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CASE REPORT

Integrating Laser Dentistry into Esthetic Dentistry

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ABSTRACT

Lasers offer simplification of procedures with predictable outcomes. Choice of laser wavelength depends upon the indication for use, ease of use, availability and its spectrum of application. The following article consists of a case report that demonstrates the combined use of various laser wavelengths for the treatment; using a diode laser for frenectomy and an Er,Cr:YSGG laser for osseous crown lengthening.

Keywords: Dental lasers, Crown lengthening, Frenectomy, Depigmentation, Diode, Er,Cr:YSGG.

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INTRODUCTION

Clinical scenarios where crown lengthening procedures are indicated within the esthetic zone require special consideration to achieve predictable restorative results. Whether they are performed for the purpose of exposing the sound tooth structure or for enhancing the appearance of the definitive restorations, these procedures must be planned to satisfy biologic requirements, while simultaneously avoiding deleterious esthetic effects. The implementation of the diagnostic criteria along with the evidence-based surgical and restorative protocols, in addition to the state-of-the-art instrumentation, such as lasers, may assist the clinician in maximizing predictability, when treating the esthetic zone.[1]

Lasers have been classified traditionally based on the active medium, e.g. gas, liquid, solid state or semiconductor diode. Whereas clinically, lasers can be classified into two types: Soft and hard lasers. The soft tissue lasers available are argon laser, Nd:YAG laser and diode laser whereas, Er:YAG and Er,Cr:YSGG are hard tissue lasers. The first diode laser was demonstrated by Robert N Hall in 1962.[2] The diode basically does not interact with dental hard tissues, this makes it an excellent soft tissue surgical laser, indicated for cutting and coagulating gingiva and oral mucosa and for soft tissue curettage or sulcular debridement.[3] A diode laser is a solid-state semiconductor laser that typically uses a combination of Gallium (Ga), Arsenide (Ar) and other elements, such as Aluminum (Al) and Indium (In), to change the electrical energy into light energy.[4] It is usually operated in contact mode using a flexible fiber optic delivery system and emits laser in continuous-wave or gated-pulsed modes.[3] The power output for dental use is generally around 2 to 10 W.[4]

In the last 6 years, two wavelengths have been developed for use on the hard tissues. These include the Erbium: Yttrium-Aluminium-Garnet (Er:YAG) at 2.94 µm and the Erbium, Chromium: Yttrium-Scandium-Gallium-Garnet (Er,Cr:YSGG) at 2.78 µm, which by many scientific accounts have very similar properties. These two wavelengths make up the erbium family of lasers.

Preliminary studies looking at the safety and efficacy of using the Er,Cr:YSGG wavelength found it to be a precise tool for bone and dental hard tissues.[5-8] All erbium lasers share a common characteristic of an affinity for the wavelengths to be highly absorbed by water, hydroxyapatite, and collagen. The highest peaks for the absorption of laser energy in water are at 3 and 10 µm.[9] The Er:YAG and Er,Cr:YSGG wavelengths cannot be delivered through quartz optical fibers like soft tissue lasers (e.g. diode and Nd:YAG) can. Currently, there are three different methods of carrying the laser energy from the unit to the handpiece. The first method is through a special optical fiber of Zirconium Aluminum Fluoride or a similar substance with negligible water content. The second alternative is a flexible hollow waveguide—a specially designed hollow tube that guides the laser energy through reflection on the internal walls of the tube. Hollow waveguides are less expensive than the optical fibers but have a relative lack of flexibility and are shorter overall in length (from 12 in to 4 ft or so). The third method of carrying the laser energy is through an articulated arm, which was traditionally used for long wavelengths, such as CO_2. At the distal end of the fiber is a handpiece. These handpieces often are designed to have removable tips that can be sterilized and reused. Tissues can respond to laser light in four different ways: Scatter, transmit, reflect and absorb. Absorption is the most desired laser/tissue interaction in dental use which in turn depends on three factors, i.e. wavelength, tissue composition and tissue's water content.[10]

Many a times, a patient may require different soft tissue and hard tissue procedures. In such cases, a combination of different types of lasers may be used to achieve the desired results. The dentist can choose from a variety of wavelengths to use in the oral cavity. There are a number of wavelengths available for dental use, but each wavelength has its individual advantages and disadvantages. Choice of laser wavelength depends upon the indication for use, ease of use, availability and its spectra of application.[11]

The following case report describes the combined use of diode and erbium lasers for treating a patient with gummy smile along with hyperpigmentation.

CASE REPORT

A 20-year-old female patient came with the chief complaint of a gummy smile and requested for the correction of her smile. She had previously undergone orthodontic treatment.

EXAMINATION

Extraoral examination showed increased gingival display on smiling. On intraoral examination, high frenal attachment was seen in maxillary labial frenum; gingival zenith of upper anterior teeth were asymmetrical; hyperpigmentation was seen in the gingiva (Figs 1 and 2). Periodontal probing along with bone sounding was carried out.

TREATMENT PLAN

Impressions for study models were made. Intraoral radiographs and orthopantogram (OPG) were advised. Smile analysis was done and a stent[12] was prepared as a guide during surgery for crown lengthening. Treatment was carried out in two phases.

In the first phase, maxillary labial frenectomy was carried out using diode laser (Ezlase 940 nm, Biolase Technologies) due to its excellent absorption in blood, hemostatic property and precision of the cut. A 300 µm surgical tip was used in contact mode under topical anesthesia. The laser parameters used were CW, 1.2 watts (Figs 3 to 5).

In the second phase, the stent was placed in position and amount of crown lengthening to be done was marked using an indelible marker (Figs 6 to 8). Osseous crown lengthening was carried out using Er,Cr:YSGG laser (Waterlase C 100, Biolase) due to its excellent absorption

Fig. 3: Immediately postoperative

Fig. 1: Intraoral view showing gingival excess

Fig. 4: Ten-day postoperative

Fig. 2: High frenum attachment seen

Fig. 5: One month postoperative

Fig. 6: Cast used to make surgical stent to indicate proposed gingival margins

Fig. 9: Gingival and osseous contouring with Erbium laser

Fig. 7: Stent in place

Fig. 10: Immediately postoperative after crown lengthening and depigmentation

Fig. 8: Marking of gingival level

both in the water contained in the soft tissues and in the hydroxyapatite crystals present in the hard tissues. Bone tapping was carried out during the osseous recontouring procedure to ensure that ledges were not created. Periodontal probing was done to ensure biologic width of 3 mm was maintained.[13] At this stage, along with the tissue contouring, depigmentation was also carried out using light brushing strokes (Figs 9 and 10). The laser parameters used were as follows:

- Soft tissue recontouring—1 W, 20 Hz, 8% water, 11% air
- Hard tissue recontouring—1.75 W, 40% water, 40% air

After 5 days, the healing of tissues was excellent. The patient was regularly recalled over a period of 1 year to check the stability of tissues (Figs 11 to 15).

DISCUSSION

Different wavelengths have different absorption coefficients based on the varied composition of human tissue. In order to maximize the thermal reaction, there should be a close match between the laser wavelength and the chromophore(s) present in the target tissue. During the thermal ablation as the temperature rises at the surgical site, the soft tissues are subjected to warming (37 to 60°C), protein denaturization, coagulation (>60°C), welding (70 to 90°C), vaporization (100 to 150°C) and carbonization (>200°C). The primary chromophores for intraoral soft tissue ablation are hemoglobin, water and melanin.[10,14]

Diode lasers (810-980 nm) emit laser light in the near infrared spectrum of the electromagnetic radiation which are highly absorbed in hemoglobin and other pigments. One of the main benefits of using diode lasers is the ability to selectively and precisely interact with the diseased tissues. The purported advantages of lasers versus conventional surgery include increased coagulation that yields a dry

Fig. 11: Five-day postoperative

Fig. 12: One month postoperative

Fig. 13: Ten-month postoperative

Fig. 14: Preoperative smile

Fig. 15: Postoperative smile

surgical field and better visualization; the ability to negotiate curvatures and folds within tissue contours; tissue surface sterilization and, therefore, reduction in bacteremia; decreased swelling, edema, scarring; decreased pain; faster healing response and increased patient acceptance. When laser cutting is in progress, the small blood and lymphatic vessels are sealed due to the generated heat, thereby reducing or eliminating bleeding and edema. Denatured proteins within tissue and plasma are the source of the layer termed 'coagulum', which is formed because of laser action and serves to protect the wound from bacterial or frictional action.[15] Also, the diode laser does not produce any deleterious effect on the root surface. Therefore, diode laser surgery can be performed safely in close proximity to dental hard tissue. All these above-mentioned advantages were evidently experienced in the above case.

Erbium lasers, by their sheer nature of being well absorbed by hydroxyapatite, originally were considered primarily hard tissue lasers. It must be remembered that the primary chromophore of the erbium family of lasers is water in the target tissue, and the largest component of soft tissue is water. Laser physics and absorption curves of various tissues have shown that the erbium family of lasers ablate soft tissue by the same mechanism as the hard tissue. The laser energy from the infrared beam is converted into local thermal energy, and this energy creates a massive expansion in the target chromophore of water. The resulting microexplosions further result in thin layers of tissue ablation. The erbium laser soft tissue removal process results in a 'shaving or planing' of the tissue that clinically appears different than the deeper penetrating ablation process seen with dedicated soft tissue lasers.[16] Venugopalan et al.[17] postulated that, during the cutting of human mucosa, the Er:YAG targets the water molecules rather than the collagen matrix. The energy causes the water molecules to be heated into steam, which in turn strains and fractures the collagen matrix in the extracellular environment. The depth of penetration of an erbium laser using a 200 to 400 microsecond pulse width is in the range of 5 to 40 µm. There is as little as 5 µm of residual thermal damage.[18] This penetration depth is vastly different than the soft tissue lasers (diodes, Nd:YAG), whereby tissue effects can be as deep as 500 µm or more.[19] The collateral damage produced by the erbium laser is minimal because the energy is absorbed in water and thermal damage is small (no charring), which may result in improved healing of the area. Neev et al.[20] discovered that there is less collagen remodelling and, in turn, faster healing with minimal scar tissue presenting after erbium laser soft tissue surgeries.

Diode lasers (810-980 nm), unlike the erbium family, are very well-absorbed in melanin and hemoglobin. These wavelengths will pass through water and penetrate much deeper into the soft tissue. Moreover, these wavelengths achieve hemostasis much better than the erbium lasers, which are not well-absorbed by these chromophores. The erbium family, therefore, is not the ideal wavelength for soft tissue surgeries in which ideally hemostasis is desired. The degree of difficulty with hemostasis seems to be greatest in cases, where the soft tissue initially is inflamed. Although the erbium laser can be used for gingivectomies, gingivoplasties, frenectomies, vestibuloplasties, excisional procedures, crown lengthening, incisions and drainages, implant exposures during second-stage surgery, aphthous ulcer palliative treatments and the removal of melanin pigmentation, the clinician must show care to assure that no iatrogenic damage occurs in adjacent tissues, such as bone, cementum or dentin due to using the erbium laser for soft tissue procedures.[21]

During the procedure, there was no bleeding. Also, postoperatively, no pain was experienced by the patient and no swelling or any other signs of infection were noticed, whereas other alternative procedures have to be accompanied by administration of antibiotics and analgesics to minimize postoperative infection and pain.

CONCLUSION

For many intraoral soft tissue surgical procedures, the laser is a viable alternative to the conventional techniques. Regarding the advantages of lasers over conventional surgical procedures, these include dry and bloodless surgery, instant sterilization of the surgical site, reduced bacteremia, reduced mechanical trauma, minimal postoperative swelling and scarring and minimal postoperative pain. Just as there is no single dental instrument that can be used for all dental procedures; there is no single laser device that can be used for all dental treatments because of the different chromophores and varied composition of the human tissue. Combining the use of diode and erbium lasers for soft and hard tissue procedures, and keeping in mind their advantages and limitations, the operator can achieve the desired predictable outcome of the dental procedure.

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