

# CO<sub>2</sub> Laser-Mediated Apically Positioned Flap in Areas Lacking Keratinized Gingiva

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**Background and Objectives:** Autogenous gingival grafts are considered the “gold standard” for gingival augmentation, however they require a second surgical site for graft harvesting. Apically positioned flaps (APFs) represent an alternative method in soft tissue augmentation procedures. Limited information is available relative to the effectiveness of laser-mediated APF in augmenting keratinized gingiva (KG). The aim of this paper is to evaluate soft tissues changes following APF using CO<sub>2</sub> laser in mandibular incisors with minimal KG and high labial frenum attachment.

**Materials and Methods:** A total of 20 patients with minimal amount of KG (< 2 mm) on the labial aspect of one mandibular incisor and high buccal frenum insertion were selected for treatment. Only 19 completed the last follow-up visit. An APF consisting of a single superficial horizontal incision just coronal to the mucogingival junction using CO<sub>2</sub> laser, elevation of a split-thickness flap, and suturing of the flap to the periosteum in an apical position was performed. The apico-coronal height of KG was measured at baseline, and at 3, 6 and 12 months postoperatively.

**Results:** Uneventful healing was observed in all patients and an increase in KG of 2-3 mm was obtained. Most patients rated the procedure and the postoperative course as non painful.

**Conclusions:** CO<sub>2</sub> laser-assisted APF procedure is a minimally invasive treatment modality associated with reduced risk of bleeding and predictable increase in the height of KG.

**Key words:** CO<sub>2</sub> laser · oral surgery · attached gingiva · high frenum · mandibular incisors

## Introduction

The width of keratinized gingiva (KG) is defined as the distance between the mucogingival junction (MGJ) and the gingival margin. No consensus is available as to what can be considered “adequate” or “sufficient” dimension of KG to maintain periodontal health. A narrow zone of KG is a predisposing factor in the ethio pathogenesis of gingival recessions, inflammatory changes in patients with sub gingival restorations, and may result in unstable attachment levels after orthodontic treatment <sup>1</sup>). Aberrant frenum attachment associated with a narrow band of KG and shallow buccal

vestibule interferes with proper tooth brushing leading to plaque accumulation and consequently marginal gingival inflammation and gingival recession. Such clinical situation is frequently observed at the buccal aspect of mandibular anterior teeth <sup>2</sup>).

Although autogenous grafting is still considered the “gold standard” for gingival augmentation <sup>3</sup>), it involves a second surgical site, increased surgical time and patient morbidity. The apically positioned flap (APF) technique has been proposed to increase the width of KG around teeth <sup>4, 5</sup>) and implants <sup>6</sup>) without the use of autogenous grafts. It has also been applied in the exposure of impacted teeth located in areas lacking keratinized tissue <sup>7</sup>). The APF technique eliminates the need for a second surgical site and consequently reduces surgical time, costs and postoperative morbidity.

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Within the last decade, lasers became increasingly incorporated into conventional therapy for various periodontal and peri-implant indications. The use of laser instead of conventional blade surgery in periodontal soft tissue management can further decrease postsurgical pain and hemorrhagic risk<sup>8)</sup>. The CO<sub>2</sub> Laser is a routine procedure for the treatment of oral leukoplakia<sup>9)</sup>. It has also been applied for gingival depigmentation<sup>10)</sup>, treatment of gingival hyperplasia<sup>11)</sup> and lymphangioma<sup>12)</sup>, root surface detoxification and conditioning<sup>13, 14)</sup> when used with relatively low energy output in a pulsed and/or defocused mode. Its use in frenectomy is associated with less postoperative pain and functional complications (i.e. chewing and speaking) and requires fewer analgesics when compared to patients treated with conventional scalpel technique<sup>15)</sup>. In a study comparing upper lip frenectomy with the CO<sub>2</sub> laser versus the Er,Cr:YSGG laser, Pié-Sánchez et al.<sup>8)</sup> concluded that CO<sub>2</sub> laser frenectomy results in minimal or no postoperative swelling or pain. Furthermore, it offers a bloodless field with shorter surgical times when compared with the Er,Cr:YSGG laser.

Most of the currently available information related to the application of CO<sub>2</sub> laser in frenectomy procedures<sup>16-21)</sup> involves maxillary midline and lingual frena. The aim of the present case series is to assess the effectiveness of CO<sub>2</sub> laser-assisted apically positioned flap in augmenting KG in mandibular incisors with minimal keratinized tissue, shallow vestibular depth and aberrant frenum attachment.



**Figure 1:** Baseline clinical photographs of one patient showing reduced height of KG associated with high frenum insertion at the buccal aspect of tooth 31.

## Materials and Methods

### Patient Selection

Systemically healthy non smoking adult patients were selected for this study from the patient population attending the Oral and Maxillofacial Surgery Department at the Lebanese University, Faculty of Dental Medicine according to the following inclusion criteria:

- presence of one mandibular incisor tooth with minimal buccal KG (< 2 mm);
- presence of high frenal insertion at the labial surface;
- adequate levels of oral hygiene with full mouth plaque scores < 15%<sup>22)</sup>;
- probing depths < 2 mm;
- no contraindication for oral surgery.

Patients taking medications known to interfere with periodontal tissue health or healing (corticosteroids, immunosuppressant's, uncontrolled diabetes, etc.) were excluded from the study.

Prior to initiating treatment, all patients were informed about the objectives of the study and their written informed consent obtained. The study was approved by the scientific and ethical committees of the Lebanese University.

All patients received initial periodontal therapy including oral hygiene instructions in addition to supra- and sub-gingival scaling as needed two weeks prior to surgery.



**Figure 2:** Immediate postoperative view of the CO<sub>2</sub> laser frenectomy/ apically repositioned flap. Note the absence of bleeding at the surgical site.

### Surgical Procedure and Postoperative Care

The surgical procedure was performed under aseptic conditions. Following local anesthesia, the root surfaces were scaled and planed using hand instruments. A superficial horizontal incision- extending 5 mm mesially and distally of the areas in which gingival augmentation is desired- was made just coronal to the MGJ (**Figs 1-2**) using CO<sub>2</sub> laser handpiece directed perpendicularly to the target tissue. The laser (Superpulse CO<sub>2</sub> Laser Surgical system, Model: Expert 25, China, Distribution by SARL Diatsem, France) (10600 nm) was applied in continuous and focus mode at an output power of 2 W (beam diameter at focal distance; 0.3 mm; delivery energy density per second = 2829 J/cm<sup>2</sup>). A split-thickness flap was elevated up to four mm apically from the incision line and the muscle/ frenal attachment fibers were dissected leaving a thin non movable periosteal layer in place. Care was taken during split-thickness supra-periosteal preparation to keep the laser tip oriented parallel to the periosteum avoiding direct contact with the buccal alveolar bone. The edge of the split-thickness flap was sutured to the periosteum apically (**Fig. 3**) using a 5/0 resorbable suture (Ethicon, Vicryl rapide 5-0, Polyglactin 910, Johnson and Johnson, USA). The exposed periosteal layer was left to heal by secondary intention.

Patients were given postoperative instructions and asked to refrain from retracting lips and cheeks in the treated area for 2 weeks. Medications including antibiotics (amoxicillin 1000 mg twice daily for 5 days)

and analgesics (Paracetamol 500 mg as needed) were prescribed. Daily rinses with 0.12% chlorhexidine digluconate solution were recommended for 10 days. When present, residues of sutures were removed 10 day following surgery. Patients were recalled on 3-month basis for regular periodontal maintenance during the entire study.

### Clinical Evaluation and Follow-up

The width of KG at the mid-buccal aspect of the involved teeth was recorded at baseline and at 3, 6, and 12 months postoperatively. Gingival recession (REC) was measured from the cemento-enamel junction to the gingival margin. Measurements were performed using a periodontal probe (15 UNC Color Coded Probe, Hu Friedy, Chicago, USA) and rounded to the nearest 0.5 mm. The MGJ was identified by rolling the alveolar mucosa coronally with the side of the probe (roll test). Patients were asked to rate the procedure and postoperative course (in terms of pain and/or discomfort) as very painful, moderately painful, slightly painful, or non painful and were asked to record the number of analgesic pills taken.

### Statistical Analysis

Means and standard deviations of KG were calculated at baseline and all evaluation intervals. There were no outliers and data was normally distributed as assessed by Shapiro-Wilk test. Comparison between baseline and follow-up KG measurements were performed using a one-way repeated measures ANOVA. Data were tabulated and analyzed using the Statistical



**Figure 3:** The edge of the mobile flap is sutured apically to the periosteum.



**Figure 4:** Three-week early healing showing the initial changes in the quality of buccal gingival tissues.

Package for Social Sciences (SPSS, version 20.0, IBM). Statistical significance was set at 0.05.

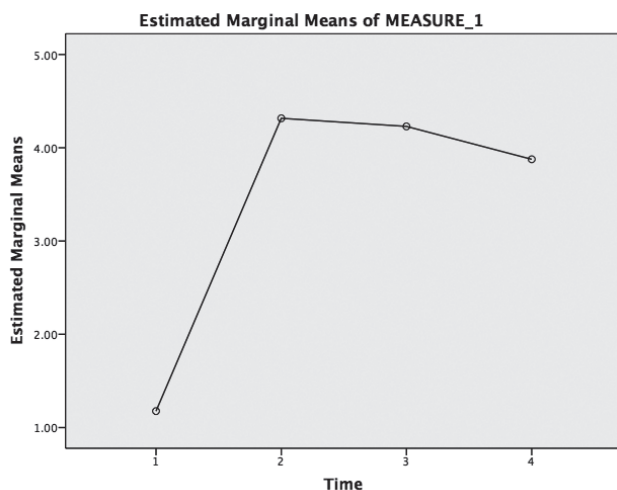
**Results**

Nineteen patients (7 males and 12 females) aged between 20 and 35 years (24.6±5.4 years) completed the study. All patients healed uneventfully (**Fig. 4**) with no postoperative complications bleeding, swelling, or hematoma. Thirteen patients rated the procedure and postoperative course as non painful while 6 described then as mildly painful. Only one patient reported taking one analgesic pill on the first day.

Changes in KG between baseline and the follow-up intervals are listed in **Table 1**. KG was statistically significantly different between all time points ( $p < 0.0001$ ). Posthoc analysis with a Bonferroni adjustment revealed that KG increased 3.14 mm on average (95% CI. 3.04 to 3.24) from baseline to 3 months ( $p < 0.0001$ ), then decreased 0.087 mm on average (95% CI, 0.038 to 0.136) from 3 to 6 months ( $p < 0.0001$ ), and further decreased 0.35 mm on average (95% CI, 3.313 to 3.93) from 6 months to one year postoperatively ( $p < 0.0001$ ).

**Table 1:** Changes of keratinized gingiva between baseline and follow-up evaluation intervals.

	Mean	SD	Minimum	Maximum
Baseline	1.18	0.11	1.00	1.40
3 Months	4.32	0.08	4.20	4.50
6 Months	4.23	0.09	4.10	4.40
12 Months	3.88	0.06	3.80	3.95



**Discussion**

Generally, frenal attachments can be managed with the simple excision technique, the Z-plasty or the localized vestibuloplasty with secondary epithelialization. These surgical techniques are usually used with the standard blade. The present case series applied the third approach modified by Carnio to manage high frenum in the mandibular incisor area and showed a significant increase in the width of KG from 1.18 mm at baseline to 3.88 mm 1 year postoperatively. This increase of about 2-3 mm is in agreement with the conclusions of previously published 2 case series<sup>4, 23)</sup> where the authors reported comparable increase in the amount of KG from a baseline mean of 2.14 ± 0.78 mm and 2.20 ± 0.38 mm to approximately double (4.25 ± 1.03 mm and 4.28 ± 0.87 mm). In a more recent study evaluating this technique to enhance donor sites<sup>24)</sup>, the authors demonstrated an increase of KG from 2.78 to 5.01 at 8 weeks following surgery. Periosteal denudation and the nature of wound healing are responsible for the formation of new attached keratinized tissue where the periostem is left exposed<sup>25)</sup>. The present findings add additional evidence to support the conclusions of Carnio and his group relative to the effectiveness of the APF technique and its modifications in increasing the width of KG without donor areas or use of commercial products.

Similarly to the findings of Carnio and his group, this study did not demonstrate any clinically significant changes in recession<sup>4, 23)</sup>. The remaining recessions



**Figure 5:** Three-month healing of the treated site showing increased KG at the buccal surface (arrow indicates the level of the mucogingival junction).

are likely to be better maintained with the improved access to toothbrushing practices. Larger scale studies and longer follow-up periods are required to identify potential changes in recession and their determinants.

Pié-Sánchez et al.<sup>14)</sup> concluded that CO<sub>2</sub> laser frenectomy results in minimal or no postoperative swelling or pain. Most patients (13/19) in the present study reported no postoperative morbidity and practically no usage of analgesics. In addition and although not specifically evaluated, the authors subjectively confirmed the bloodless field during the CO<sub>2</sub> laser-assisted procedure with shorter surgical times. This is consistent with the conclusions of the clinical study by Haytac and Ozelik<sup>15)</sup> indicating that CO<sub>2</sub> laser treatment for frenectomy provides good patient perception in terms of postoperative pain and function. CO<sub>2</sub> lasers allow performing surgery with excellent intra- and postoperative homeostasis and coagulation. CO<sub>2</sub> laser treatment of highly vascularized lesions<sup>26, 27)</sup> and cyclosporine-induced gingival overgrowth<sup>28)</sup> has also yielded satisfactory bleeding control and clear visibility during the procedure, as well as reduced postoperative pain and swelling. The minimal postoperative swelling and edema associated with the CO<sub>2</sub> laser is due to intraoperative closure of lymphatic vessels at the incision margins<sup>27)</sup>. Reduced wound contraction and scarring are among the most important advantages of CO<sub>2</sub> laser treatment<sup>29, 30)</sup>. This has been attributed, at least partly, to the relative resistance of matrix proteins to laser irradiation and the slow removal and replacement of the residual matrix<sup>31)</sup>.

In the present study, the continuous mode was applied at a power of 2 W and delivery energy density per second of 2829 J/cm<sup>2</sup>. The CO<sub>2</sub> laser is a shallow-penetrating type of laser that is absorbed at the tissue surface with minimal scatter or penetration and produces therefore a relatively thin layer of coagulation around the ablated site (31). Arashiro et al.<sup>32)</sup> reported

that the width of the coagulation layer was 100-300 µm in an incision of porcine skin with the CO<sub>2</sub> laser continuous mode at 6 W. Cercadillo-Ibarguren et al.<sup>33)</sup> showed that in the case of incisions of porcine oral mucosa, the width of the thermal effect was 20-35 µm at 1-10 W. In a study evaluating the histologic effects of CO<sub>2</sub> laser irradiation on biopsies of porcine oral mucosa and underlying bone under conditions that simulate laser application in gingival surgery<sup>34)</sup>, Krause et al. demonstrated that more than 3 passes of the laser beam in the same line of incision at energy densities of 1,032 J/cm<sup>2</sup> penetrated the mucosal layer to involve underlying bone. It should be noted that although thermal damage to bone is possible according to the abovementioned study, direct extrapolation from Krause et al.' findings is not feasible since soft tissue partial dissection in the present case study was performed parallel and not perpendicular to the alveolar bony plane during the APF. In addition, despite the practical difficulties related to keeping the laser tip parallel to the periosteal bed and away from alveolar bone during preparation of the split-thickness flap, surgeon's experience and the selected settings of the CO<sub>2</sub> laser allowed a precise control of the incision depth and a minimal penetration within the thin buccal tissues.

## Conclusions

The CO<sub>2</sub> laser-assisted APF can be effectively used as an alternative to blade frenectomy and autogenous grafts to increase the width of KG. This method can reduce the procedure duration, patient morbidity, and frequency of postoperative control appointments. Further investigations are needed to compare mandibular labial frenectomies performed with different types of laser and identify technique modifications that could yield better root coverage in recession areas.

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