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Pre-prosthetic atraumatic laser-assisted mandibular rehabilitation: Er,Cr:YSGG 2780 nm for alveoloplasty and mucocele removal. A case report

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ABSTRACT

Lasers are a popular technology in many areas of dentistry due to their low invasiveness, quick tissue response, and rapid healing time. Mucoceles develop from minor salivary glands, whereas bony exostosis is a prosthodontic challenge that prevents optimal prosthetic management. Scarring, pain, and discomfort are common drawbacks of traditional surgical approaches, which are followed by prolonged postoperative healing. Laser-assisted mandibular rehabilitation is a promising approach with predictable results. The patient complained of severe pain during denture fabrication, as well as a small, painless swelling on the inner aspect of the lower lip. The patient was able to receive the planned complete dentures after undergoing atraumatic laser-assisted removal of mucocele and bone exostosis with an Er,Cr:YSGG (Erbium, chromium-doped, yttrium, scandium, gallium, and garnet) laser treatment at 2780 nm. Both procedures were completed quickly, and there were no postoperative complications to report. Blanching overlying both lesions quickly faded after healing and was replaced by a healthy pink mucosal color; both lesions were monitored until complete healing. The Er,Cr:YSGG effectively ablated and removed both soft and hard tissue lesions with minimal bleeding and pain.

Key words: erbium lasers, mucocele, alveoloplasty, pre-prosthetic rehabilitation, minimal invasiveness.

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Introduction

Laser-assisted atraumatic procedures are quite beneficial in soft and hard tissue management. Mucoceles are common minor salivary gland disease, and its management may be challenging while bony exostoses are common hard tissue lesions that hinder prosthetic management and rehabilitation. Mucoceles are defined as mucous-filled cavities that can develop in the appendix, lacrimal sac, paranasal sinuses, and oral cavity.[1,2] They are localized and most frequently located on the lower lip. Most of them fall into one of 2 categories: I. The extravasation kind is the result of trauma, such as lip biting. II. Mucus retention kind that is caused by minor and/or accessory salivary gland duct obstruction.[1,2]

They are localized and most frequently located on the lower lip.[3] Despite usually being asymptomatic, they cause discomfort when they obstruct function. Surgical excision, marsupialization, micro marsupialization, cryosurgery, laser vaporization, and laser excision are all possible forms of treatment.[4,5] Among the drawbacks of surgical approaches is that in some cases, the wound margins contract, and the exposed surface heals by granulation.[6]

Prosthetic treatment of the edentulous mandible with bony exostosis can be particularly challenging. One of the key issues that hinder proper prosthetic rehabilitation is inadequate buccal or lingual bony contour in the mandible, where alveoloplasty is indicated.[7] Alveoplasty, alveolectomy, or alveoloplasty is described as smoothing, leveling, or altering the external contours of the bone.[8] It is the most common pre-prosthetic surgical procedure after the extraction of natural teeth. In 1974, Boucher coined the term "alveolectomy" to describe the surgical removal of a portion of the alveolus.[9] The term alveoloplasty has recently become popular for recontouring the alveolar process rather than removing it.[7] The contouring of the alveolar ridge aims to preserve as much soft and hard tissue as possible while gaining favorable tissue support for the designed prosthesis.[10] A variety of case reports explained surgical approaches to address the issue; however, few reports have focused on atraumatic laser-assisted procedures.

It is crucial to keep in mind when shaping the ridge that more bone removal results in a greater amount of resorption.[7] Therefore, conservative contouring should only be used to remove unfavorable undercuts and irregular sharp ridges. Alveoloplasty should aim to preserve as much hard tissue as possible while gaining favorable tissue support for the designed prosthesis. In the literature, many conventional alveoloplasty methods have been recommended.[6] Conventional surgical approaches have several drawbacks, including a large exposed wound surface, pain and discomfort, and a protracted postoperative healing period.[6] As a result, prosthetic rehabilitation is delayed until the healing process is complete, which can be unpredictable.[6] Technological advancements have offered novel approaches such as piezosurgery or piezoelectric bone surgery.[7] The main drawback of piezosurgery in osteotomies is the fact that it is time-consuming to work against cortical bone.[11] Also, Erbium lasers in non-contact modes accelerate bone healing faster than piezotomes.[11]

In many aspects of dentistry, ECr:YSGG 2780 nm (erbium, chromium, yttrium, scandium, gallium, garnet) lasers are a very appealing technology that is minimally invasive and offers quick tissue response and healing.[12] The rehabilitation in prosthetic dentistry is significantly impacted by the rapid development of lasers and their wavelengths with a wide range of applications on soft and hard tissues.[12,13]

The case report presented here illustrates the use of (Er,Cr:YSGG 2780 nm) laser for successful hard- and soft-tissue manipulation to recontour the mandibular ridge, removing a bony exostosis and a lower lip mucocele that precludes function as well as to facilitate prosthetic rehabilitation.

Case Report

A systemically healthy 55-year-old male patient was referred to the Department of Prosthodontics, University of Alexandria – laser unit. The patient presented a chief complaint of severe pain during denture fabrication. The patient also complained of a small painless swelling in the inner aspect of the lower lip that interfered with function. The patient reported trauma “fell over his face and hurt his lower lip several months ago” as the cause of the lesion. The intraoral examination and palpation revealed anteriorly prominent small buccal bony exostosis and complete mandibular edentulism (Figure 1). A round, solitary, fluctuant swelling was also discovered on the right canine area of the lower lip’s inner surface. The swelling was 2.5-3 mm in size and extended superiorly toward the lingual vestibule, 5-6 mm above the vermilion border of the lower lip. No other oral anomalies were detected.

After consultation, the removal of both lesions using an Er,Cr:YSGG 2780 nm laser (Waterlase®, Biolase, San Clemente, CA, USA) was recommended. The patient and clinician wore laser safety glasses, and appropriate safety measures were taken.

For the mucocele

No anesthesia was administered, and the parameters of the laser were adjusted according to soft tissue requirements. Soft tissue mode, biopsy procedure, and the rapid cut option were selected. The S mode with a pulse duration of 700 µs at a power of 2.5 W, frequency 70 Hz, and air: water 20:40 on a pulsed mode were selected.[14] A tip was used and directed at an angle of approximately 15° in non-contact mode approximately 1.0-2.0 mm away from the tissues. The tip was gradually moved around the base of the lesion with a circular motion until full excision was achieved (Figure 2). The procedure took approximately 3 minutes to complete the excision. No suturing was needed. Healing was favorable, and the patient was recalled for follow-up at 9, 16 days, and 10 months later.

For the bony exostosis

Two cartridges of 4% (1:100.000) epinephrine infiltration anesthesia were administered. Er,Cr:YSGG laser settings were adjusted to hard tissue: Restorative option, H mode with a pulse duration of 60 µs, and comfort prep mode at a power of 5.0 W, 15 Hz, 80% water, 50% air, in a pulsed mode.[15] With a Minnesota retractor, soft tissues were retracted and then the excessive osseous tissues were ablated in a non-contact mode (bulk removal). The bone was then re-contoured and smoothed, removing any sharp edges, to create the final ridge contour using the laser in a defocused mode (approximately 3.0 to 4.0 mm away from the tissues). The amount of tissue interaction and ablation was controlled by the operator by varying the distance of the laser tip from the target tissue, and a greater distance from the target tissues enabled the operator to precisely level, smooth, and contour the tissues. A medium-sized bone file was used to ensure smooth and even bony surfaces. The flap was approximated and secured with non-resorbable suture 5-0 silk sutures (Assut, black, braided, silk, suture Switzerland). Digital palpation was used to determine the uniformity of the ridge postoperatively. The ablation procedure took approximately 15 minutes. The patient was prescribed an analgesic (50 mg of diclofenac potassium 8 h for 5 days) and an antibiotic (1000 mg of Amoxicillin-Clavulanic Acid twice daily every 12 hours for 5 days) and was recalled for follow-up at 9 and 10 months later (Figure 3A and B).

Outcome

Blanching overlying both lesions was evident before treatment and was replaced with healthy pink mucosa both on the lower lip and at the bony exostosis site fol-

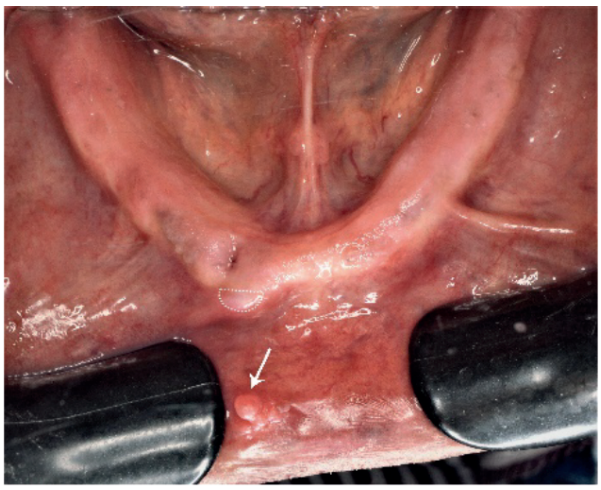

Figure 1. Preoperative occlusal view showing the bony exostosis.

Figure 2. Intraoral view of the Er,Cr:YSGG 2780 nm mucocele excision procedure.

lowing removal. Complete epithelialization was achieved. The procedure was completed in a brief period (approximately 3 minutes for the mucocele and 15 minutes for the bony exostosis), with neither sutures nor anesthesia for the mucocele, with minimal bleeding and notable patient satisfaction. The mucocele was removed completely without rupturing the membrane.
Healing was speedy and favorable. Minimal edema subsided in less than 48 hours. Regarding the alveoloplasty, sutures were removed 9 days later, and initial healing was noted. Complete healing was accomplished, and the patient was followed up 10 months later with no recurrence of the mucocele (Figure 3B). The alveoloplasty also healed properly (Figure 3A) evidenced by the patient's ability to have a complete denture as planned, and his satisfaction secondary to pain and discomfort alleviation. The overall function improvement was reported by the patient.

Mucocele histopathological examination

Histopathologic examination (Figure 4) revealed an extravasation cystic space containing mucin pools and macrophages, lined by compressed granulation tissue. Normal salivary gland tissue was found at the periphery. The whole lesion was covered by parakeratinized stratified squamous epithelium, no carbonization was evident as determined by the macroscopic shape of the incision, and almost no brown color was observed at the surgical site.

Discussion

Numerous methods have been reported for removing osseous tissues, recontouring them, and removing mucoceles. This report describes the use of Er,Cr:YSGG 2780 nm for minimally invasive, combined soft and hard tissue management, alveoloplasty, and mucocele removal. The use of lasers associated with adequate parameters found in the literature[14,15] to remove a mucocele eliminates the need for sutures, leaves the mucosa with little to no scarring, and enables precise ablation. Hemostatic properties and a significant reduction in pain and discomfort following surgery are also positive features.[16]

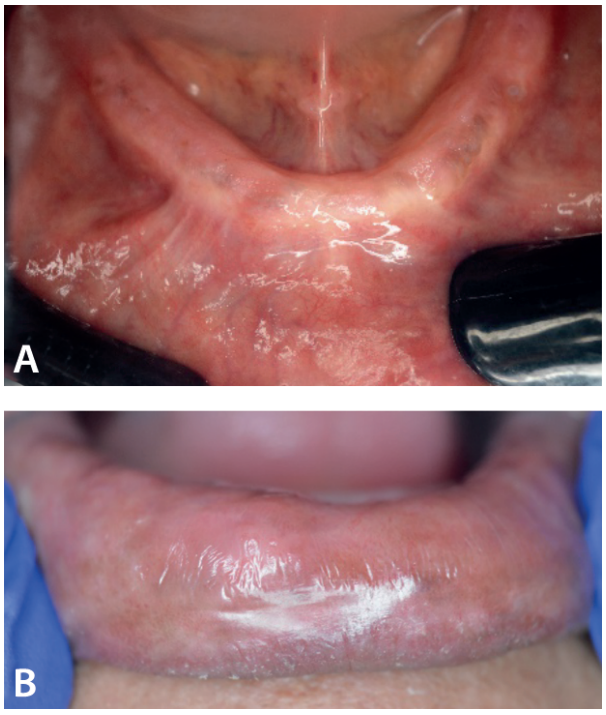

Figure 3. Complete healing of the alveoloplasty achieved after 10 months of follow-up.

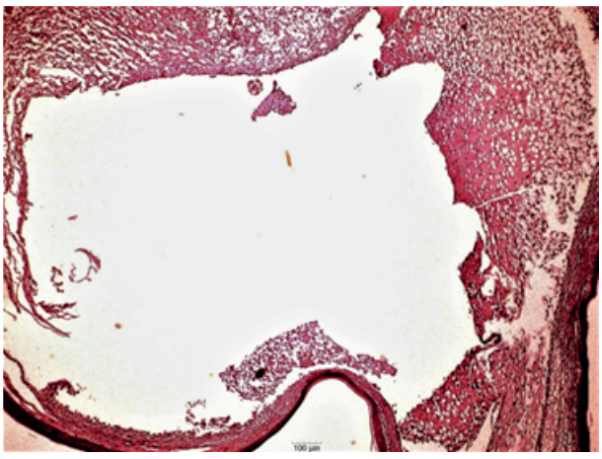

Figure 4. Histopathological evaluation of the mucocele under 40X light microscope.

Cryosurgery, micro-marsupialization, intralesional corticosteroid injection, CO_2, diode or erbium laser, and other techniques are explained in previous research, in addition to traditional surgery, which necessitates the removal of the lesion along with all the surrounding glandular acini down to the muscle layer.[17,18]
The excision of mucocele might have been accomplished with the use of other laser types, such as the 940 nm diode laser, whose strong absorption by hemoglobin and melanin makes soft tissue manipulation achievable. Despite the benefits of employing a diode laser during oral mucosa surgeries, it has been claimed that this technique results in delayed healing compared with traditional surgical scalpels.[13]
Conventional surgical approaches, including cutting bone with drills, burs, and piezotomes, have been previously reported despite scarring, pain, and discomfort, followed by prolonged postoperative healing.[6,11,18]
Erbium laser technology has succeeded over the past 20 years and is now quite capable of bone and tooth structure ablation with notable advantages. Although sometimes slower than a high-speed handpiece, lasers are more useful for hard-tissue procedures than most clinicians realize.[11] It is unquestionably advantageous that the erbium laser can remove tooth structure without generating heat or microfractures.[11]
The erbium laser does not produce heat or a zone of osseous necrosis when used to remove and recontour bone.[19] While delivering water to the osteotomy site and lowering the risk of heat-induced bone necrosis, water spray coolants may result in unintended patient body liquid splatter in the operating room.[11]
Er,Cr:YSGG can interact with soft tissue, dentin, enamel, and bone.[20] In the present study, minimal carbonization was evident as determined by the macroscopic shape of the incision, and almost no brown color was observed at the surgical site, which agreed with the results of other studies.[19-22] The erbium laser-like Er,Cr:YSGG causes minimal thermal damage to the surrounding tissues. Although laser osteotomies allow for a precise cut with significantly less procedural bone loss than drills and burs and disinfection of the surgical site itself, the complete lack of osteotomy depth control is still a significant downside.[11]
The parameters used in our case report are based on other parameters used in different case reports and studies, with slight variations that adapted to our clinical situation.
According to Fornaini *et al.*, the pulsating laser's interpulse halt prevents the tissue from overheating allowing for thermal relaxation time for tissues.[23] Our mucocele excision power choice was supported by Sindel *et al.*'s finding that the Er, Cr: YSGG laser with a 2.75 Woutput prod uced the lowest temperature increase.[24]
An alternative technique was used in this clinical case report to carry out typical surgical procedures with minimal invasiveness and favorable tissue healing.

Conclusions

Erbium lasers offer a precise, predictable method that improves the patient's experience by minimizing postoperative symptoms and hastening tissue healing. Er,Cr:YSGG laser successfully excised both soft and hard tissue lesions with minimal bleeding, minimal invasiveness, and pain control. Laser-assisted mandibular rehabilitation with satisfactory and favorable patient outcomes was reported in this case.

Contributions: all the authors conceived the idea and planned for the case. Nourhan S. Emam: performed the procedure; Ahmed M. Abdelhamid, Lucette G. Segaan, Mohamed Moataz Khamis: supervision. All authors led the writing, approved the final form of the manuscript, and agreed to be accountable for all aspects of the work.

Conflict of interest: the authors declare no conflict of interest.

Ethics approval and consent to participate: ethics approval was not required. This case was performed at Alexandria University, as a requirement for Nourhan S. Emam's PhD, and it was supervised by the other authors as her professors.

Informed consent: written informed consent was obtained from the patient for the publication of this case report and any accompanying images.

Availability of data and materials: all data generated or analyzed during this study are included in this published article.

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