Treatment of Gingival Melanin Hyperpigmentation by Er,Cr:YSGG Laser: Report of 2 Cases

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Abstract

Background: Gingival melanin hyperpigmentation is clinically presented as "black gum" which is not medical but esthetic problem especially for those who have gummy smile. Various treatment modalities have been made for cosmetic removal of pigmented area including laser ablation which recently seems to be the most effective, reliable and satisfactory method. This paper describes two cases of depigmentation technique using Er,Cr:YSGG laser.
Methods: Two patients with gingival melanin hyperpigmentation were treated by 2780 nm Er,Cr:YSGG laser device which was set at 1.0-1.75 watt, 7% water and 11% air for gingival ablation, and then 0.5 watt, 0% water and 11% air for biologic bandage. The operation was done in non contact mode under topical anesthesia. Patients were observed for 12 months.
Results: Removal of melanin pigment was seen immediately after treatment. Healing was good within a week. No post operative complications such as infection, pain or bleeding was encountered. The final outcome was satisfactory for all patients. However, second application may be needed. Slight repigmentation was found in one patient in the eleventh month of observation.
Conclusion: Considering good clinical outcome and patients satisfaction, Er,Cr:YSGG laser ablation is possibly a method of choice for effective removal of gingival melanin hyperpigmentation.
Key words: Gingival pigmentation, melanin, hyperpigmentation, depigmentation, Er,Cr:YSGG laser

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Clinically, gingival melanin hyperpigmentation is presented as light to dark brown and sometimes blue-black area mostly located in facial aspect of gingiva. Attached gingiva is the most common site. The color is often a diffuse, symmetric, ribbon-like dark band or irregularly shaped patch with a well-demarcated border.[1] The condition is physiologic and should be differentiated from those pathologic conditions that produce oral pigmentation.

The pathologic pigmentation can be the result of endogenous or exogenous factors. The endogenous factors are diseases such as Peutz-Jeghers syndrome or endocrine disturbance such as Addison's disease, Albright's syndrome (polyostotic fibrous dysplasia), pregnancy or other causes including Von Reckling Hausen's disease (neurofibromatosis), Gaucher's disease, Wilson's disease, human immunodeficiency virus (HIV) infection, chronic pulmonary disease, hemochromatosis, thalassemia, jaundice, melanoma, trauma and inflammation.[2,3] The exogenous factors are heavy metals such as gold, bismuth, arsenic, mercury, silver, lead, and copper or maybe any kind of tattoos such as amalgam tattoo, graphite or intentional tattoos.[4] Smoking, tobacco, chewing nuts and certain medications such as antimalarial drugs, minocyclin, ketoconazole and oral contraceptive may produce oral pigmentation as well. These pathologic conditions are beyond the scope of this article.

Physiologically, normal color of skin is composed of 6 sources. They are 1) brown or black melanin which is the most important pigment of the skin, 2) red oxyhemoglobin, 3) dark blue or purple reduced hemoglobin, 4) yellow carotene, 5) brown or black melanoid and 6) yellow soft keratin.[5] Physical condition such as skin thickness, quality of epithelial keratinization, the extent of connective tissue vascularization, and the presence of subcutaneous fat tissue also dictate color variation of the mucosa and gingiva as well.

Chemically, melanin granule is round and approximately 0.3 microns in diameter with molecular weight of 20,000[6]. Melanin is insoluble in water and most organic solvents. An approximate composition was 57% carbon, 9% nitrogen, 3.5% hydrogen, 30% oxygen and varying amounts of sulfur in some natural melanins.[7] The melanin pigment is produced by melanocyte from tyrosine through the action of tyrosinase and stored in the form of melanosomes.

Histologically and microscopically, melanocyte is dendritric cell located in the basal and suprabasal cell layers of the epithelium. In the cell of melanocyte, revealed well-developed Golgi complex, extensive area of rough endoplasmic reticulum and melanin pigment.[8] The pigment in the form of melanosomes are transferred to the outer layer of the skin and phagocytosed by melanophores. Melanophores are cells containing phagocytosed melanin granules, which are keratinocytes of the epithelium, fibroblasts or macrophages of the connective tissue. From Masson-Fontana and hematoxylin & eosin stained specimen, melanophores are found mostly in the basal cell layer of epithelium along the free and attached gingiva and the greatest density at free gingival groove.[9] Besides the pigment density, the depth of the pigments in gingival layer also makes clinical difference in color. Brown color is associated with more superficial melanin and blue color is associated with more profoundly located melanin in the connective tissue.[7]

In contrary to general opinion, gingival pigmentation is not confined to the black populations. People of other nationalities also present melanin hyperpigmentation, e.g. French, Filipino, Arab, Chinese, Indian, German, Italian, Jewish, Greek, and Romanian.[10] Number of melanocytes in different populations are comparable but the melanocyte activities vary, causing difference in color. The prevalence of melanin pigmentation has been reported that it varies between 0-89% with regarding to ethnic factors and smoking habits.[11] Gingival melanin hyperpigmentation is not a medical but esthetic problem to many individuals especially those with gummy smiles. Fair-skinned people with moderate or severe gingival pigmentation frequently request cosmetic treatment of the "black gum".[10]

Various treatment modalities have been made for cosmetic removal of pigmented area. Chemical solutions such as a mixture of 90% phenol and 95% alcohol has been used to destroy tissue down to basal cell layer[12] but the agent is harmful to oral tissue and repigmentation soon develops. Various conventional periodontal surgical procedures such as gingivectomy or removal of the attached

gingiva have been used but these procedures are associated with alveolar bone loss, prolonged healing and excessive pain.[13] These surgical techniques, if are performed solely for cosmetic reason, offers no permanent results.[8, 14] A free gingival graft which required additional surgical site has also been used, but color matching and demarcated line around graft itself may pose esthetic problem.[15] Bur abrasion or deepithelialization using surgical bur has been employed but the technique is difficult to control the depth of deepithelialization. Moreover, bleeding and post operative pain are anticipated.[16, 17] Cryosurgery required high technical skill and special instruments.[18-20]

Laser ablation of hyperpigmented epithelium is another effective treatment option. Different dental lasers have been reported for successful treatment of gingival hyperpigmentation including those heat producing lasers such as 10,600 nm carbon dioxide (CO_2) laser[11, 21, 22], 1064 nm Nd:YAG laser[23], 820 nm semiconductor diode laser[24] and 514 nm argon laser[25]. Non heat producing lasers which are 2940 nm Er:YAG[10, 26] and 2780 nm Er,Cr:YSGG[27] have also been reported as effective, pleasant and reliable method with minimal post operative discomfort and faster wound healing for depigmentation procedure.

Er,Cr:YSGG laser has been developed in mid-nineties and has been commercially available in 1998. The laser machine was approved by the U.S. Food and Drug Administration (FDA) for several soft and hard tissue procedures including endodontic therapy and oral osseous surgery. The second generation of Er,Cr:YSGG laser used in this report (Waterlase, Biolase Technology, San Clemente, CA, USA) emits photons at a wavelength of 2780 nm. with a pulse duration of 140-150 μs, pulse repetition rate of 20 pulses per second (20Hz) and power output ranging from 0 to 6 Watt (pulse energy 0-300 mJ) through a fiber-optic cable delivery system terminating in a handpiece with a sapphire crystal that is bathed in air-water spray. Er,Cr:YSGG laser employs patented Hydrokinetic® technology for oral hard tissue cutting. The manufacturer terms the hydrokinetic process when water mist absorbs laser energy, then becomes energized, expanded and moved with kinetic motion so quick that the water droplet can mechanically cut oral hard tissue. The laser ablates tissue in less than a 5-mm range with the maximum energy at 1 to 2 millimeters from the sapphire tip to the target tissue. For soft tissue cutting, the process is tissue vaporization with adjustable air and water coolant to minimize collateral thermal damage to surrounding tissue. The depth and efficiency of cutting can be adjusted by different parameters such as the power setting, the air and water percentages, the tip selection, and distance from target tissue. Advantages of Erbium lasers are minimal thermal injury, patient comfort during procedure and faster wound healing.

Two cases of gingival melanin hyperpigmentation treated by depigmentation procedure using 2780 nm Er,Cr:YSGG laser were reported in this paper.

Material and Method

Laser device

An Er,Cr:YSGG laser device (Waterlase, Biolase, San Clemente, CA.) emitting a 2780 nm laser, pulse duration from 140 to 150 μs, frequency of 20 Hz and power output ranging from 0-6 W (figure 1) was employed to accomplish the described procedure. The laser is delivered through a zirconium/fluoride trunk fiber connected to a handpiece with interchangeable fiber tip. A 6.0 mm G6, 600μm and a 4.0 mm G4, 600μm sapphire tip was used. Power setting from 1.00 to 1.75 W, air setting of 11% and water setting of 7% in non contact mode was used for deepithelialization procedure and power setting of 0.5 W, air setting of 11% and water setting of 0% was used for biologic bandage at the operated site.

Method for depigmentation

The procedure was performed under topical anesthesia using cream 2.5% lidocaine, 2.5% pilocorpin anesthetic cream (EMLA, Astra Pharmaceuticals Lp, Wayne, PA.) applied for 5 minutes before treatment and repeated during the procedure to stabilize the analgesic effect. Operating at parameter setting as described above, the tip was held 1 - 1.5 mm away from tissue with angle of 135-150 degree made by tip shank and lasing tissue surface. The laser ablation was initially made in pigmented attached gingiva, about the middle of free-gingival margin

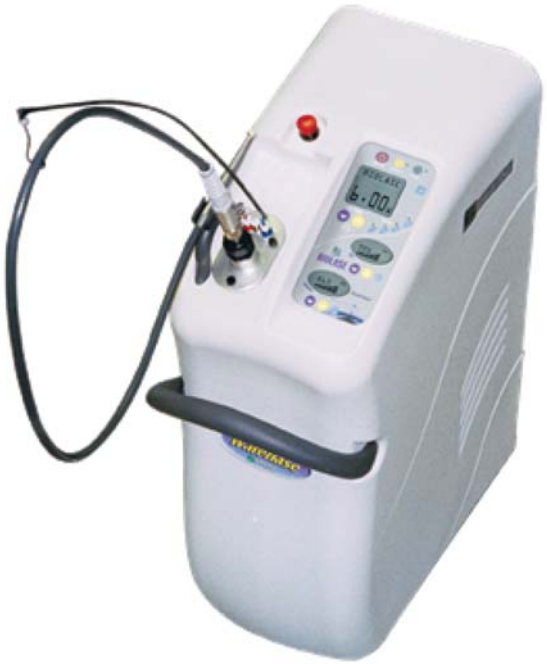

Figure 1 *Er,Cr:YSGG laser machine*

to mucogingival junction. The tip movement was in short straight vertical line, up and down, and overlapped to create sufficient depth to the pigment layer, and then moved toward mesial or distal direction. First, the operating area was at the large area of attached gingiva, secondly at the area near mucogingival junction and finally at the area near free gingival margin which must be done with extreme caution to avoid disfigure of gingival margin. The pigmented area should be removed as much as possible. However, some deep pigments may still remain because some of them reside deeper than basement membrane layer and because of the scalloped rete pegs of epithelium. Ablation beyond epithelium layer may lead to excessive bleeding from connective tissue layer or even from alveolar bone perforation. Second session of treatment was recommended for patients with deep pigments and the procedure was repeated in 2 weeks. The first depigmentation procedure took approximately 45 minutes and the second procedure took approximately 15 minutes.

After deepithelialization process, the wound was lased to have biologic dressing with parameter setting as 0.5 watt of power, 11% air and 0% water. With the tip 1 cm away from tissue in defocus mode, large area of wound was covered with protein coagulum which appeared as white spray and disappeared when moisten with saliva. No antibiotic or analgesic was prescribed. Post operative instruction was given to avoid hot or spicy food and to avoid trauma in the operated area. Patients were scheduled in 2 weeks for follow up and for second treatment if necessary. Photos were taken before treatment, immediate after treatment, 1 week, 2 weeks, 1 month, 6 months and 1 year post operatively.

Case 1: (figure 2)

A healthy 28-year old male with dark skin color had a chief compliant of "black gum" and he wanted to have it removed before his wedding in next 6 months. The gingival melanin hyperpigmentation appeared on the labial surface of both maxillary and mandibular arches as dark brown continuous band at the attached gingiva and diffuse light brown color along free gingival margin and some interdental papilla. The treatment was done one arch at a time under topical anesthesia. First treatment was done on the maxillary arch mostly at the attached gingiva. Second treatment was done in following 2 week for residual pigment along gingival margin. Mandibular arch was done in 1 treatment visit. Post operative instructions were given and no analgesic was prescribed.

Case 2: (figure 3)

A 31-year old female with fair skin color complained about her unesthetic gingiva. The gingival melanin hyperpigmentation on the maxillary arch was moderately diffused on broad area of the entire anterior labial attached gingiva. On mandibular arch, the pigment was densely gathered as brown continuous band. The patient scared of pain and dental injection and she had no experience with dental laser. The treatment was performed in 3 separated visits under topical anesthesia. In first visit, mandibular arch was depigmented. In second visit, maxillary arch depigmentation and little depigment correction was done in mandibular arch area of tooth #33. The third visit was made to correct some residual pigmented area of tooth #21 and #22. Post operative instructions were given and no analgesic was prescribed.

Clinical results

During the procedure, laser ablated the gingival epithelial surface little by little to reach the pigments without causing any bleeding which was benefitial for clearly

visualization. To enhance visualization, normal saline soaked cotton or gauze was used to remove epithelial remnant. Removing deeper pigment resided below basal cell layer caused some bleeding spots which were stopped by laser coagulation mode. Laser ablation of pigmented epithelium immediately produced a melanin pigment-free surface without any carbonization. The lased wound looked fresh with no bleeding. With biologic dressing instead of

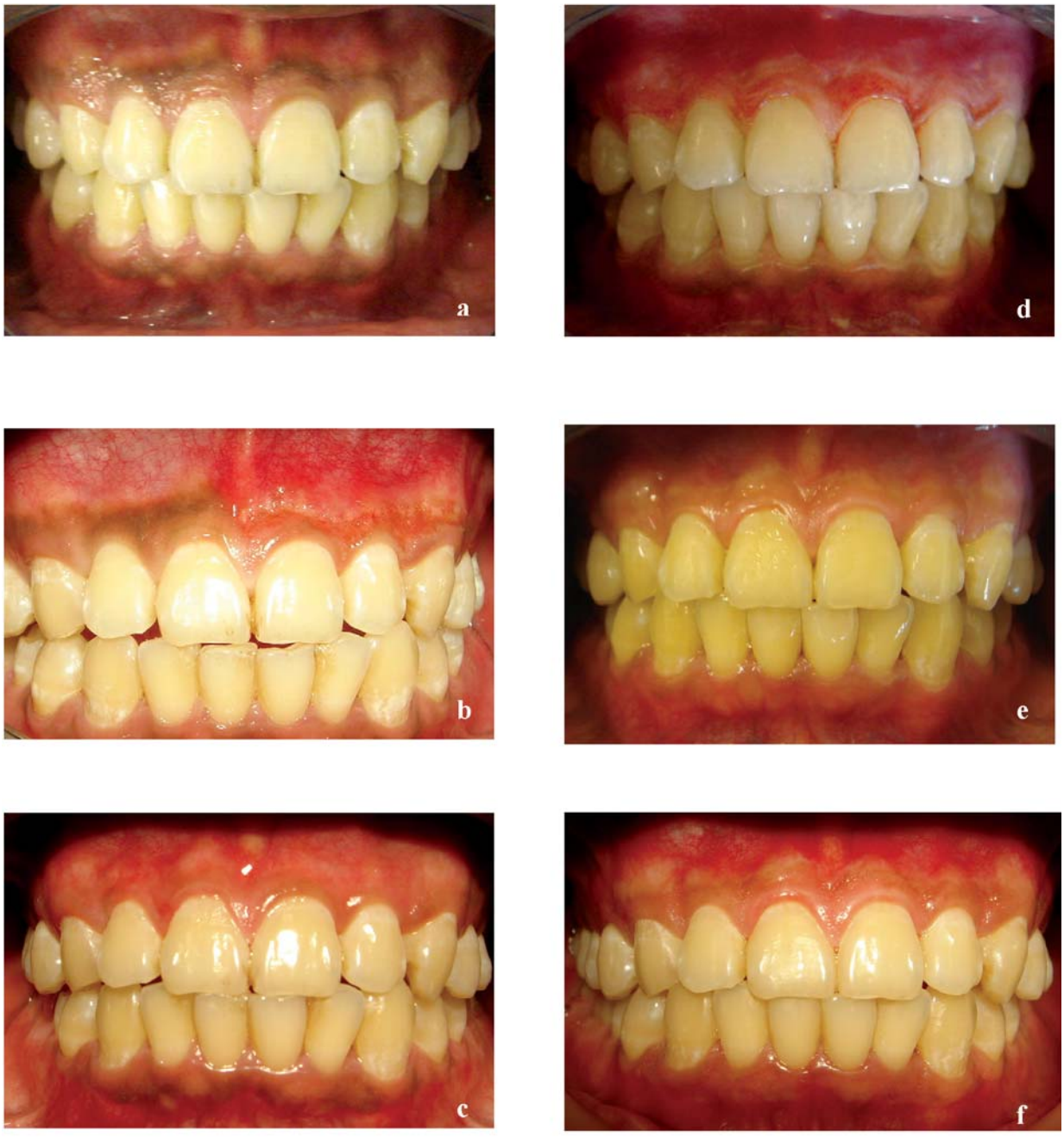

Figure 2 *The pictures demonstrated steps of depigmentation procedure in the first case.*

a. *before treatment.*
b. *immediate post depigmentation of left maxillary gingiva compared to untreated right side.*
c. *1 week post operation of maxillary arch showing complete healing of laser ablated area but there are some residual pigments along free gingival margin.*
d. *second treatment was done mostly along free gingival margin.*
e. *the finished case of both arches was photographed 1 week after mandibular arch depigmentation.*
f. *complete 1 year follow up with slight repigmentation found in the 11th month on maxillary arch .*

periodontal dressing, patient were discharged from dental office to perform normal daily activity.

Generally healing was good in 1 week with pink color comparable to nearby non-treated area, resulting in a significant improvement in esthetic appearance. No infection or significant post operative complications such as pain or bleeding were encountered. One patient reported slight discomfort during the first day; however, none required analgesic for pain control. Second treatment of remaining melanin pigment was done in both cases. The final esthetic outcome was satisfactory for these two patients.

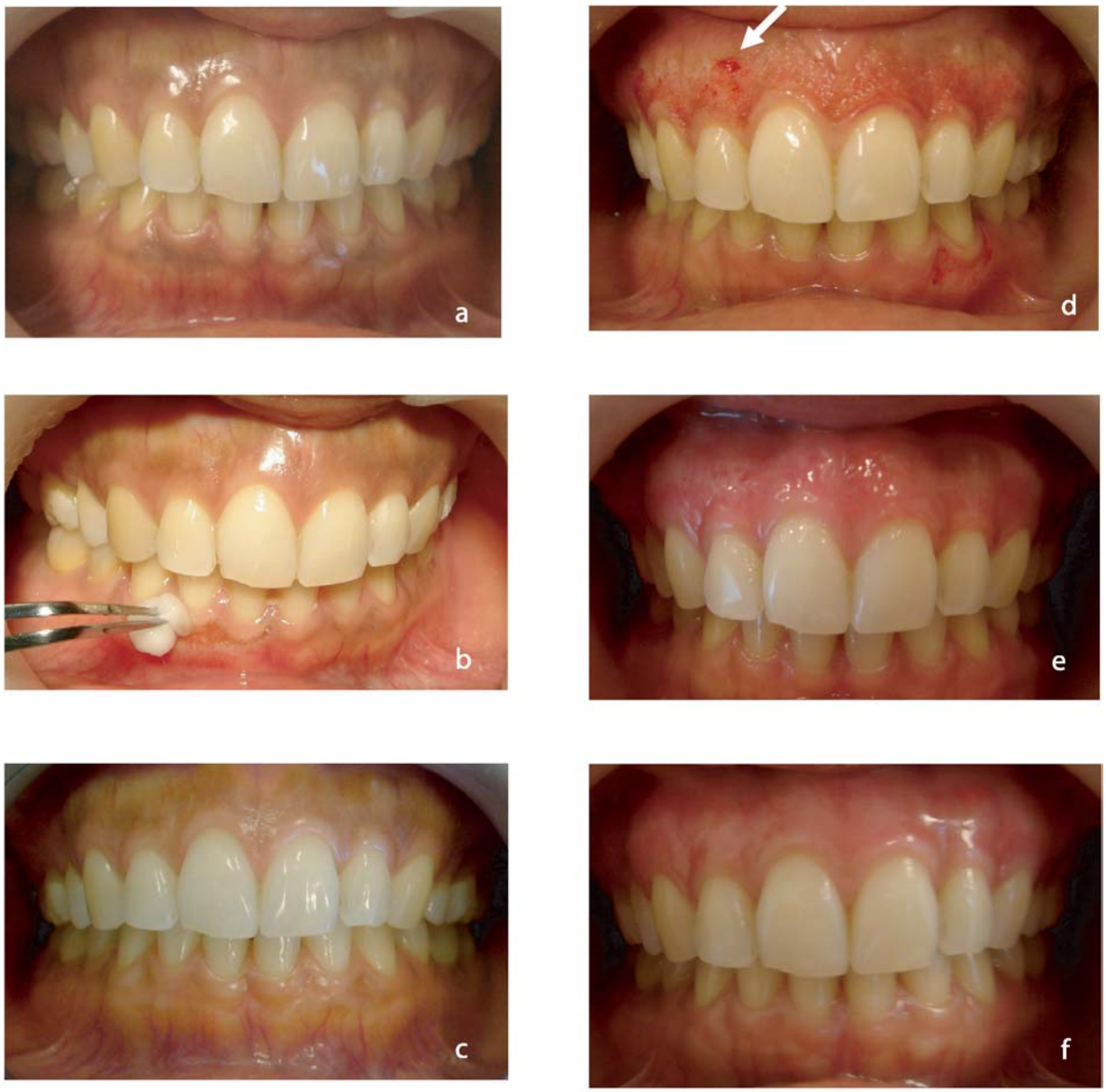

Figure 3 *The pictures demonstrated steps of depigmentation procedure in case 2.*

a. Melanin hyperpigmented gingiva before treatment.

b. Immediate post depigmentation of right mandibular arch.

c. 1 week post depigmentation of mandibular arch showing complete healing of laser ablated area.

d. Maxillary arch depigmentation and little depigment correction in mandibular arch area of tooth #33. Note bone perforation area of tooth #12 (arrow).

e. 1 week post depigmentaion of maxillary arch showing good healing.

f. The finished case of both arches after second depigmentation on area of tooth # 21 and #22

Discussion

Treatment of gingival hyperpigmentation by dental lasers has been recognized as one of the most effective, comfortable and reliable technique[27] especially by erbium lasers which seem to be the laser of choice for the procedure.[10] Er,Cr:YSGG laser is well absorbed by tissue water molecule including melanin containing cell, thus this wavelength was chosen for depigmentation procedure. Using method mentioned above, 2 cases of moderate to severe gingival melanin hyperpigmentation have been successfully treated and followed up to 12 months.

The procedure is actually deepithelialization. With Er,Cr:YSGG laser ablation, least trauma is produced comparing to non-erbium lasers, bur abrasion and conventional scalpel method. Thus, less pain, less bleeding, no charring and faster wound healing can be obtained by this described procedure.

This method was performed under topical anesthesia which was repeated within 15-20 min after the procedure had begun. There was no patient complaint of severe pain during and postoperative,only slight discomfort during eating on the first day postoperation was noted from one patient.

Bleeding is found very occasionally, when melanin pigment resides deeper in connective tissue layer where blood vessels are abundant. The deepest spot is mostly on free gingival groove at the central portion of the interdental papilla. Besides these deep spots, operating area generally is in bloodless field. Together with char-free surface, clinician visualization of residual pigments is excellent. Different from other lasers that produce carbonization at treated surface which make clinician confused with the pigment.

Immediate result of Er,Cr:YSGG ablation was outstanding. Because of wavelength property that absorbed in water, there is less than ten μm of residual thermal damage. This penetration depth of thermal damage is vastly different than carbon dioxide laser, Argon laser, diode, and Nd:YAG laser, whereby tissue effects can be as deep as 100, 200, 500 and 600 μm respectively.[11, 28] Minimal thermal damage by erbium laser contributes to faster wound healing. Absence of burning or charring is psychologically good for patient who is esthetic concerned and/or surgery phobia. The immediate wound looked resemble to nearby area only no epithelial coverage which looked slightly redder and some area looked hypopigmented.

Wound healing generally completed in 1 week which was corresponding to previous reports using erbium family of lasers.[27, 29] Whereas complete healing of carbon dioxide laser, Argon laser, diode and Nd:YAG can be up to 2 weeks. Unexpected bone exposure by Nd:YAG laser took 5 months to heal[23], while bone exposure by Er,Cr:YSGG laser in the second case took 3 days for re-epithelialization and re-collagenization, and then 2 weeks for complete healing. Carbon dioxide and Nd:YAG lasers create severe collateral thermal damage to underlying bone, present as melting or carbonized layer on lased surface, which is major factor in delayed bone healing. Er,Cr:YSGG laser with concomitant air and water spray, in the other hand, creates clean cut with no evidence of charring or melting[30, 31]. When considering laser-mediated osteotomy or ostectomy, the Er,Cr:YSGG appears to be a popular laser among clinicians.[32-34]

Highest level of caution is required in delicate free gingival margin and thin epithelium covering bone prominence. To avoid complications such as disfigurement of scallop gingival contour and bone exposure, clinician may decrease power, decrease lasing time at particular area, increase distance between the sapphire tip to the target tissue, or step the footswitch just in short intervals. Making wider angle between the tip and lasing area is another technique that help to control the depth of ablation.

Slight repigmentation was found in one case in the eleventh month. However, the severity of pigmentation was less than before treatment. The exact mechanism of repigmentation is not known but according to migration theory, active melanocytes from adjacent pigmented tissues migrate to treated area, and cause failure.[35] Following exposure of UV light, repigmentation of the skin can be developed. Smoking activates the melanin production as well. In this repigmented case, patient smokes occasionally. Considering good clinical outcome and patient satisfaction, including simple and reliable technique, Er,Cr:YSGG laser is possibly a method of choice for safe and effective removal of gingival melanin hyperpigmentation.

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การรักษาภาวะเหงือกสีเข้มเกินจากเม็ดสีเมลานินด้วยเออร์เบียมโครเมียมวายเอสจีจีเลเซอร์: รายงานผู้ป่วย 2 ราย

*สุภาพร สุทธิ์ประเสริฐพร**

บทคัดย่อ

บทนำ: สีเหงือกเข้มเกินจากการที่มีเม็ดสีเมลานินมาสะสมอยู่มากหรือที่เห็นเป็น าเหงือกดำำ โดยปกติ ไม่เป็นปัญหาทางสุขภาพ แต่เป็นปัญหาในเรื่องความสวยงาม โดยเฉพาะในคนที่เวลายิ้มหรือพูดแล้วเห็นเหงือกมาก การกำจัดเม็ดสีเมลานินออกจากเหงือกมีหลายวิธีรวมทั้งวิธีการใช้เลเซอร์ลอกผิว ซึ่งปัจจุบันดูเหมือนจะเป็นวิธีที่มีประสิทธิภาพ และให้ผลเป็นที่น่าพอใจมากที่สุด บทความฉบับนี้มีวัตถุประสงค์เพื่ออธิบายวิธีการกำจัดสีเหงือกเข้มโดยการใช้เออร์เบียมโครเมียมวายเอสจีจีในผู้ป่วย 2 ราย

วิธีการ: ผู้ป่วยที่มีสีเหงือกเข้มเกินจากการที่มีเม็ดสีเมลานินมาสะสมอยู่มากได้รับการลอกเหงือกโดยใช้เครื่องเลเซอร์ชนิดเออร์เบียมโครเมียมวายเอสจีจี ความยาวคลื่น 2780 นาโนเมตร ตั้งพารามิเตอร์สำหรับลอกเหงือกที่ 1.0-1.75 วัตต์ น้ำร้อยละ 7 ลมร้อยละ 11 และพารามิเตอร์สำหรับห้ามเลือดหรือปิดแผลหลังกระบวนการลอกเหงือกที่ 0.5 วัตต์ น้ำร้อยละ 0 ลมร้อยละ 11 ปล่อยเลเซอร์โดยไม่สัมผัสกับเนื้อเยื่อเป้าหมาย กระบวนการทำภายใต้ยาชาเฉพาะที่ชนิดทา มีการเฝ้าติดตามผู้ป่วยเป็นระยะเวลา 12 เดือน

ผล: การลอกเหงือกทำให้เมลานินโดนกำจัดออกไปทันที แผลหายดีภายใน 1 สัปดาห์ ไม่มีภาวะแทรกซ้อนเช่น การติดเชื้อ ความเจ็บปวด หรือเลือดออกหลังการรักษา ผู้ป่วยทุกรายพอใจผลการรักษา อย่างไรก็ตาม การลอกเหงือกครั้งที่สองอาจจำเป็นในผู้ป่วยบางราย และในเดือนที่ 11 ของการติดตามผล พบการกลับมาของสีเมลานินจางๆ ในผู้ป่วย 1 ราย

สรุป: เมื่อพิจารณาจากผลการรักษาและความพึงพอใจของผู้ป่วย การลอกเหงือกด้วยเลเซอร์ชนิด เออร์เบียมโครเมียมวายเอสจีจีอาจเป็นวิธีที่เหมาะสมและได้ผลดีที่สุดสำหรับกระบวนการกำจัดสีเหงือกที่เข้มเกินจากเมลานิน

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