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Research Article

Effectiveness of the Er,Cr:YSGG Laser in the Removal of Oral Plexiform Neurofibroma (Case Report)

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Abstract

Background: Plexiform neurofibroma [PN] is a non-malignant tumor that affects the peripheral nerve sheath and is associated with neurofibromatosis type 1 [NF1.1]. Because they are infiltrative, plexiform neurofibromas can be difficult to cure. Laser therapy has emerged as a potentially effective approach for the management of oral plexiform neurofibromas, rendering it a valuable diagnostic tool within the field of dentistry.
Case Study Presentation: A male patient, aged 60, diagnosed with NF1, presented with painless swellings of the mandibular left edentulous alveolar ridge, which was causing difficulty in wearing a denture. The tumor was diagnosed as an oral plexiform neurofibroma. The entire lesion was excised surgically using an Er,Cr:YSGG laser system with specific parameters to minimize thermal damage to the surrounding tissues. Histological analysis confirmed the diagnosis of plexiform neurofibroma, with minimal thermal damage and desiccation observed at the excision margin.
Conclusion: The utilization of the Er,Cr:YSGG laser [2780 nm] for excision biopsy of plexiform neurofibroma led to exceptional postoperative healing and minimal thermal damage to the tissue. The laser's ability to precisely ablate the target tissue while minimizing damage to the surrounding structures was crucial in preserving the integrity of the specimen for histopathological analysis.

Keywords: neurofibromatosis type 1; plexiform neurofibroma; Er,Cr:YSGG laser; thermal damage; carbonization; desiccation.

1. Introduction

Neurofibromas can be classified into two main groups by the World Health Organization (WHO): dermal and plexiform. Whereas plexiform neurofibromas are linked to several nerve bundles, dermal neurofibromas originate from a single peripheral nerve. Additional subtypes identified by clinicopathology are plexiform neurofibroma, diffuse neurofibroma, epithelioid neurofibroma, and localized neurofibroma (also known as sporadic neurofibroma).[1]
A plexiform neurofibroma also known as pachydermatocoele (PN/P), is a benign tumor that affects the peripheral nerve sheath and consists of many nerve fascicles. It is a diagnostic criterion for

neurofibromatosis type 1 [NF1] and a histological variant of neurofibroma. The likelihood of plexiform neurofibroma progressing into a malignant peripheral nerve sheath tumor is highly potential [2].
Plexiform neurofibroma is a diffuse, elongated fibroma that runs along the nerves. It primarily affects the upper cervical or trigeminal nerves and is characterized by an early-life overgrowth of subcutaneous and epidermal tissue that gives the appearance of wrinkles and pendulous tissue. [1]
The growth of this benign tumor is gradual, and it is invading the adjacent tissue along the nerves. The growth of Schwann cells on the inner side of the nerve sheath is what makes plexiform neurofibroma unique. These cells cause the lesion to become thicker, twist, and turn in strange ways.[3]
NF1, also known as Von Recklinghausen's illness of the skin, is considered to be a definitive indicator of the presence of PN. Although oral lesions are present in around 72% of NF1 patients, the literature has extensively documented only a limited number of these instances. Some common radiologic signs are an enlargement of the mandibular foramen and/or canal, a rise in bone density, the presence of a deep coronoid notch, a depression on the medial side of the ramus, and more than one radiolucency.[4]

Various surgical techniques, including the traditional scalpel, Cryotherapy, electrosurgical scalpel, or lasers, can be used to remove this type of lesion[5]. The field of dentistry extensively utilizes dental lasers across various domains[6]. Lasers are used as very effective scalpels for the excision of maxillofacial tumors with maximal salvage to the surrounding tissues, and they are regarded as standard tools of therapy and care for both patients and surgeons[7]. The interaction of various irradiation parameters, including the laser source's wavelength, the physical characteristics of the exposed tissue, the energy of the laser pulse, continuous wave (CW) or pulsed irradiation, the size of the laser beam on the tissue, the duration of the laser pulse, and the repetition rate, determines the effects and interactions of the laser on tissue[8].
Dentists favor dental lasers due to their hemostatic, antibacterial, decontaminating, and tissue-ablating characteristics. Erbium, chromium: yttrium-scandium-gallium-garnet [Er,Cr:YSGG] lasers are utilized by dental practitioners for a diverse array of applications [9]. The versatility of this treatment enables the treatment of both soft tissues and hard tissues, such as bone, dentin, and enamel. The Er,Cr:YSGG laser employs water on the surface of the tissue to generate a clear, gentle, and uniform ablation, enabling highly accurate cutting. Reports indicate that the utilization of Er,Cr:YSGG lasers results in minimal or negligible harm to tissue, hence expediting the process of wound healing. Additionally, it achieves exceptional hemostasis, minimizes postoperative swelling and pain, requires minimal suturing, sterilizes the surgical site, and enhances patient acceptance and satisfaction.[10,11]

In this paper, we report a case of oral plexiform neurofibroma associated with NF1.

2. Case presentation

A 60-year-old male patient visited the laser medical research clinics of the Institute of Laser for Postgraduate Studies at the University of Baghdad. He sought dental care to remove painless swelling in the mandibular left edentulous alveolar ridge, which was causing difficulty in placing a denture [Figure 1]. Upon questioning the patient's medical background, he revealed that the onset of swelling had started disrupting the functionality of his denture approximately one year ago, showed a rapid enlargement within a span of less than two months, and persisted. The swelling exhibited a growing pattern, devoid of any concurrent pain or hemorrhage. The patient possessed a medical background of type I neurofibromatosis, characterized by the presence of several small tumors dispersed throughout the body. Furthermore, the history revealed a familial background. The intraoral examination demonstrated the presence of a non-ulcerated, widespread, unilateral swelling in the mandibular left edentulous alveolar ridge, which was found to be sessile. The swelling was devoid of discomfort. It had a diameter of around 10 mm and was solid when touched. Initial diagnosis of oral neurofibroma was established and scheduled the complete removal of the lesion using laser technology. The patient provided informed written consent before the excision procedure. The local ethics committee approved the research and conducted it in accordance with the ethical guidelines outlined in the 1964 Declaration of Helsinki and its subsequent revisions. Following the administration of 2% lidocaine and a 1:80,000 adrenaline dosage, the entire lesion was removed from its base, along with 2mm of healthy tissue, in order to distinguish between the healthy and diseased tissue.

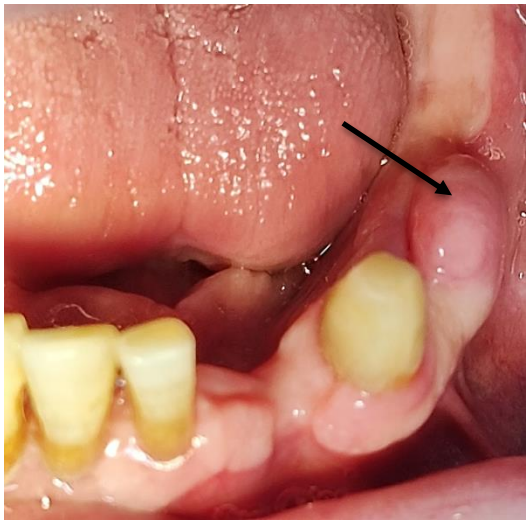

Fig. 1: Oral Plexiform Neurofibroma.

The excision was performed using the Er,Cr:YSGG laser system [Waterlase iplus, Biolase, California, USA] with the following specifications: a wavelength of 2780nm, a power of 2.75 W, a pulse repetition rate of 75 Hz, air at 20%, and water at 40%. The MGG6 tip in H mode was used in contact with the oral lesion. The duration of the treatment is around 10 minutes.
These laser parameters were selected based on the settings offered by the manufacturer, which correspond to other studies dealing with oral benign soft tissue lesions.

Ultimately, coagulation was accomplished by utilizing a laser bandage with a power output of 0.5 W, a frequency of 30 Hz, 1/20% water/air spray, and a non-contact mode for the tip [Figure 2]. The wound following the surgical intervention underwent secondary healing. Following quick fixation in a 10% formalin solution, the excision biopsy was subsequently subjected to histological investigation in order to determine the nature of the lesions. The analysis revealed the presence of an oral plexiform neurofibroma, along with indications of thermal damage and desiccation at the margin of the excision.

Fig. 2. Immediately after removal of the lesion.

Thermal damage was measured in millimeters and found it to be 0.2 mm. Desiccation was observed, but carbonization did not. The patient was recalled on days 1, 3, and 7 to assess the healing progress, and found no problems. By day 7 after the surgery, the lesion had fully healed [Figure 3]. Additionally, the patient received a referral for further prosthetic management.

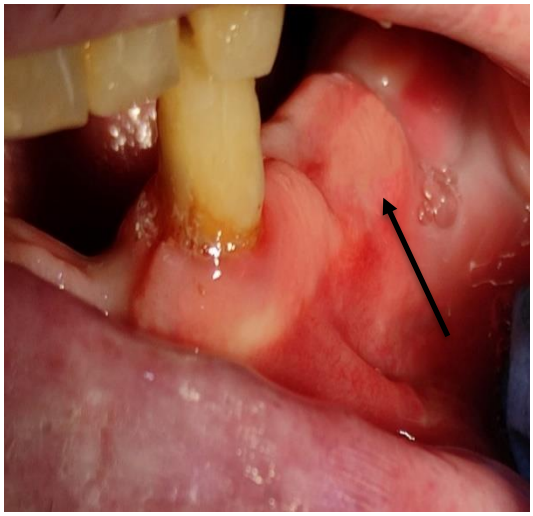

Fig. 3. 7 days post-operatively.

3. Discussion

Neurofibromatosis type 1 is an autosomal dominant condition affecting several organ systems with a diverse array of clinical presentations. It is one of three illnesses grouped together under the general term "neurofibromatoses." The other two, schwannomatosis and neurofibromatosis type 2, differ from neurofibromatosis type 1 both clinically and genetically. The neurofibroma - a nerve sheath tumor that develops in close proximity to spinal, peripheral, or cranial nerves - is the characteristic that distinguishes neurofibromatosis type 1[12].

Pathogenic variations in the NF1 gene lead to the loss of functional neurofibromin, which is the cause of NF1. NF1 is mainly characterized by the presence of pigmented lesions, such as cafe-au-last spots, two or more neurofibromas of any type, or one or more plexiform neurofibromas, Freckling in the axillae or groin, Optic glioma, two or more Lisch nodules, dysplasia of the sphenoid, dysplasia or thinning of the long bone cortex, first-degree relative with NF1[13].

The preferred treatment for plexiform neurofibroma is surgical excision. However, achieving total resection can be challenging due to the tumor's infiltrative features. The tumor may become intertwined with nearby tissues and nerves, making complete removal difficult and potentially resulting in a recurrence[13].

In this current study, the patient had an overgrowth on his mandibular left edentulous alveolar ridge. Possible treatment options for PN encompass the traditional scalpel, electrocautery, and laser therapy.

Lasers can cause thermal damage to tissues. However, by carefully adjusting variables such as power output, type of optic fiber, emission modes, and wavelength, it is possible to reduce or eliminate these effects on the target and surrounding tissues. It is important to consider emission modalities, particularly continuous wave [CW] or pulsed emission. Clinicians should consistently choose pulsed emission, as it permits the residual tissue to cool prior to the subsequent laser energy pulse. This process serves the purpose of controlling tissue overheating. In order to achieve the desired therapeutic effect with the shortest possible irradiation period, it is necessary to minimize the heat impact on tissues[14,15].

Amaral et al. [2018] [15] examine a case of a 44-year-old female patient diagnosed with neurofibromatosis type 1 [NF1]. The patient exhibited the presence of intraoral neurofibromas, specifically localized on the tongue. A surgical laser with a high-power diode and a wavelength of 808 nm was employed to remove a

neurofibroma from the patient's tongue. The technique yielded negligible hemorrhaging, and sutures were unnecessary.

Furthermore, in 2020, a single neurofibroma located in the gingiva was surgically removed utilizing a diode laser operating at a wavelength of 940nm and a power of 3 W. The patient exhibited consistent recovery over a period of six months, without any reoccurrence[16].

In 2024, a case report describes a 73-year-old male patient with a solitary, non-syndromic plexiform neurofibroma at the upper anterior alveolar ridge, the lesion was successfully removed using a 940 nm diode laser, with good precision, little bleeding, and a positive postoperative healing[17].

The Er,Cr;YSGG laser readily absorbs water and does minimal damage to adjacent tissues, especially the underlying muscle layers. A limited amount of tissue stress has a role in facilitating a positive healing process after surgery, which is characterized by the production of minimal scars[18].

Studies have indicated that the utilization of the Er,Cr:YSGG laser in surgical procedures yields superior outcomes in terms of postoperative wound healing compared to alternative laser technologies. Patients who undergo surgery with Er,Cr:YSGG lasers report a significant decrease in their recovery time. In light of these conditions, the question arises as to how improved or equivalent healing outcomes can be achieved following an intervention that involves thermal injury. Previous studies have provided evidence that low-level laser treatments can effectively suppress anti-inflammatory mechanisms, promote cellular stimulation, expedite tissue regeneration, enhance wound healing, and reduce pain and edema. From a certain standpoint, when considering the potential improvement in healing after a thermal injury, it appears that the application of laser surgery can have a beneficial impact on neighboring tissues. This is likely to accelerate the healing process by inhibiting the inflammatory pathway and promoting regeneration through mechanisms such as angiogenesis, collagen deposition, fibroblast proliferation, and tissue re-epithelialization.[19] In comparison with our study, we also found that the healing progression with the Er,Cr,YSGG laser is favorable and more eventful.

Sarkar et al. reported that treatment with Er,Cr:YSGG laser results in little patient discomfort, no need for anesthesia, minimum bleeding, and good wound healing[20].

The Er,Cr:YSGG laser has a sterilizing effect since it eliminates many bacterial and viral colonies that could potentially cause infection. This contributes to faster recovery time[21]. The laser management on the first day of wound development increases the number of polymorphonuclear neutrophils and mast cells, which accelerates healing[19].

Tissues subjected to irradiation consistently exhibit thermal damage as a result of the photothermal effects. When a laser beam is incident, there is a notable rise in temperature over 100°C, leading to the vaporization of tissue. The temperature in this region has risen by more than 50°C. In the field of oral pathology, it is crucial to minimize peripheral damage, particularly in cases with suspicious lesions, in order to preserve the integrity and legibility of the specimen's edges.[22] This work demonstrates the safe utilization of the Er,Cr;YSGG laser in oral biopsy operations, specifically when employing controlled power levels and fluence regulation.

This current case did not exhibit carbonization, either at the macroscopic or microscopic level. This is attributed to the utilization of air/water spray with an Er,Cr;YSGG laser.

A scholarly publication in 2010 entitled " Histologic evaluation of thermal damage produced on soft tissues by CO 2, Er,Cr:YSGG and diode lasers"[23] examined the thermal impacts of various laser types on soft tissues. The samples of Er,Cr:YSGG that were subjected to irradiation using a water/air spray exhibited a carbonization area that was less than 25% of the perimeter of the irradiation margin. Significant differences were seen when comparing individuals exposed to water/air spray irradiation to those who were not, indicating a moderate carbonization area.

Conversely, we observed the presence of desiccation in the form of a highly eosinophilic layer along the excision margin [Figure 4]. Desiccation occurs due to the photothermal impact of a laser[24]. The use of Er,Cr;YSGG laser [2780 nm] with 2.75 W output power in pulsed wave mode, a pulse duration of 60 μs, and a 600 μm fiber tip showed optimal results for excising a plexiform neurofibroma associated with NF1, showing minimal damage to the tissue, and protecting the tissue for an adequate histopathological analysis.

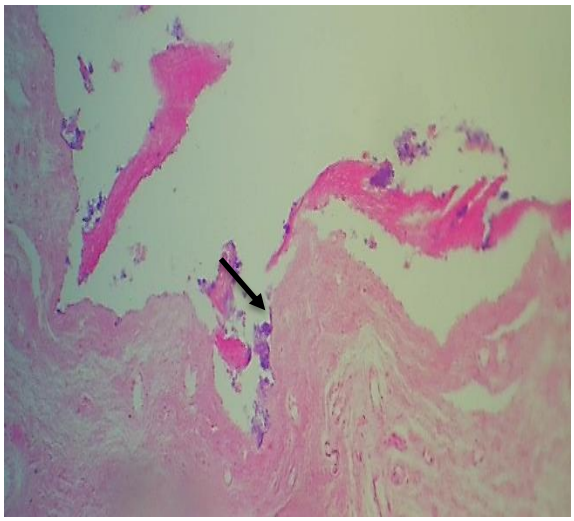

Fig. 4: Cross-sectional histological view of plexiform neurofibroma 10x showing the marginal desiccation.

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فعالية ليزر الاربيوم كروميوم في إزالة الورم الليفي العصبي الضفري الفموي

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الخلاصة

الخلفية: الورم الليفي العصبي الضفري [PN] هو ورم غير خبيث يؤثر على غمد الأعصاب الطرفية ويرتبط مع الورم الليفي العصبي من النوع 1 .[NF1.1] وقد ظهر العلاج بالليزر كنهج فعال محتمل لإدارة الأورام الليفية العصبية الضليعية الفموية، مما يجعلها أداة تشخيصية قيمة في مجال طب الأسنان.

عرض دراسة حالة: مريض ذكر، يبلغ من العمر 60 عامًا، تم تشخيصه بالإصابة بالورم الليفي العصبي من النوع الاول، أظهر تورمًا غير مؤلم في الحافة السنخية اليسرى للفك السفلي. قمنا بتشخيص الورم على أنه ورم ليفي عصبي ضفيري فموي واستأصلناه جراحياً باستخدام نظام ليزر .Er, Cr:YSGG تسبب هذا الإجراء في أضرار حرارية طفيفة وأدى إلى الشفاء الناجح بعد الجراحة.

الاستنتاج: استخدام ليزر Er,Cr:YSGG [2780 نانومتر] لخزعة استئصال الورم الليفي العصبي الضفيري أدى إلى شفاء استثنائي بعد الجراحة، والحد الأدنى من الضرر الحراري للأنسجة، والتوصيف النسيجي للورم الليفي العصبي الضفيري.