ray diagnostic data, a mucoperiosteal flap is cut in the projection of the lesion; in this area of the lower jaw, a bone is formed using a piezotomic device. Bone window, the bone fragment is removed and placed in a physiological solution, the filling material is removed from the nerve canal, the wound is washed with a physiological solution, the bone fragment and the mucoepiphyseal patch are repositioned and fixed. At the stage of surgical treatment of the wound, treatment with 1-2 ml of dexamethasone solution for 1-2 minutes is effective. In the post-operative period, the patient is appointed Analgesics, non-steroidal anti-inflammatory drugs, antibiotics, glucocorticosteroids, antihistamines, group B vitamins and physiotherapy.

In the treatment complex, the use of low-intensity laser therapy is effective for the nervous system for cell biostimulation and pain relief. Complex treatment is effective in early treatment, which allows to prevent nerve degradation, nerve function is restored within 2-3 months. CBCT has been widely used in contemporary implant dentistry for 3D pre-surgical planning and fabrication of surgical guide, prevention of disrupting adjacent root or anatomically vital structures and precise implant placement in correct position and angulation depending on the residual bone volume.

The clinical application of 3D-printed surgical templates provides accurate positioning of the apical region of the root, reducing surgical trauma, minimize the amount of osteotomy during apicoectomy procedures and providing a degree of protection of adjacent tissue structures.[30-32]

Although various methods of treating this pathology are described in the literature, the search for new atraumatic and effective treatment methods continues.

In the presented clinical case, original method of treating endodontic nerve injuries using a surgical template obtained by three-D software modeling is described.

Case report

A 48-year-old patient, 25 years after the removal of an unsuccessful endodontic treatment the teeths, continued to complain of similar traumatic inferior alveolar nerve neuropathy. The patient took analgesics, analgesics, 10% lidocaine spray. A CT scan revealed excess filling material that was planned to be removed using a surgical template. CT scan

data is transferred to surgical implant planning software, the data is overlaid. Using Computed Tomography Software for Surgical Implant Planning, a template was designed for drilling the bone in the localization projection of material. 3D Surgical template is printed, in the oral cavity drilling was carried out through the hole of the template, under X-ray control, after osteotomy, the excess material was removed, the patient was prescribed a comprehensive treatment. Prescribed Dexalgin, amoxicillin, ibuprofen 600 mg 3 times a day for 3 weeks, anti-inflammatory, analgesic effect, dexamethasone at a dose of 0.5 mg. 2 tablets for the first 3 days and 0.5 mg, 1 tablet 10 mg 1 time per day, neurorubin (B1, B6, B12) 1 time per day for 3 weeks. After 2 weeks, the patient's complaints disappeared. A control X-ray showed the restoration of young bone tissue at the osteotomy site.

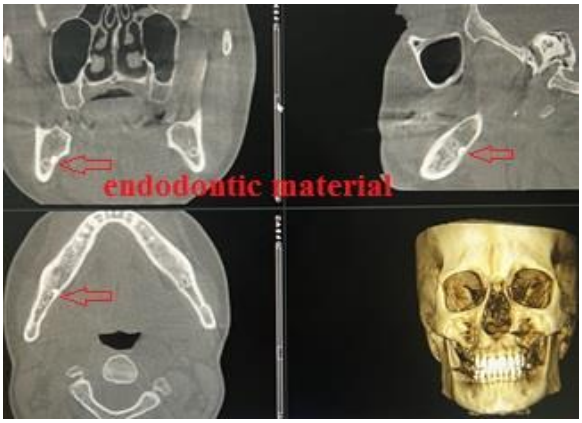

Figure 1 a, b, c. *The red arrow shows excess endodontic material located near the inferior alveolar nerve canal*

Figure 2. *3D scanning lower jaw*

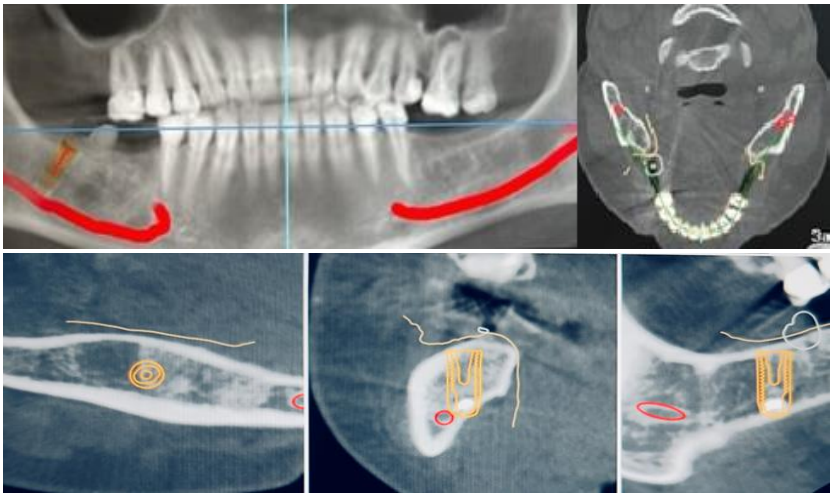

Figure 3 a, b, c, d. *Computed tomography software for surgical implant planning, used for planning surgical drill template, for access to material*

Figure 4. *3D Surgical template is planning*

Figure 5. *3D Surgical template is printed*

Figure 6. *3D printed surgical template installed in the oral cavity prior to surgery*

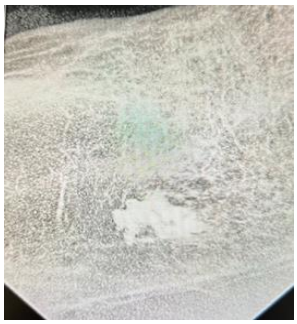

Figure 7. *Detection of filling material by targeted X-ray*

Figure 8 a, b, c. *Surgical drilling, for access to filling material*

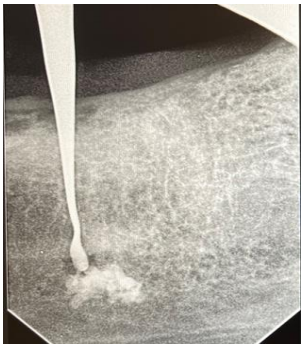

Figure 9. *Removal of filling material*

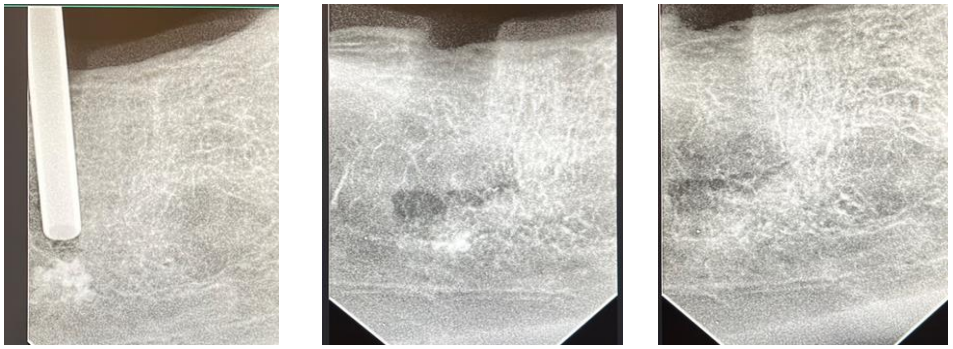

Figure 10 a, b, c. *X-ray after removal filling material 1 month after removal filling material*

Discussion

Treatment of iatrogenic post-traumatic neuropathy of the trigeminal nerve against the background of endodontic treatment is an urgent problem in dentistry.

There is still no consensus regarding treatment protocols for such injuries, but there is a clear understanding that the management and success of treatment of sensorineural deficits will be influenced by the mechanism and duration of nerve injury, clinical signs and symptoms associated with the injury, including psychological ones, functional or pain complaints of patients.

A recent Cochrane systematic review of treatment options for post-traumatic neuropathy resulting from dental procedures concluded that there is still a need for randomized controlled clinical trials to examine the effectiveness of surgical, medical and psychological treatments for iatrogenic injuries of the inferior alveolar and lingual nerves.[33,34]

Pharmacological treatment of acute nerve fiber injuries includes the use of corticosteroids and non-steroidal anti-inflammatory drugs.

Glucocorticosteroids - adrenocorticotropic hormone have been shown to inhibit central axonal sprouting, reduce ectopic discharge in injured sensory axons, and prevent neuroma formation.[35]

Drug of choice - Dexamethasone - 8-12 mg/day for one week not only minimizes neuropathy after nerve injury when given in high doses for one week after injury, but is especially recommended due to its significant anti-inflammatory effect compared with others corticosteroid drugs. It is recommended to prescribe a decreasing dose of dexamethasone (from high to low) for 5-7 days after trigeminal nerve injury.[36,37]

Nonsteroidal anti-inflammatory drugs (NSAIDs) are the best inhibitors of prostaglandin synthesis from damaged peripheral nerve endings. Prostaglandins released as a result of peripheral nerve injury sensitize peripheral nociceptor fibers and central neurons.[38]

The drug of choice is ibuprofen - 600-800 mg three times a day for three weeks (after finishing dexamethasone!).

If necessary, two to three weeks after the injury, based on a repeat neurosensory examination, the doctor may prescribe another three weeks of taking NSAIDs if there are no signs of gastrointestinal disorders.

Additional pharmacological agents - antidepressants, anticonvulsants, antisympathomimetics, etc. These types of pharmacological treatments should be used with caution, as they should be prescribed and monitored by a doctor who is familiar with the side effects of these drugs and has experience in treating nerves damage.

Supportive pharmacological agents: Neurorubin-Forte Lactab - one tablet twice a day for 4 weeks - contains high doses of vitamins B_1, B_6, B_{12}, which play an important role in ensuring optimal metabolism in nerve cells. In high doses – has a weak analgesic effect.

Surgical treatment of endodontic IAN lesions reduces neuropathic pain while providing only moderate sensory recovery.[39]

To prevent post-traumatic neuropathy that occurs during endodontic treatment, it is necessary. Before starting treatment, perform an x-ray diagnosis: determine the relationship between the tooth root and the purpose of the nerve. Endodontic treatment is carried out according to standard protocols adopted in endodontics. During endodontic root treatment, avoid filling the root with a high-pressure jet of sodium hypochlorite using a syringe before measuring the length of the root canal with an apex locator, and avoid using toxic fillers during filling and after filling. It is necessary to take a control x-ray.

Compared with the traditional approach, endodontic microsurgery using a guide template has many advantages:

1) the root apex can be more accurately positioned by drilling a hole, resulting in minimally invasive preparation,
2) operative time and bone preparation volume can be significantly reduced,
3) postoperative healing is more favorable and the reduced risk of infection leads to a better prognosis,
4) more predictable outcomes can be expected.

Conclusion

The introduction of digital planning software and the use of 3D printed surgical guides in endodontic microsurgery have significantly improved treatment planning as well as operative and psychological comfort for patients.

Declarations

Conflicts of interest and financial disclosures

The author declares that he has no conflict percent and there was no external source of funding for the research in question.

Ethical approval

The study was approved by the University ethics committee and was conducted in accordance with the Declaration of the World Medical Association.

Source of funding

This research received no external funding.

Data Availability Statement

Not applicable.

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ԷՆԴՈԴՈՆՏԻԿ ԹԵՐԱՊԻԱՅԻ ՀԵՏ ԿԱՊՎԱԾ ՅԱԹՐՈԳԵՆ ՀԵՏՎՆԱՍՎԱԾՔԱՅԻՆ ՆԵՐՅՈՊԱԹԻԱՅԻ ԲՈՒԺՈՒՄ՝ ՕԳՏԱԳՈՐԾԵԼՈՎ 3D ՏԵԽՆՈԼՈԳԻԱՆԵՐ

Կարեն Սևտերտերյան,[1] Վլադիսլավ Տարասենոկ,[2] Լյուդմիլա Տատինցյան[3]

1. Երևանի Մ.Հերացու անվան պետական բժշկական համալսարանի վիրաբուժական ստոմատոլոգիայի և դիմածնոտային վիրաբուժության ամբիոնի դասախոս, Երևան, Հայաստան
2. Երևանի Մ.Հերացու անվան պետական բժշկական համալսարանի օրդինատոր, Երևան, Հայաստան
3. Երևանի Մ. Հերացու անվան պետական բժշկական համալսարանի թերապևտիկ ստոմատոլոգիայի ամբիոնի դոցենտ, Երևան, Հայաստան

Ամփոփում

Եռորյակի նյարդի հետվնասվածքային ներյոպաթիան էնդոդոնտիկ թերապիայի բարդություններից մեկն, լուրջ խնդիր է, դրսևորվում է զգայական խանգարումներով և էական բացասական ազդեցություն ունի հիվանդի կյանքի որակի վրա: Նյարդի վրա լցանյութի մեխանիկական ճնշումը առաջացնում է այտուց և հեմատոմա նյութի քիմիական ազդեցությամբ՝ նեյրոտոքսիկություն: Նյարդային վնասվածքով հիվանդին բուժելու որոշումը պահանջում է համալիր բուժում: Էնդոդոնտիկ բուժման արդյունքում առաջացած ավելցուկային էնդոդոնտիկ նյութի վաղ վիրաբուժական հեռացումը ապահովում է վերականգնման լավագույն կանխատեսում: Ժամանակակից թվային տեխնոլոգիաների զարգացմամբ հաջողություններ են գրանցվել էնդոդոնտիկ բուժման գործընթացում:

Ներկայացված կլինիկական դեպքում նկարագրված է ստորին ալվեոլային նյարդի էնդոդոնտիկ թերապիայի հետ կապված յաթրոգեն հետվնասվածքային ներյոպաթիայի բուժման մեթոդ՝ օգտագործելով վիրաբուժական շաբլոն, որը ստացվել է եռաչափ ծրագրային մոդելավորման միջոցով: Վիրաբուժական իմպլանտների պլանավորման համար համակարգչային տոմոգրաֆիայի ծրագրակազմի միջոցով նախագծվել է շաբլոն՝ նյութի տեղայնացման պրոյեկցիայում ոսկորը մշակելու համար: Տպվել է 3D վիրաբուժական շաբլոն, տեղադրվել է բերանի խոռոչում նյութի տեղայնացման պրոյեկցիայում, ոսկորը մշակել է շաբլոնի անցքով, ռենտգեն հսկողության տակ, օստեոտոմիայից հետո ավելորդ նյութը հեռացվել է, հիվանդին նշանակվել է համալիր բուժում:

Արդյունքներ: 2 շաբաթ անց հիվանդի գանգատներն անհետացան: Զգայական խանգարումները վերականգնվեցին և դրական ազդեցություն ունեցան հիվանդի կյանքի որակի վրա: Վերահսկիչ ռենտգենը ցույց տվեց երիտասարդ ոսկրային հյուսվածքի վերականգնում օստեոտոմիայի տեղում:

Եզրակացություն: Թվային պլանավորման ծրագրաշարի ներդրումը և 3D տպագրված վիրաբուժական շաբլոնի օգտագործումը էնդոդոնտիկ միկրովիրաբուժության մեջ զգալիորեն բարելավել են բուժման պլանավորումը, ինչպես նաև հիվանդների հոգեբանական հարմարավետությունը:

ЛЕЧЕНИЕ ЯТРОГЕННОЙ ПОСТТРАВМАТИЧЕСКОЙ НЕЙРОПАТИИ СВЯЗАННОЙ С ЭНДОДОНТИЧЕСКИМ ЛЕЧЕНИЕМ С ИСПОЛЬЗОВАНИЕМ 3D-ТЕХНОЛОГИЙ

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Резюме

Посттравматическая нейропатия тройничного нерва является одним из осложнений эндодонтического лечения и представляет серьезную проблему, проявляется сенсорными нарушениями и оказывает существенное негативное влияние на качество жизни пациентов. Механическое давление на заполнителя вызывает отек и гематому а вследствие химического действия вещества – нейротоксичность. Решение о лечении пациента с посттравматической нейропатии требует комплексного лечения. Раннее хирургическое удаление избытка эндодонтического материала, возникшего в результате эндодонтического лечения, обеспечивает наилучший прогноз выздоровления. С развитием современных цифровых технологий достигнуты успехи в процессе эндодонтического лечения.

В представленном клиническом случае описан новый метод лечения посттравматической нейропатии нижнеальвеолярного нерва с использованием хирургического шаблона, полученного методом трехмерного программного моделирования. С помощью программного обеспечения компьютерной томографии был разработан шаблон для сверления кости в проекции локализации материала. Хирургический шаблон распечатан 3D принтером,после установки во в полости рта сделан остеотомия под рентгенологическим контролем и лишний материал удаляен, после пациенту назначен комплексное лечение.

Результат: Через 2 недели жалобы больного исчезли, сенсорные нарушения восстановились и оказали положительное влияние на качество жизни пациента. При контрольном рентгенологическом исследовании выявлена регенерация молодой костной ткани в месте остеотомии.

Заключение: Внедрение программного обеспечения для цифрового планирования и использование 3D-печатных хирургических шаблонов в эндодонтической микрохирургии значительно улучшили планирование лечения, а также операционный и психологический комфорт для пациентов.

Sevterteryan K, Tarasenok V, Tatintsyan L. Treatment Of Yatrogenic Post-Traumatic Neuropathy Associated With Endodontic Therapy Using 3D Technologies. *Bulletin of Stomatology and Maxillofacial Surgery*. 2024;20(1):73-81. doi: 10.58240/1829006X-2024.1-73