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Clinical Application of a Digital Pulsed Diode Laser in Depigmentation Therapy

Dr. Kenneth Luk received his BDS degree from the University of Liverpool and was subsequently awarded the Diploma in General Dental Practice from The Royal College of Surgeons (England). Currently, he is a part-time lecturer at The University of Hong Kong and also maintains a private practice in Hong Kong. He has achieved fellowship status from the International Congress of Oral Implantologists (ICOI). Dr. Luk has incorporated the use of lasers in his practice since 2003. He is a member of the Academy of Laser Dentistry (ALD) and has achieved Standard Proficiency in various laser wavelengths. He also serves on ALD's International Relations Committee.

Disclosure: *Dr. Luk is a presenter for Elexxion and receives an honorarium for his services.*

Pretreatment

A. Case Outline

A 26-year-old female of Chinese ancestry presented with a chief concern of unaesthetic dark-colored gums. She noted this as a cosmetic problem, present for more than 10 years. She was healthy with a negative medical history and smokes 4 cigarettes per day.

Her skin complexion is fair (Figure 1). She was not a mouth breather and her lips were competent. Dark, unaesthetic gingival tissue was noticeable in her smile profile (Figure 2).

Intraoral examination revealed melanin pigmentation on both upper and lower labial gingival tissues (Figure 3). There were no restorations in her dentition and the periodontal condition was good.

B. Diagnosis

1. Provisional Diagnosis

Congenital melanin pigmentation of the labial gingivae.

2. Treatment Plan

The proposed plan was to use laser energy to conservatively ablate the pigmented gingival epithelium. Two laser wavelengths were to be employed in sequence, with the use of the second wavelength dependent on the outcome of the first.

The patient was informed of possible surface tissue ablation on the treated sites, and was told that relapse of the condition is possible.

The patient agreed to the plan after an informed consent/refusal discussion took place.

The lower anterior soft tissue (adjacent to teeth #22-27) was treated once with an erbium:YAG laser (Opus Duo, OpusDent, Yokneam, Israel), with an emission wavelength of 2940 nm. The operating parameters were 400 mJ, 10 Hz, and a 1000-micron sapphire tip was used. A protective gingival spacer was also used (Figure 4). The procedure was performed under topical anaesthesia with no water spray until the target pigment area was removed. Total exposure duration was estimated at 1 minute and 40 seconds. Figures 5 and 6 show the immediately postoperative result. The hemostasis was very good but the patient reported some discomfort during the procedure. Six weeks later, the patient returned for a follow-up examination and there was no significant reduction in the pigmentation (Figure 7).

The patient then asked whether the diode laser would be effective for depigmentation, since her outcome experience was not good with the erbium laser. She was then offered to have the procedure repeated, this time using a diode laser on the other pigmented area.

Depigmentation of upper gingivae (adjacent to teeth #5-12) under local anesthetic with a digital pulsed diode laser (810 nm wavelength) was then agreed upon, and is the focus of this manuscript.

3. Indications, Considerations, and Precautions for Lasers

Various laser wavelengths have shown success in melanin depigmentation of gingiva (see page 16).

The graph (Diagram 1) shows the relative absorption of different laser wavelengths. The erbium:YAG (2940 nm) and CO_2 (10,640 nm) lasers produce soft tissue surface ablation that is relatively non-selective because of the high water absorption as well as minimal tissue penetration. The dental erbium laser, with its microsecond pulse width and low repetition rate, typically produces less hemostasis than the CO_2 laser.

The Nd:YAG laser at 1064 nm is a versatile soft tissue laser. Similar to diode lasers, it reacts with the chromophores of melanin and hemoglobin. The Nd:YAG, transmissive through water, can penetrate into soft tissue. Its free-running pulse mode allows for thermal tissue cooling between the short pulses.

The diode lasers at 810 and 980 nm are also transmissive through water, and are attracted to pigmented tissue. The continuous wave or the mechanically gated pulsed mode both produce a long tissue interaction time. This requires much longer relaxation time for tissue to cool (Diagram 2). Hence, low power (1 to 3 W) is recommended for most soft tissue procedures. The use of a "high fluency technique" for the 980 nm diode wavelength, developed by Dr. Mike Swick, enables the clinician to increase power and reduce potential collateral tissue damage from the heat-stacking effect by using water irrigation as a coolant.

A major precaution during any soft tissue laser procedure is to avoid collateral thermal damage to underlying bone or adjacent tooth structures, especially when using a noncontact and/or noninitiated tip.

The digital pulsed diode laser is the 4th generation of diode laser technology. The aim of using a digital pulsed diode is to achieve high power intensity and short pulse width (16 µsec) with penetration only into the pigmented area, thereby minimizing the surface ablation effect and the heat-stacking effect beyond the target tissue (Diagram 3).

Treatment

A. Laser Operating Parameters

Digital Pulsed Diode Laser (Claros, Elexxion, Radolfzell, Germany)
Wavelength: 810 nm
Delivery System: Fiberoptic Beam: 600 µm noninitiated
Power: 30 W
Tissue Exposure Mode: Digital Pulsed 16 µsec
Pulse energy: 0.48 mJ
Pulse Rate: 20,000 Hz
Average power: 9.99 W
Exposure duration: 2 minutes

B. Laser Safety Check

A laser safety check was carried out.

The operating room was closed with a laser-in-use sign posted outside.

All personnel and the patient were issued protective glasses (L6). This is equivalent to an optical density of 6. Note: Normal protective glasses (L4) from other laser devices for the same wavelength are not recommended for this laser device.

As an added safety measure, a remote controlled signal light (battery-operated flashlight and a transmitter) is placed outside the operating room. When the laser is firing, the signal light flashes with an orange-colored light every second.

C. Treatment Delivery Sequence

Buccal local infiltration was given using 2 carpules of 2% lignocaine with 1:80000 adrenaline (Xylocaine, Astra, North Ryde, Australia).

OpalDam® (Ultradent Products, South Jordan, Utah) was place on the cervical margin from tooth #5 to 12 to protect the teeth from laser exposure.

The 600-micron noninitiated fiber was placed 2 mm from the target tissue of teeth #5, 6, and 7. The fiber was directed at right angles to the target tissue. The fiber was kept in motion at all times, and the total exposure time was 26 seconds. Tissue blanching and instant depigmentation were visible. No surface ablation was noted.

The decision was then made to add water irrigation to the procedure for the remaining soft tissue areas (teeth #8-12). The aim was to avoid dehydration by high-speed evacuation by keeping the surface tissue cool and moist. The same parameters as above were used for an additional exposure time of 1 min 14 sec.

As noted, the total laser exposure lasted 1 minute and 40 seconds, and as a result of the water irrigation, there was no sign of tissue blanching.

D. Postoperative Instructions

Postoperative instructions were given to the patient as follows:

- Diet control: Avoid colored food additives like soya sauce, and avoid spicy food for one week.
- Refrain from smoking for one week.
- The patient was given a prescription for ibuprofen if needed for discomfort.
- Rinse with warm salt water and maintain good oral hygiene.

E. Assessment of Treatment Outcome

There was no surface tissue damage and instant depigmentation was visible.

There were no intraoperative or postoperative complications, and the prognosis was very good.

Follow-Up Care

A. Assessment of Treatment

When the patient returned to her office immediately after treatment, her colleagues noticed the marked difference in her smile. She reported mild discomfort after the anesthetic wore off, although she took no analgesics. She also reported that her teeth were sensitive at times on the first day.

The patient returned for her first follow-up 6 days following treatment (Figure 8). The tissue was pink in color, and an overexposed area around tooth #7 was healing within normal limits.

At 3 weeks, the patient returned for inspection and there was no darkening in color of the gingivae (Figure 9).

At the 7-week follow-up visit, the gingival tissue had not darkened and in fact remained lighter in color than the preoperative condition. The teeth were free of symptoms (Figure 10).

At 6 months, the patient noticed mild darkening of the gingivae. She was still very satisfied with the result (Figure 11). Electric pulp testing (EPT) and cold tests were within normal limits. Periapical radiographs revealed no sign of any apical lesions or abnormalities (Figures 12-13).

B. Conclusion

The result of this technique is comparable to other techniques used by other laser wavelengths. The immediate postoperative cosmetic appearance of the gingivae is an advantage with this procedure which the author named "Atraumatic Depigmentation Therapy."

Since the treatment was performed, the patient has been more confident with her smile (Figures 14-16). Although local anesthetic was required for treatment with the diode laser, this technique was preferred to the other procedure performed on the lower gingivae, both in terms of less discomfort during the procedure and improved gingival appearance immediately postoperative. The patient's lower gingivae did not show when smiling, and she was not concerned with further treatment of that tissue. She was very satisfied and expressed a desire to whiten her teeth.

The digital pulsed diode laser enhances previous diode technologies which have a longer gated pulse width. It thus offers more energy delivery options for desired tissue interactions. Although this case gives successful cosmetic results, more cases and longer postoperative follow-ups should be carried out to give a comprehensive assessment of this technique.

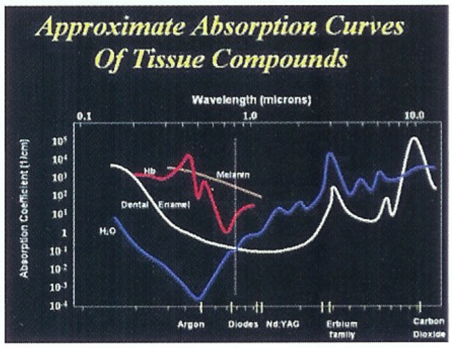

Diagram 1: Graphic display of chromophores of various laser wavelengths. The 810 nm diode laser is indicated with a dotted line.

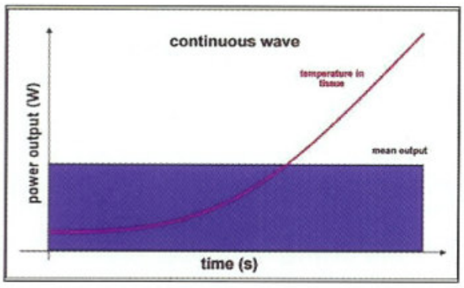

Diagram 2: Graphic display of the constant tissue temperature rise when exposed to continuous wave laser energy.

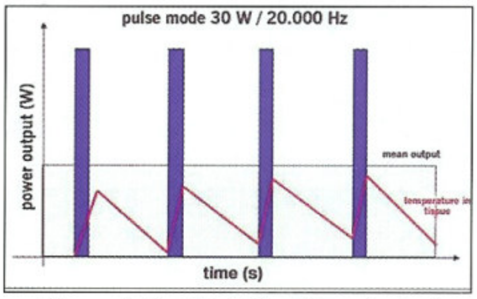

Diagram 3: Graphic display of tissue temperature rise and fall in response to the small interaction time of a short-pulsed laser.

Figure 1: Preoperative, frontal view

Figure 2: Preoperative smile

Figure 3: Preoperative anterior gingival tissue showing hyperpigmentation

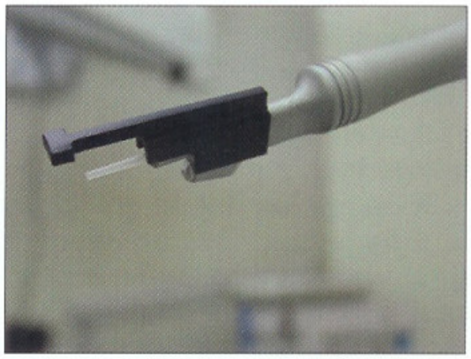

Figure 4: Gingival spacer shield fitted to the Er:YAG laser handpiece and tip

Figure 5: Immediate postoperative view of the mandibular right side, Er:YAG laser used

Figure 6: Immediate postoperative view of the mandibular left side, Er:YAG laser used

Figure 7: Six weeks postoperative, Er:YAG laser

Figure 8: Six days postoperative, maxillary anterior, diode laser used

Figure 9: Three weeks postoperative, maxillary anterior, diode laser used

Figure 10: Seven weeks postoperative, maxillary anterior, diode laser used

Figure 11: Six months postoperative, maxillary anterior, diode laser used

Figure 12: Six-month postoperative radiograph, maxillary anterior right side

Figure 13: Six-month postoperative radiograph, maxillary anterior left side

Figure 14: Six months postoperative, right profile smile

Figure 15: Six months postoperative, left profile smile

Figure 16: Six months postoperative, frontal view

Lasers and Depigmentation

Different laser wavelengths have been used for removal and reduction of congenital gingival pigmentation. Other techniques include conventional periodontal gingivectomy and gingivoplasty procedures, as well as the use of cryogenics. A sampling of the literature reveals several laser references with successful outcomes:

1. Yousuf A, Hossain M, Nakamura Y, Yamada Y, Kinoshita J, Matsumoto K. Removal of gingival melanin pigmentation with the semiconductor diode laser: A case report. *J Clin Laser Med Surg* 2000;18(5):263-266.
2. Atsawasuwan P, Greethong K, Nimmanon V. Treatment of gingival hyperpigmentation for esthetic purposes by Nd:YAG laser: Report of 4 cases. *J Periodontal* 2000;71(2):315-321.
3. Tal H, Oegiesser D, Tal M. Gingival depigmentation by erbium:YAG laser: Clinical observations and patient responses. *J Periodontal* 2003; 74(11):1660-1667.
4. Esen E, Haytac MC, Oz IA, Erdogan O, Karsli ED. Gingival melanin pigmentation and its treatment with the CO_2 laser. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2004;98(5):522-527.

In the previous issue of the *Journal of the Academy of Laser Dentistry*, Dr. Kenichi Takahashi described his treatment of hyperpigmentation using an Er:YAG laser in a contact mode with an 800-micron diameter fiber and an average power of 2 W (200 mJ, 10 Hz), which is a different parameter and spot size from Dr. Luk's technique. Dr. Takahashi had good results, although the reader will note that surface ablation did occur and hemostasis was only adequately managed with the erbium wavelength.

In *Wavelengths,* Dr. Michael Swick explains his pioneering technique of using a copious water spray with high fluence from the 980 nm diode laser. His clinical results show one good solution to the problem of excessive thermal energy effects.

1. Swick MD. Cosmetic diode laser gingivectomy with frenectomy. *Wavelengths* 2000;8(4):19.
2. Swick MD. A char-free technique for the Ceralas D15 diode laser. *Wavelengths* 2000;8(4):20.

Dr. Luk's instrumentation demonstrates another method of attenuating the tissue temperature rise by using very short pulses of 810 nm diode laser energy.

As always, the laser energy must be carefully directed toward the target tissue to remove the pigmented gingiva; each wavelength will have unique interaction properties, and the clinician must carefully evaluate the progress of the surgery.

Lasers in Dentistry

In this issue, we feature two laser wavelengths for a variety of soft tissue and hard tissue procedures

- Dr Kenneth Luk uses a diode laser with digitally pulsed technology to remove melanin hyperpigmentation from otherwise healthy gingival tissue. His case shows a comparison between his use of an erbium laser and then his subsequent use of a diode laser.

The *Journal* is again pleased to publish clinical cases fromthree of the recent successful Advanced Proficiency candidates who presented during the ALD's 12th Annual Conference in New Orleans.

- Dr. Emil Litvak performs removal and recontouring of hyperplastic gingival tissue that occurred following orthodontic treatment. He carefully employs an Er:YAG laser to recreate a more normal amount of periodontal soft tissue.
- Dr. Glenda Payas has two clinical case studies using an Er:YAG laser. In the first, she performs soft tissue crown lengthening on the upper anterior arch for a patient with hyperplastic gingival tissue; the second case shows removal of several bony protuberances that occurred following full-mouth extractions. She employs this wavelength to its full advantage in safely treating gingiva and bone.
- Dr. Ronald Schalter also presents two clinical case studies with an Er,Cr:YSGG laser. In the first case, he prepares the upper and lower anterior teeth for direct composite restorations. His second case demonstrates a fibroma excision. In both instances, Dr Schalter demonstrates the usefulness of this wavelength for hard and soft tissue treatments.

These cases show the numerous clinical indications for use of both the diode and the erbium family of lasers and once again demonstrate how dental lasers continue to be utilized for good patient care.

Case Studies