



# The use of a digitally pulsed, high power diode laser for the treatment of physiological gingival pigmentation.

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## INTRODUCTION

Gingival pigmentation, whether focal or diffuse, may be of aesthetic concern to patients. Establishing the underlying aetiology of the pigmentation is essential to ensure that the correct management is performed.<sup>1</sup>

Oral pigmentation is relatively common and can have a variety of clinical presentations.<sup>1</sup> The characteristics of the pigmentation such as the location, colour, distribution, duration, surface characteristics and presence of cutaneous lesions are important features to consider in reaching a diagnosis.<sup>2</sup> Investigation of the patient's dental, medical, familial histories and social habits are factors to consider. Possible aetiologies of oral pigmentation include traumatic, reactive, exogenous foreign bodies, drug-induced, neoplastic, genetic dysfunction and systemic disease associations.<sup>2</sup> A biopsy and laboratory studies are often required to reach a definitive diagnosis. Pigmented lesions that have a recent onset, have increased in size or cannot be explained by local factors require a biopsy to establish a diagnosis.<sup>1</sup>

Physiological oral pigmentation is associated with an increase in melanocyte activity, not an increase in melanocyte number.<sup>1</sup> Melanocytes are specialized, unicellular, dendritic, melanin-producing cells derived from the neural crest during embryogenesis. Melanocytes reside in the basal and suprabasal layers of the epidermis and oral epithelium.<sup>1,5</sup>

Keratinocytes are the predominant cell type found in the epidermis and oral epithelium.<sup>5-8</sup> The primary functions of keratinocytes are the formation of a protective barrier and re-epithelialization at sites of injury.<sup>3</sup> Wounds to the skin or oral mucosa will be repaired in part by the migration of keratinocytes.

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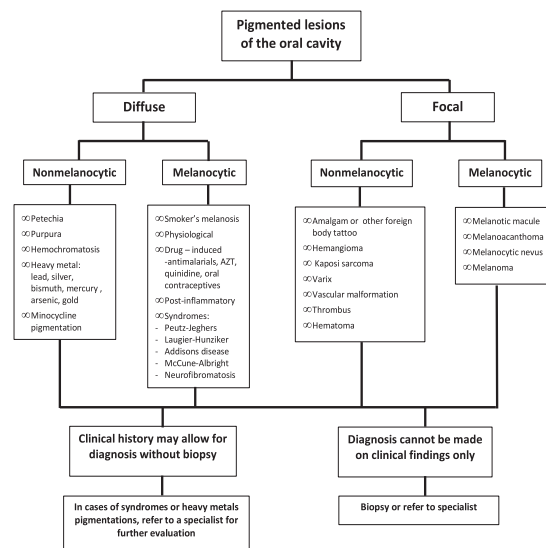
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## ACRONYMS

CO<sub>2</sub>: carbon dioxide laser (10600 nm)

Er:YAG: Erbium-doped Yttrium Aluminum Garnet Erbium laser (2940 nm)

Nd:YAG: Neodinium-doped yttrium aluminium garnet (1064 nm)



**Figure 1:** Algorithm for the diagnosis and management of pigmented lesions of the oral cavity.<sup>1</sup>

After an injury and barrier disruption, neutrophils, monocytes and macrophages are recruited to the site of injury. The expression of several growth factors and cytokines results in the activation of the keratinocytes.<sup>3</sup> The keratinocytes from the wound margins will dissolve their hemidesmosomal connections, detach from the basement membrane and migrate across the exposed connective tissue to achieve re-epithelialization.<sup>3,4,7</sup> A single layer of keratinocytes migrate from the wound edges within a few hours of tissue injury. Wound healing in the oral cavity occurs more rapidly than in skin. The normal wound healing process consists of specific phases namely inflammatory, proliferation, remodelling and maturation. The inflammatory phase involves haemostasis and inflammation, which starts at the moment of injury and continues for four to six days. The proliferation phase involves re-epithelialization, angiogenesis, granulation tissue formation and collagen deposition (takes place from day four to day 14 after injury). The maturation and remodelling phase starts from day eight after injury and proceeds for about a year.<sup>3,4</sup>

Keratinocytes and melanocytes reside together in the basal layer of the oral mucosa, forming a keratinocyte-melanocyte unit.<sup>5,7</sup> Melanocytes are cells capable of synthesizing amino acid tyrosinase, (a copper-containing enzyme) which initiates events leading to melanogenesis (i.e. the synthesis of melanin). Melanocytes produce melanin in membrane bound organelles namely melanosomes. These melanosomes are transmitted via melanocytic dendritic processes to the keratinocytes in the keratinocyte-melanocyte unit.<sup>5</sup> Melanogenesis is genetically determined and there are differences in the degree of pigmentation between racial/ ethnic groups.<sup>1</sup> Melanocytes produce two types of melanin – i.e. eumelanin (large, brown/black granules) and pheomelanin (yellow red granules). The ratio of eumelanin to pheomelanin determines the colour and degree of pigmentation observed clinically.<sup>5</sup>

Physiological gingival pigmentation can present in varying shades of brown to black depending on the depth and type of melanin deposition in the mucosa by melanocytes.<sup>1</sup> The degree of physiological gingival pigmentation can increase with age and the colour intensity can be influenced by factors such as hormonal fluctuations, smoking and medications the patient is taking. Physiological pigmentation affects males and females equally, presenting as asymptomatic, solitary or diffuse brown macules.<sup>5</sup> Clinically physiological pigmentation affects mainly the attached gingiva, however pigmentation has also been noted in other sites such as the fungiform papillae on the dorsum of the tongue.<sup>6,9,10</sup> Physiological pigmentation of the gingiva generally occurs in a symmetrical, bilateral pattern and does not extend beyond the mucogingival junction.<sup>5</sup> The diagnosis of physiological pigmentation can be made clinically (after ruling out other potential aetiologies, refer to Figure 1) and treatment is not required, unless it is of a cosmetic concern.<sup>1,15</sup>

The techniques that are most frequently employed to treat physiological gingival pigmentation includes the use of a scalpel, cryosurgery, bur abrasion, electrosurgery and laser ablation.<sup>11</sup>

Laser ablation has been recommended as an effective technique to treat gingival pigmentation.<sup>12</sup> Numerous lasers are commercially available for treatment such as the CO<sub>2</sub> laser, Er:YAG, Nd:YAG and various diode lasers (805-980 nm).<sup>6,12-14</sup> During laser depigmentation the endogenous melanin serve as a chromophore that absorbs the laser wavelengths of 351-1064 nm, resulting in elimination of the pigment.<sup>16</sup>

## CLINICAL CASE REPORT

A 22-year-old male presented with gingival pigmentation to a general dental practitioner with experience and training in using dental lasers. The patient did not find the dark appearance of his gingiva aesthetically pleasing. He stated that the dark areas on his gingiva had been present since childhood.

The clinical examination demonstrated physiological gingival pigmentation in both the upper and lower arches (Figure 2). The pigmentation was also clearly visible due to the patient's high smile line. The patient had no medical history of significance and was a cigarette smoker (four cigarettes per day).

Different techniques can be employed to eliminate pigmented areas with lasers.<sup>17</sup> The "non-surgical" technique involves the non-initiated laser tip not making contact with the tissue, although the laser beam still has the necessary effect on the melanin.<sup>18-20</sup> The treatment protocol followed to manage the abovementioned patient was a "surgical" depigmentation technique utilising a 400 micron initiated tip, with a paint brush motion over the pigmented epithelium, allowing direct contact with the tissue.<sup>21</sup> The area of contact with the diode tip was air-cooled. A constant high volume suction was employed to remove the plumes generated by the lasing procedure. Water irrigation was also applied to cool the tissue between lasing.<sup>19</sup>

### Assessment of the areas of pigmentation

A clinical assessment of the grade of gingival pigmentation was

done in accordance with the Dummett-Gupta oral pigmentation (DOPI) index.<sup>22</sup>

The scoring criteria for DOPI is as follows:

- 0 = pink tissue, no clinical pigmentation;
- 1 = mild light brown tissue, mild clinical pigmentation;
- 2 = medium brown or mixed brown and pink tissue, moderate clinical pigmentation;
- 3 = deep brown/ blue-black tissue, heavy clinical pigmentation.

The Hedin melanin index was used to describe the extent of the pigmented area.

The Hedin melanin index was scored as follows:<sup>23</sup>

- 0 = no pigmentation;
- 1 = one or two solitary units of pigmentation in the papillary gingiva;
- 2 = >3 units of pigmentation in the papillary gingiva without formation of a continuous ribbon;
- 3 = ≥1 short continuous ribbons of pigmentation;
- 4 = one continuous ribbon including the entire area between the canines.

## CLINICAL PROCEDURE PERFORMED

### Step 1

A critical step in treatment of physiological gingival pigmentation is establish the base colour of the tissue, by assessing the mucosa on the inside of the lip. The normal pink colour of the mucosa will be easily distinguishable from the gingival pigmentation (Figure 2). One can then compare the base colour of the oral mucosa to the colour of the gingival tissue and this evaluation establishes the severity of the gingival pigmentation by using the DOPI and Hedin melanin indexes.

A critical factor to bear in mind is that the darker the pigmentation, the greater affinity the 810nm diode laser exhibits to the melanin chromophores.

### Step 2

Local infiltration of anaesthetic solution was administered in both the anterior upper and lower arches in order to ensure that the patient felt no discomfort from the heat produced by the laser. A reported advantage of laser depigmentation is a reduced need for local anaesthesia, allowing a decreased amount of local anaesthetic solution.<sup>24</sup>

A soft tissue digitally pulsed diode laser (Claros, Elexxion AG, Germany) with a wavelength of 810nm ± 10nm was used with an initiated 400-µm diameter tip. The average power of five Watts was emitted in pulsed mode with a pulse duration of 10µs in contact with the pigmented tissue. The maximum frequency of 50 Hz was set on the laser (and due to the digital pulse, 20 000 such interval cycles occurred every second). The pulse energy delivered to the tissue was 0.48mJ. With these settings, the laser beam interacts with the gingival tissue and the tissue has a period where it can "cool" down during laser use. This phenomenon in which the tissue is allowed to cool in the remaining time of the cycle is known as thermal relaxation. The exposure duration was 2-5 minutes per quadrant.

Dental Laser Safety regulations were adhered to as required.<sup>25,26</sup>

### Step 3

The laser tip was moved over the tissue at a clinical hand speed that allowed a tissue interaction of "gentle" sloughing of the surface tissue. The power setting of the laser was adjusted based on the preferred hand speed of the clinician and in order to achieve the clinically visible level of sloughing. This entire process of depigmentation for both the upper and lower arches took approximately 20 minutes. The immediate post-operative result is illustrated in Figure 3.

Once the gingival pigmented areas were lased and cooled, the tissue was vigorously wiped with a wet cotton roll to remove the sloughed tissue. The patient remained comfortable and pain free throughout the procedure.

**Step 4**

The post-operative instruction to the patient was that he should rinse his mouth with a salt water mouthwash twice per day for three days.

**Step 5**

A post-operative consultation was conducted at 21 days and again at six months after the diode laser depigmentation procedure.

**Table 1:** The DOPI and Hedin index for gingival pigmentation.

Treatment interval	DOPI	Hedin
Before treatment	3	4
Follow up (21 days)	2	3
Follow up (60 days)	2	3

**RESULTS**

The gingival pigmented areas treated were assessed before treatment, 21 days and six months post-operatively. The gingival unit assessed for DOPI included the interdental papilla with half the marginal gingiva on either side of it and the associated attached gingiva. The Hedin melanin index total scores were recorded for the mandible and maxilla (Table 1).



**Figure 2:** Pre-operative photographs



**Figure 3:** Immediate post-operative photographs



**Figure 4:** 21 Days post-operative photographs



**Figure 5:** Six Month post-operative photographs

An improvement was noted after 21 days and six months following laser depigmentation as illustrated in Figures 4 and 5.

**DISCUSSION**

Although the depigmentation technique using a scalpel has been considered as being the gold standard, the major disadvantage is that this technique is painful and results in excessive bleeding during, as well as after, the procedure compared with laser treatment.<sup>27</sup>

Furthermore, the healing period with the scalpel technique is on average between 7-10 days provided that the exposed lamina propria was covered with a periodontal pack.<sup>28</sup>

The reported advantages of laser depigmentation include easy clinical application, short treatment time, easy gingival reshaping, haemostasis, negligible post-operative pain and elimination of the need for a periodontal dressing. Disadvantages of laser surgery include delayed type of inflammatory reaction, which may take place with mild post-operative discomfort lasting up to 1-2 weeks. Re-epithelialization is delayed due to lack of wound contraction when compared with conventional surgery.<sup>11, 24</sup>

The management of gingival pigmentation using the CO<sub>2</sub>, Er:YAG and diode lasers has been shown to be more effective and less traumatic than the mechanical technique of using a scalpel with a number 15 blade.<sup>11,13,17</sup> Repigmentation of treated tissue may occur over time. The literature reports that occurrence of repigmentation with the scalpel technique is 21.4% and with laser therapy 22.8%. Partial repigmentation is reported in about half of the patients after two to four years in most treatment techniques.<sup>29,30</sup> The exact mechanism of repigmentation is not understood and the literature addressing this issue is limited.<sup>31</sup> It may be attributed to the migration of active melanocytes from the adjacent pigmented tissues to the treated areas.<sup>24,29</sup>

The Er:YAG laser has been documented to be associated with an up to 30% recurrence of gingival re-pigmentation in six months.<sup>17</sup> The diode laser (810 nm) has a marked advantage over the Er:YAG laser, as the diode laser is reported to record a lower recurrence rate.<sup>32</sup>

**CONCLUSION**

Laser ablation of physiological gingival pigmentation has been reported to be an effective treatment modality.<sup>18</sup> A high powered diode laser with a high frequency and short pulse width can be used to successfully treat gingival pigmentation.

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