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ORIGINAL ARTICLE

Clinical Application of Diode Laser (980 nm) in Maxillofacial Surgical Procedures

AQ2 *Tahrir N. Aldelaimi, BDS, MSc, FIBMS, DLMFS,* and Afrah A. Khalil, BDS, MSc†*

Key Words: Diode laser, facial lesions, laser surgery, maxillofacial surgery, surgical procedure

(*J Craniofac Surg* 2015;00: 00–00)

Since the first report on laser radiation by Maiman (1960), many potential fields for its application have been investigated.[1,2] Among these, medical laser surgery certainly belongs to the most significant advances. Various kinds of lasers have already become irreplaceable tools of modern medicine. Although clinical applications (Fig. 1) were first limited to ophthalmology and dentistry, the other fields of medical laser treatment have meanwhile considerably widened. Soon after laser invention was demonstrated, researchers began to examine Maiman's vision of the laser as a useful instrument for medicine. Their efforts laid the foundation for the present clinical use of lasers in medicine.[3–5] The specialty of maxillofacial surgery has benefited from the use of lasers, which are quickly becoming the standard of care for many surgical procedures, given the advantages of improved precision, visualization, and reduced discomfort.[1,3] Lasers are versatile and valuable devices in various disciplines of dentistry—prosthetics, periodontics, pedodontics, endodontics, implantology, cosmetic and operative dentistry, and oral and maxillofacial surgery.[3,6,7] Lasers are becoming more commonplace and even routine, either as adjunctive treatment methodologies or as stand-alone additions to the dental armamentarium. The growing number of dental laser practitioners, propelled by the increasing body of evidence concerning the safe, effective, and appropriate use of lasers in dentistry and maxillofacial surgery, will continue to advance the application of Einstein's "splendid light" in their operations, to the benefit of patient and practitioner alike. For many procedures, lasers are now becoming the treatment of choice by both clinicians and patients, and in some cases, the standard of care. Despite the common way of stimulated emission, that characterizes all laser emission, semiconductor lasers are different from other types of lasers in both operating performance and pumping mechanism. Diode lasers emit light in the range of near-infrared region to the visible red region. The main advantages of semiconductor laser are its compactness, simplicity, and efficiency. They require very little auxiliary equipment and can be readily linked to optical fibers that enable the diode laser to be used for medical purposes.[8] The aims of this study is to apply and assess the clinical usefulness of diode laser 980 nm in the treatment of different maxillofacial conditions.

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AQ5 The authors report no conflicts of interest.

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MATERIALS AND METHODS

This clinical study was carried out at the Department of Maxillofacial Surgery, Ramadi Teaching Hospital, Rashid Private Hospital, and Razi Private Hospital, Anbar Health Directorate, Anbar, Iraq, on a total of 32 patients including 22 (≈70%) male patients and 10 (≈30%) female patients with age range from 5 months to 34 years. The details of the laser surgical procedures were explained verbally to the patients and their parents, and each patient (and/or parent) was given a written instruction and questionnaire sheet. All of the patients (and/or parent) signed an informed consent agreement for using laser in surgery (Fig. 2). All of the patients were evaluated by clinical examinations, documented by digital photos, and asked to fill the questionnaire sheet upon follow-up visit, and all of the patients were prepared for laser surgery (Fig. 3) and viral screen (hepatitis B surface antigen, hepatitis C virus, and human immunodeficiency virus) was requested. The Chirolas 20 W, 980 nm diode laser, A.R.C. laser system, is classified as a class IV laser product that is hazardous to the eye from the direct beam and diffuses reflections. Therefore, eye and skin must be protected from exposure to direct or scattered radiation. All of the personnel participating in the surgery wore protective safety eyeglasses and masks. In addition, placing reflective materials such as glass, metals with uneven surface, polished plastic, and volatile materials have been avoided in the way of laser beam. The same surgical technique was used for all of the patients, who were operated on under sedative analgesia using injectable midazolam (5 mg/mL) intravenously in a dose of 0.03–0.1 mg/kg; the dose and dose range depend on individual patient response. Topical anesthesia (Xylocaine Spray 10%) was sprayed over and around the operation site frequently. After surgery, all of the patients were given verbal instructions that included the following: avoid taking hot, spicy, citrus, and hard foods for a few days; soft diet instructions; meticulous oral hygiene is practiced; patients were asked to fill in a questionnaire chart for the study; cephalexin (capsules 250 mg, 500 mg) and (syrup 125 mg/mL, 250 mg/mL) were prescribed for 3 days; ibuprofen (capsules 250 mg) (suspension 20 mg/mL) was used as analgesia (on need) during the postoperative period; commitment to follow-up appointments on the exact date. All of the patients were examined at 3 days, 1, 2, and 4 weeks after surgery (Fig. 4) to assess pain, bleeding, edema, functions, and overall satisfaction. In the follow-up appointments, clinical observations, assessments, and documentation by digital photographs were done by the operator during examination in addition to the data collected from the questionnaire sheets including the patient's notes on the operation day and during follow-up visits.

RESULTS

A total of 32 patients including 22 (≈70%) male patients and 10 (≈30%) female patients with age range from 5 months to 34 years

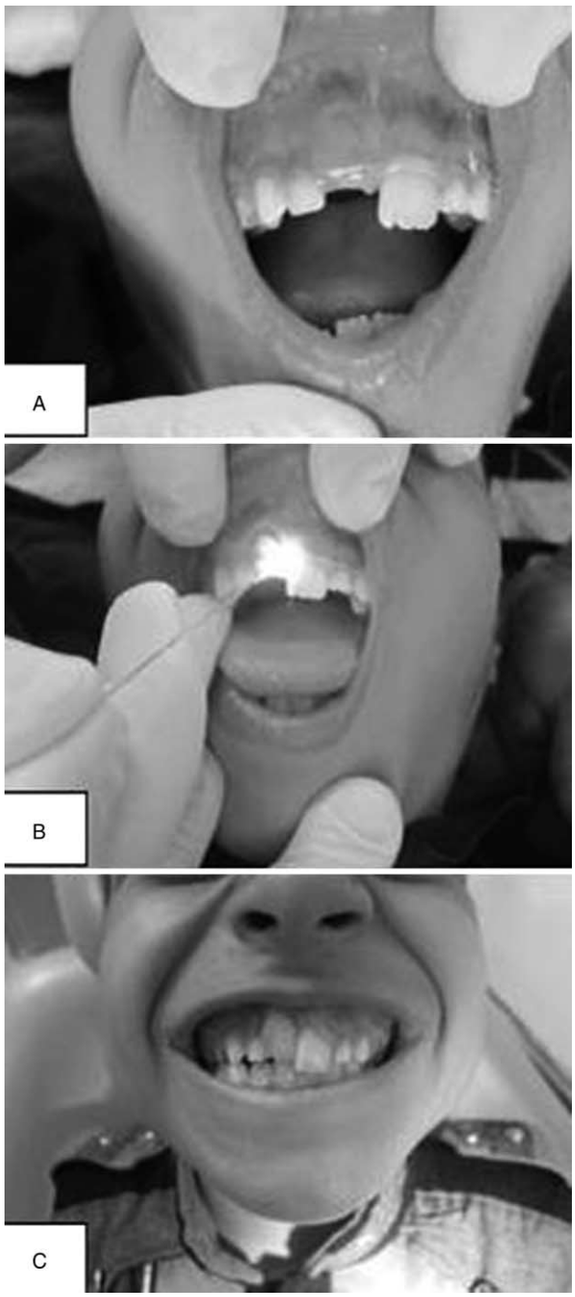


FIGURE 1. A, Preoperative view showing thick gingival. B, Laser application. C, Tooth eruption.

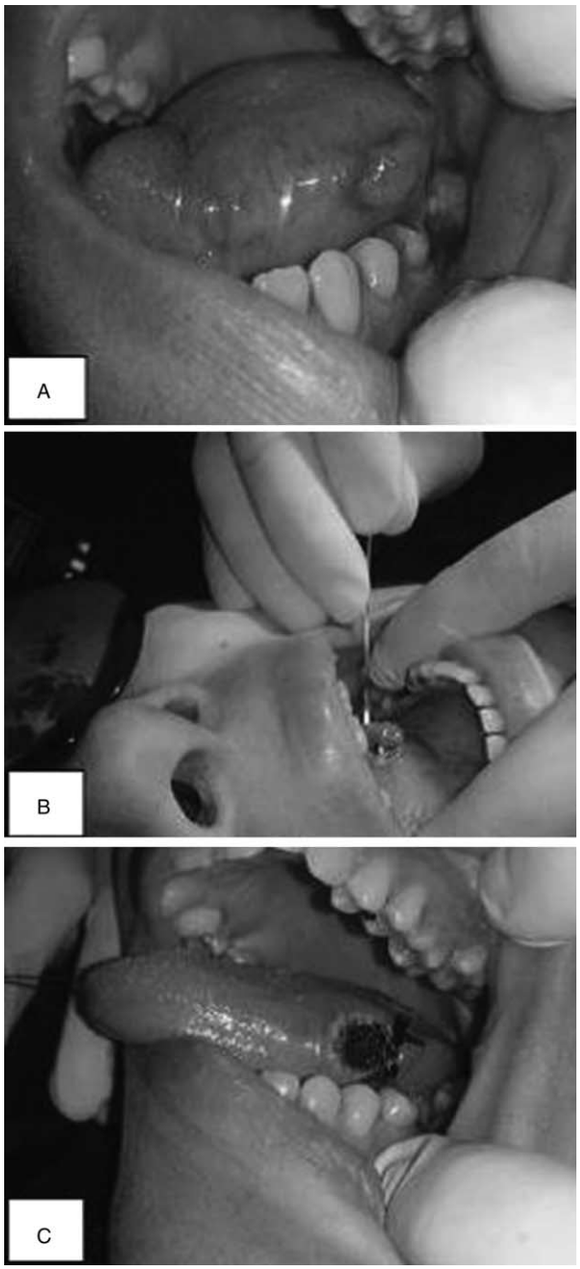
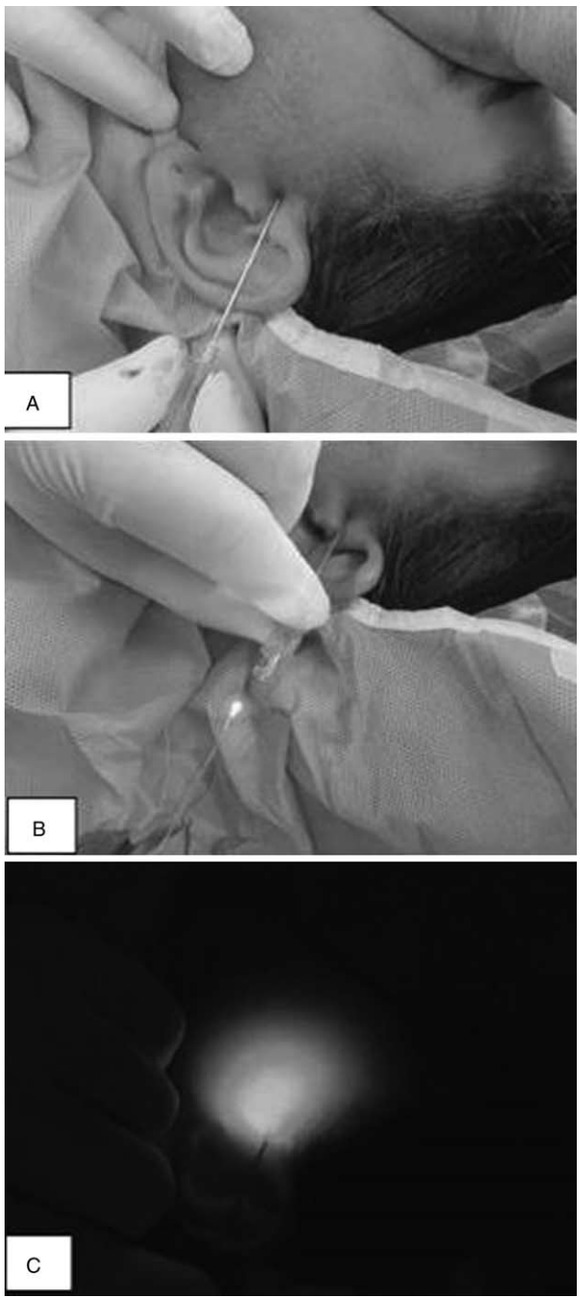


FIGURE 2. A, Pregnancy tumor. B, Laser application. C, End of surgery.

attended the Department of Maxillofacial Surgery, Ramadi Teaching Hospital, Rashid Private Hospital, and Razi Private Hospital, Anbar Health Directorate, Anbar, Iraq. Patients were examined and evaluated clinically and prepared for surgery. Demographic and clinical data, including information concerning patient's age, sex, clinical presentation, dental history, and medical history were recorded. As shown in Table 1, tongue-tie was treated in 8 patients (12.8%), hemangioma in 5 patients (16.0%), and pyogenic granuloma was found in 4 patients (12.8%). Most patients were treated using continuous-wave mode, and the time of exposure ranged from 1–2 to 6–7 min with power (Watt) of 3 to 10 W among the treated patients. All of the patients underwent sedative analgesia and topical anesthesia spray during the surgical operation; therefore, no patient experienced pain during the surgical operation, and only 3 (9.6%) patients experienced mild pain during the first 3 days postoperatively only. The intraoperative field was bloodless, and there was no need to use sutures after laser surgery in all of the patients, which gives us a clear surgical field. The wound was left open (to be healed by second intention) and covered with coagulative layer, which was clearly formed on the irradiated tissue surface, which effectively eliminated bleeding and soreness after the operation. There were no evident complications or secondary infection. There was mild edema (E/O and/or I/O) that was noticed during the first 3 days after the surgery; then it subsided gradually. Postoperative functional abilities were within normal limit during 1,



AQ18 **FIGURE 3.** A, Insertion of applicator. B, Laser application. C, Laser fiberoptic tip inside TMJ. TMJ, temporomandibular joint.

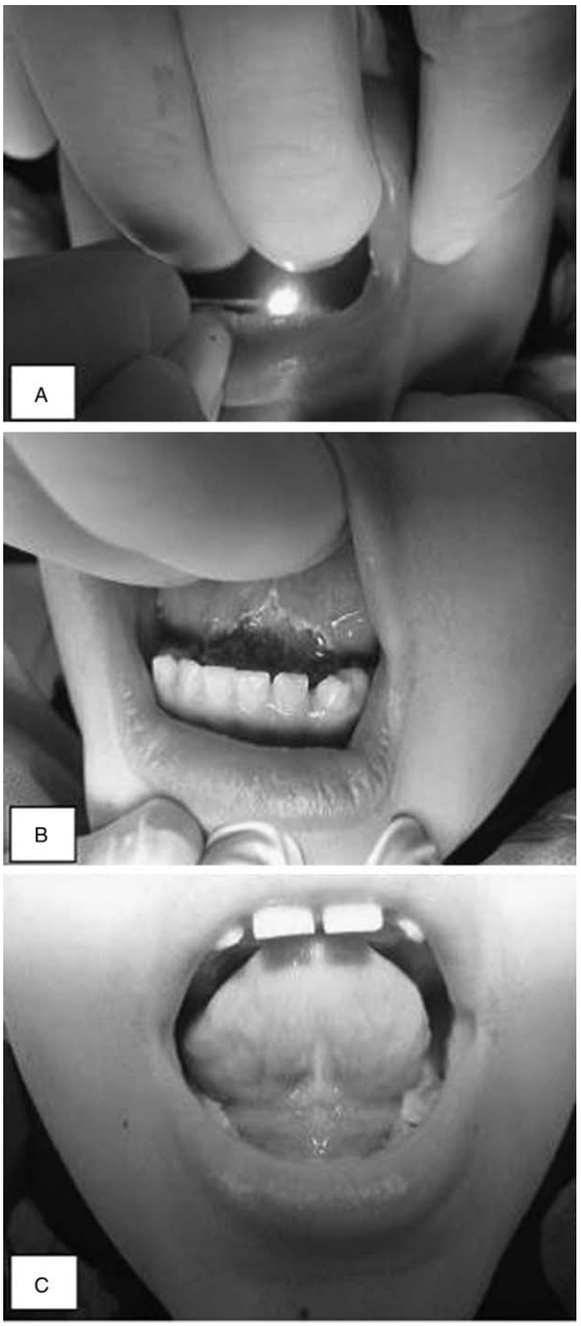


FIGURE 4. A, Laser application. B, End of surgery. C, Four weeks after surgery.

2, and 4 weeks postoperatively. In general, patients were comfortable with no pain, either intraoperatively or postoperatively with fewer functional complications and showed marked excellent overall satisfaction throughout 1, 2, and 4 weeks postoperatively.

DISCUSSION

Photothermal interaction with tissue is the basic concept of diode surgical laser. In this process, radiant light is absorbed by the tissue and transformed to heat energy changing tissue structure. Laser light within was converted to thermal energy on contact with the tissue, causing laser tissue interaction that, when appropriately applied, can produce reactions ranging from incision, vaporization to coagulation.[3,4] This wavelength has the affinity for melanin or dark pigments and is strongly absorbed by the blood hemoglobin, which contributes to their thermal effect. Since lasers were first introduced into dentistry and maxillofacial surgery, there have been investigations done to establish the laser parameters (ie, wavelength, power density, continuous or pulsed mode, time of exposure, spot size) that are most effective and least harmful for treating the soft and hard tissues of the oral cavity. Laser treatment has served as an alternative or adjunctive treatment to more conventional

TABLE 1. Clinical Presentation

No.	Lesion or Condition	N (%)	Mode	Power, W	Exposure Time, min
1	Pyogenic granuloma	4 (12.8)	CW	10	6–7
2	Pregnancy tumor	3 (9.6)	CW	10	6–7
3	Gingival fibromatosis	4 (12.8)	CW	5	4–5
4	Fibroma	2 (6.4)	CW	4	5–6
5	Tongue-tie	8 (25.6)	CW	10	5–7
6	TMJ pain and clicking	4 (12.8)	Pulsed	5	1–2
7	Hemangioma	5 (16.0)	Pulsed	10	6–7
8	Implant exposure	2 (6.4)	Pulsed	3	4–5
Total		32 (100%)			

CW, continuous-wave; TMJ, temporomandibular joint.

therapies because of its many advantages, including ablation or vaporization, hemostasis, and sterilization.[7–9] For routine clinical dental treatments, pain control is important for a patient's physical and dental well-being, as well as for the effectiveness of the therapy.[10] The coagulation effect on small vessels that provides hemostasis and seals the sensory nerve endings, providing the needed anesthesia, was reduced in this clinical series study.[11,12] In this present study, the use of 980 nm diode laser allowed increased surgical precision and accuracy, thereby reducing unnecessary damage to underlying tissues, and the procedure was with no bleeding in all of the patients, resulting in improving visualization of the surgical field, eliminating the need for post-operative sutures, and shortening the operation time; probably the efficiency of the laser allows sealing lymphatic and blood vessels that renders a bloodless surgical field.[13–15] Hemostasis occurs because the generated heat coagulates the tissue at the wound edges and because of denaturation of plasma proteins, hemoglobin, and perivascular tissue locally and by contraction of the vessel wall, and this hemostasis may account for the minimal fluid extravasation observed, with a minimal inflammatory response around the tissues under surgical management, which eliminates the need for sutures in all of the patients because of the formed coagulated layer over the raw area with no evident bleeding, and to avoid the primary intention of healing and reattachment.[12,14] In this clinical work, all of the patients were satisfied with good acceptance with respect to patient perceptions after laser and conventional surgical frenectomy and suggested that laser surgical frenectomy was superior to the conventional technique regarding patient perception and post-surgical discomfort. In addition, all of the patients returned to their normal daily activities because of diminution of surgery time and depletion of blood loss and pain besides that patients were provided with minimally invasive surgery, where tissue injury is reduced to a minimal degree.[3–5,16] In this study, there was no postsurgical edema because of laser-induced hemostasis and reduced tissue injury, except in 3 patients who had a mild edema that subsided after 3 days because of a relatively larger raw area, resulting in a more inflammatory response.[12,17,18] Because it is the result of a reduced swelling and a minimal inflammatory response and this can be explained by precision surgical laser procedures without any adverse effect on surrounding normal tissue, and the ability of lasers to seal lymphatic channels results in reduced postoperative edema, which in turn results in less postoperative discomfort, also the sealing of nerve endings resulting in reduced inflammatory response, and the formation of a fibrin clot over the surgical wound that protects the wound from external irritation, causing less pain after surgery and avoiding the use of analgesic drugs.[11] Patients treated with laser surgery have no functional complications because there was no damage to adjacent healthy tissues, with less wound contraction during healing, meaning that there is less mucosal scarring, resulting in satisfactory mobility of the soft tissue, and consequently, there is a minimal oral dysfunction.[13,14,18,19] One of the main benefits of using dental lasers is the ability to interact selectively and precisely with diseased tissues, that explains the less degree of surrounding tissue injury, no significant complications, limited scarring and contraction, and probably biostimulation effect of laser. The scalpel and the conventional electrosurgical unit are the instruments used for excision of soft lesion. In addition, laser can be used for excision and incision as an alternative method for soft tissue lesion removal. All of the laser tissue interaction produces some degree of tissue vaporization and a surrounding zone of thermal necrosis. This zone of thermal damage should be minimum, as it does not affect wound healing and graft take. The factors that determine the initial tissue effect include wavelength, laser power, waveform, tissue optical properties, and tissue thermal properties.

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