Aesthetic laser therapy correction of physiological gingival hyperpigmentation

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Abstract

A beautiful smile is dependent on many factors. One of those factors is the gingival scaffold. Symmetry, proportion, as well as colour and appearance of the gingiva are critical to an aesthetically pleasing smile. Physiological gingival hyperpigmentation does not present as clinical pathology requiring intervention, nonetheless it may be of aesthetic concern to the patient. Minimally invasive intervention by means of cryosurgery, electrosurgery, laser therapy or other may produce dramatic change in the appearance of the patient's smile with a sustainable, long-term aesthetic outcome. Hereafter a case is presented demonstrating laser therapy removal of gingival hyperpigmentation with stable, pink gingival aesthetics at the 2-year follow-up.

Introduction

Aesthetics are a set of principles concerned with the nature and appreciation of beauty, and as these are applied to dentistry both patient and clinician scrutinize these toward achieving a healthy and aesthetic smile. Gingival hyperpigmentation, especially in cases of vertical maxillary excess, high lip line, high aesthetic demand, may be of significant concern to the patient seeking its correction.[1] There may further be a psychological and cultural consequence to hyperpigmentation of the gingiva visible upon smiling that is displeasing to the patient. Normal, healthy gingiva is described in texture, consistency and colour, as firm, stippled, and coral-pink or salmon-pink in nature.[2] Briefly, gingival hyperpigmentation may be considered physiological or pathological in nature.[3] Discernment between the two is paramount since physiological hyperpigmentation may be removed for aesthetic concerns while pathological lesions may be sinister in nature and require more scrupulous intervention for the sake of the patient's health. Physiological variations in differing race groups, particularly of African and Indian descent, may or may not include hyperpigmentation of the gingiva seen as macules varying greatly in terms of size, shape and location.[4] Melanocytes are located in the epithelial basal and suprabasal layers and synthesize and store melanin pigments, by converting tyrosine into melanin, stored in these layers in the form of melanosomes.[5] The degree of pigmentation depends on melanocyte activity, determined by one's race, genetic disposition, and hormone production.

Removal of hyperpigmented gingival tissue for aesthetic reasons may be carried out by a variety of methods including cryosurgery, chemical agent cauterization, bur abrasion, scalpel gingivoplasty, electrosurgery, gingival graft, and laser techniques.[1] The latter comprises an extensive branch of dentistry by itself, employing a variety of devices (Table 1) including diode lasers, CO_2 lasers, Er:YAG laser, Nd:YAG laser, and Er,Cr:YSGG laser.[6] Here a case is reported of aesthetic intervention of physiological gingival hyperpigmentation by Er,Cr:YSSG laser with stable and aesthetically pleasing results at the 2-year follow-up.

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Figure 1: Preoperative view of the patient's smile

Figure 2: Retracted, preoperative, intraoral view demonstrating the degree of pigmentation and extension of the affected areas

Case report

A 34-year-old female patient of Indian descent presented by referral to a specialist in periodontics and oral medicine at her request for "pink gums". The patient was a non-smoker and the medical history was non-contributory. Examination of the face denoted multiple, poorly defined, hyperpigmented macules of the lips, mild in severity and greater in number on the lower lip. The patient's high smile line was noted with excessive gingival display, the entirety of which involved hyperpigmentation, blue-black/dark brown in colour (Fig. 1). Intraoral examination denoted a healthy, largely restorative-free dentition, with exemplary oral hygiene maintenance. Hyperpigmentation was noted involving the attached gingiva of both the mandible and maxilla, with the latter greater in severity (Fig. 2). The patient scored 4 on the Dummet Oral Pigmentation Index in terms of pigmentation intensity (heavy clinical pigmentation), and scored 2 on the Takashi melanin pigmentation index in terms of its extension (formation of continuous ribbon extending from the neighboring solitary units).[4] In both the mandible and the maxilla the hyperpigmentation appeared mostly as singular, posteriorly extending macular lesions with well demarcated borders limited coronal to the mucogingival junctions. A diagnosis of physiological gingival hyperpigmentation was made and intervention for aesthetic correction was indicated (the patient initially sought treatment of the maxilla only). Digital smile design (DSD) and smile analysis of the patient indicated need for correction of the altered passive eruption. De-epithelialization of the affected areas as well as crown lengthening by laser gingivoplasty was opted for. The working field was retracted and isolated (OptraGate, Ivoclar Vivadent), and local anaesthesia achieved by slow infiltration of a 4 % articaine with adrenaline (1:200,000) local anaesthetic solution (Ubistesin™ forte, 3M ESPE). The area, mucosa and teeth surfaces, were cleaned with sterile gauze soaked in chlorhexidine gluconate aqueous solution (never use an alcohol solution with medical lasers). An Er,Cr:YSSG laser (Waterlase iPlus 2.0, Biolase) was used for all the periodontal soft tissue surgeries. The crown lengthening by gingivectomy was first carried out as per the DSD guide, with a fine tip (MGG6), applied more parallel to the tooth, with the unit's power settings at 3W 75Hz, with water and air settings 50 and 40 respectively. Thereafter, a broader, chisel tip (MC3) was interchanged for the depigmentation/gross de-epithelialization, with power settings increased to 5W 25Hz. The tip size and power allowed for faster removal of tissue with water and air settings on for cooling.

Broad, gradual strokes de-epithelialized the pigmented areas up to 1 – 2 mm beyond the lesions' borders. To conclude

Figure 3: Immediately postoperative, crown lengthening and de-epithelialization of pigmented tissue completed

Figure 4: 10-days postoperative, rapid healing with dramatic results in gingival colour

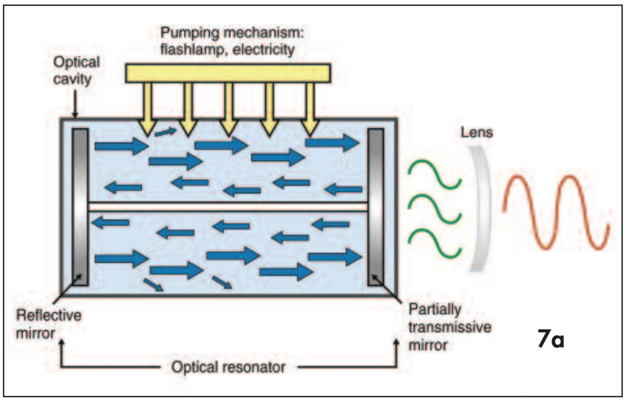
Figure 5: The patient's smile 10 days after the laser de-epithelialization and crown lengthening

Figure 6: Patient's smile at the 2-year recall; dental bleaching, increased clinical crown size, coral-pink gingiva, all contribute to a healthy, aesthetic smile

the procedure, the unit was set to "laser bandage" mode, with lowered power settings at 1-1.5W 75Hz, and water and air off for hemostasis, leaving a layer of coagulum that would aid with the tissue healing. After the entire affected area was de-epithelialized (Fig. 3) postoperative instructions were given (no tooth brushing near the treated area for 1 week, rinse with chlorhexidine mouthwash BID 1 minute (Andolex C, iNova Pharmaceuticals), soft diet avoiding spicy/irritating foods). The patient was recalled at 10 days, reporting having had no pain or discomfort, and demonstrating near complete healing of the entire treated area (Fig. 4). There were no areas of hyperpigmentation noted (Fig. 5). The patient was rescored as zero for both pigmentation indices. Following dental bleaching the patient presented at the 2-year recall with no notable signs of repigmentation. The patient remained a score of zero on both indices. The gingival contour and colour remained stable with aesthetic results pleasing to the patient (Fig. 6).

Discussion

Pigmentation of the gingiva may pose an aesthetic concern to the patient seeking cosmetic correction thereof. Laser depigmentation is an evidence-supported, beneficial treatment modality.[1] "Laser" is an acronym for light amplification by stimulated emission of radiation.[7] Possibly the first report of laser radiation on oral soft tissues was as early as 1965.[8] The first commercial laser for use in dentistry, the dLase 300 Nd:YAG laser, was introduced in 1990.[6] At present, a range of laser wavelengths are used in dentistry for a plethora of applications (Table 1). The fundamental mode of action of lasers is that waves consisting of photons (basic unit of radiant energy, light) travel at the speed of light and these waves can be defined by their wavelength and amplitude.[11] Amplitude is the vertical height of the wave, and in lasers this corresponds to "brightness", its potential energy to do work. Wavelength is the distance between two corresponding points on the wave – the unit typically in laser dentistry is nanometer (nm). Waves rise and fall around the zero axis many times a second, referred to as oscillations, and the number of oscillations per second is the frequency, measured in hertz (Hz). The laser utilized in the treatment of this case (Er,Cr:YSSG) functions at a wavelength



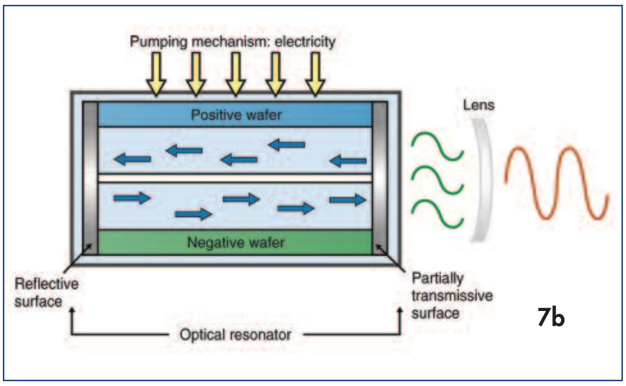


Figure 7: (a) Components of a gas or solid active-medium laser, eg. CO_2 or Nd:YAG laser, and (b) a diode laser. Adapted from Principles and Practice of Laser Dentistry 2nd ed (p. 14), by Convissar RA, 2015, St. Louis: Mosby Elsevier

Table 1: Lasers currently used in dentistry

Laser type	Active medium	Wavelength (nm)	Treatments, applications
Excimer lasers	Argon fluoride (ArF)	488	Hard tissue ablation, phased out of dentistry. Medical use primarily
	Xenon-chloride (XeCl)	308	Dental caries and calculus detection
Gas lasers	Carbon dioxide (CO2)	9300;10,600	Sulcular debridement, peri-implantitis, soft tissue surgery
	Argon (Ar)	488 - 514	Phased out of dentistry. Medical use primarily.
	Helium-neon (HeNe)	630	Pulp vitality testing, therapeutic photobiomodulation
Diode lasers	Indium-gallium-arsenide-phosphorus (InGaAsP)	800 – 1064	Dental caries and calculus detection
	Galium-aluminum-arsenide (GaAlAs)		Intraoral general and implant soft tissue surgery, sulcular debridement (subgingival curettage in periodontitis and periimplantitis), analgesia, treatment of dentin hypersensitivity, pulpotomy, root canal disinfection, aphthous ulcers, gingival depigmentation
	Galium-arsenide (GaAs)		
Solid-state lasers	Potassium titanyl phosphate (KTP)	532	Dental bleaching, medical applications
	Neodymium:yttrium-aluminum-garnet (Nd:YAG)	1064	Soft tissue surgery, sulcular debridement, analgesia, dentin hypersensitivity, pulpotomy, root canal disinfection, enamel caries removal, aphthous ulcers, gingival depigmentation
Erbium group:	Erbium-doped yttrium aluminium garnet (Er:YAG)	2940	Caries removal, cavity preparation, soft tissue surgery, sulcular debridement (teeth and implants), scaling root surfaces, osseous surgery, dentin hypersensitivity, analgesia, pulpotomy, root canal treatment & disinfection, aphthous ulcers, gingival pigmentation
	Erbium: yttrium-scandium-gallium garnet (Er:YSSG)	2790	
	Erbium, chromium: yttrium-scandium-gallium garnet (Er,Cr:YSSG)	2780	
Other	Low level lasers	600 – 635	Non-surgical, photobiomodulation, caries detection

2780 nm, and at a frequency of 1 – 100 Hz. Hertz also states the number of laser pulses per second of emitted energy. To put these properties into perspective, light from a household bulb is white and diffuse, it is not focused. Laser light differs in that it is monochromic (a beam of single colour), and that its waves are coherent. This means they are identical in size and shape. The amplitude as well as the frequency of all the waves of photons are identical. The production of focused electromagnetic (EM) energy is a direct result of this coherence. Whilst a 100Watt bulb may light a room, a 2Watt laser may perform a surgical excision, since all the photons in the laser light are focused and "work together".[12] A laser consists of three structural components, namely the active medium, the pumping mechanism, and the optical resonator (Figs. 7a, b). In-depth electromagnetism physics may not be essential knowledge for the clinician, but it may be helpful to know that lasers derive their product nomenclature from these components. The active medium may consist of a container of gas (CO_2 lasers), a solid crystal (Er,Cr:YSSG laser), a solid-state semiconductor (diode laser), or as a liquid. The active medium is surrounded by the pumping mechanism which is an excitation source

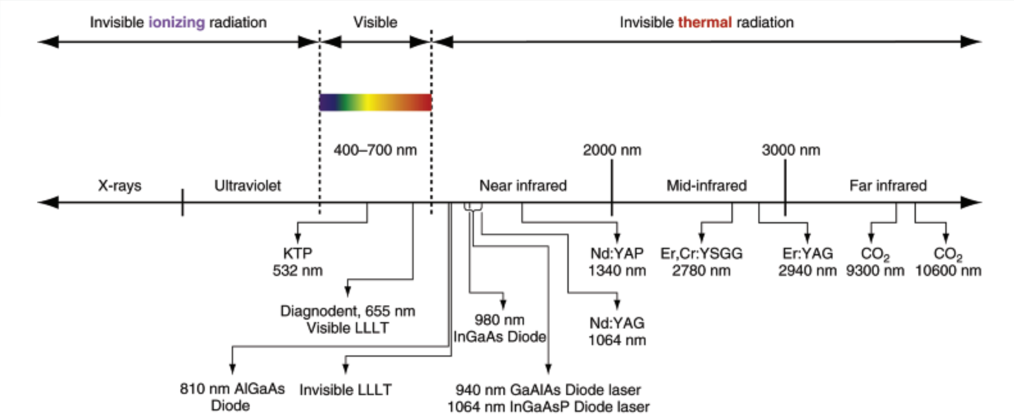


Figure 8: Wavelengths of the various laser lights and their position within the EM spectrum. Adapted from Principles and Practice of Laser Dentistry 2nd ed (p. 14), by Convissar RA, 2015, St. Louis: Mosby Elsevier

(source of energy, electric coil, lamp strobe, etc.). The excitation source will excite electrons, and as they return to their resting state they emit energy in the form of photons. Completing the laser cavity are optical resonators (typically mirrors) that reflect waves back and forth, thereby collimating and amplifying the beam.[12] As with normal light, the clinician may note that laser light waves exist on the EM spectrum and can correlate the type of laser to its respective wavelength (Fig. 8). All commercially available dental lasers emit light and wavelengths ranging 500 – 10,000 nm.[13] As such, a dental laser may fall within the visible or invisible and non-ionizing range of the EM spectrum. An erbium laser for example then may have an additional light source in the device for the clinician to visualize the application point. Furthermore, the point of caution here is that all persons in the laser operating room are to wear laser protective eyewear.

When the laser is activated there may be four possible interactions between the laser light and the target area, depending on the tissues' optical properties, depending on the light's wavelength.[10] Reflection will occur when the light is deflected off the surface, with no effect. This may be of consequence to neighbouring, absorbing tissues, and may cause injury to a nearby person's unprotected eyes. The laser light may also be transmitted, again with no effect on the target tissue, but possible unintended or detrimental effect to neighbouring tissue. Absorption may be the most desired effect. The amount of absorption further depends on the tissue's water content, and pigmentation. The fourth interaction is scattering, whereby the photons penetrating the tissue change directions and leads to absorption in a greater area. As laser energy is absorbed by the tissue the interaction is photothermal (laser energy transformed into thermal energy). The effects then are either incision/ excision, ablation/vaporization, or hemostatic/ coagulation.[14] When the beam's spot size (diameter) is small and focused, it is suited for an incision/excision procedure. A wider beam size will interact with the tissue more superficially producing surface ablation. And when the beam is out of focus or less focused coagulation can be performed. In the treatment of this gingival hyperpigmentation case, a larger beam diameter allowed for superficial tissue interaction but deep enough to target the basal and suprabasal epithelial layers rich in melanocytes. The ablative action of the laser over a wider area allowed for removal of the superficial gingival layers rather than focused cutting. Oral mucosa is high in water content and the laser's effect primarily involves the thermal change in the tissue. When water temperature is raised to 100° C vaporization of the water within the mucosa occurs, called ablation. Incision and excision of oral soft tissues occurs at this temperature. Between 60° and 100° C proteins will denature without vaporization of underlying tissue, ideal for the removal of diseased degranulation tissue, for hemostasis and coagulation.[15] Charring of the tissues will however occur at temperatures at around 200° C.[16] When removing hyperpigmented tissues, lower temperatures are needed, and much less energy is needed since chromophores attract lasers. Conversely, higher energy would be needed to excise fibrotic tissue with less chromophores.[17]

Lasers used for the aesthetic correction of physiological hyperpigmentation have been extensively described in the literature, and suggested as superior to other treatments due to the fast healing, reduced pain and discomfort, clean and dry operating field, and stable results.[1, 19, 20,21] The formation of protein coagulum on the laser treated wound surface

Table 2: Literature review 1951 – 2013; pigmentation recurrence rates (%) by random-effects Poisson regression[1]

Treatment	No. of studies	Repigmentation rate (%)
Bur abrasion	16	8.99
Scalpel gingivoplasty	23	4.25
Gingival graft	3	1.96
Laser	27	1.16
Electrosurgery	9	0.74
Cryosurgery	12	0.32
	Laser	
Nd:YAG	4	2.86
CO2	4	2.14
Er:YAG	8	1.41
Diode	12	0.19

reduces postoperative pain. Laser light may also "seal" free nerve endings.[18] The patient treated in the case presented here required only 1 ampoule local anaesthetic infiltration per quadrant delivered segmentally across the working area. The operating field was dry and void of any profuse bleeding. Nearly the entirety of the hyperpigmented lesions had the superficial layers of tissue layers removed. Healing was rapid with no report of pain, infection, nor discomfort. At as early as 10 days postoperative the area was nearly entirely healed with radical results in tissue colour and contour. The literature reports the expected chronological and degrees of repigmentation following removal by various modes of treatment. Depigmentation by laser ranks low (1.16 %) in terms of percentage repigmentation (Table 2).

Conclusion

Er,Cr:YSSG laser therapy for de-epithelialization can successfully alter blue – black/dark brown gingiva to uniform pink colour with numerous benefits for both clinician and patient. The results can be dramatic for patients seeking this treatment, remaining stable over the long-term, contributing greatly to an aesthetically pleasing smile.

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