Laser-Assisted Gingivectomy to Treat Gummy Smile

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KEYWORDS

• Gummy smile • Laser gingivectomy • Laser crown lengthening
• Altered passive eruption • Excessive gingival display

KEY POINTS

- Gingivectomy for a gummy smile correction is a procedure often performed in everyday clinical practice because of the growing popularity of the "smile makeover" procedures. It aims at exposing a greater gingival-incisal length of the clinical crown, often before prosthetic restorations.
- Laser gingivectomy is a safe and mini-invasive alternative to the classic surgical methods—scalpel, piezo surgery, electrocautery, and so forth.
- The advantages of laser surgery are less to no anesthesia, faster, predictable, and uneventful gingival healing, no need for suturing, as well as the possibility to work on patients on anticoagulant and antiaggregant therapy, affected by disease-related disorders of blood coagulation, diabetics, and so forth.
- Lasers can alter the mucosa and gingival tissues without causing bleeding, which enables the clinician also to perform hard tissue crown lengthening by "flapless" remodeling of the bone.

INTRODUCTION

Excessive gingival display (EGD), often referred to as a "gummy smile" or a "high smile line," is the extensive exposure of the gingiva during a smile. It is a common concern among patients, which may compromise the esthetic outcome of the dental treatment. The dentist needs to be familiar with the etiology of the EGD to perform a thorough examination in order to reach to the accurate diagnosis. It is crucial for the adequate treatment of the issue.

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The gummy smile is a nonpathological condition, causing esthetic disharmony in which more than 3 to 4 mm of gingival tissue is exposed when smiling.[1] The anatomic landmarks that have to be in harmony are the maxilla, lips, gingival architecture, and teeth.[1 2] The possible causes can be short lip length, hypermobile lip/hyperactive lip activity, short clinical crown, dentoalveolar extrusion, altered passive eruption (APE), vertical maxillary excess (VME), or gingival hyperplasia.[1 2] The cause is often multifactorial. The accurate diagnosis is essential for the adequate treatment plan and is based on a few consecutive assessments. Patient's medical history gives information about the age and overall health. Facial cephalometric analysis evaluates the facial thirds and can denote VME in cases with skeletal class II relationships. Lip analysis may indicate a short lip, hypermobility of the lip, or both. Dentoalveolar analysis specifies the horizontal and vertical dimension of the clinical crown; a differential diagnosis is made between a short clinical crown due to incisal edge wear and APE. The diagnosis is confirmed by analyzing the incisal edge and the patient's age and determining whether the discrepancy is located at the incisal margin or the gingival margin. Periodontal analysis includes periodontal probing depth, clinical attachment level, presence or absence of gingival recession, which indicates whether the short clinical crown is due to inflammation, gingival hyperplasia or APE. APE is defined as a condition in which the relationship between teeth, alveolar bone, and the soft tissues create an EGD.[2 3] If the cementoenamel junction (CEJ) can be detected in the gingival sulcus and all other causes have been ruled out, a diagnosis of APE can be made.[2] Determining the etiologic factor(s) is crucial for determining the appropriate treatment options. In cases of short lip or mild VME, lip-repositioning orthognathic surgery is usually required. Hypermobile lip is treated with botulinum toxin A injections, and severe VME can be corrected by orthognathic surgery. Gingival hyperplasia is treated by performing gingivectomy, and APE can be corrected by soft and/or hard tissue crown lengthening.[2 4]

LASER BASICS

The term "laser" (L.A.S.E.R.) is an acronym for "Light Amplification by Stimulated Emission of Radiation". Depending on the optical properties of the tissues, light can interact with them in four different ways: *reflection*, *absorption*, *transmission*, and *scattering*.[5] The main laser–tissue interaction is *photothermic*, which means that laser energy is transformed into heat. The three main photothermic laser-tissue interactions are as follows: 1. *Incision/excision*, 2. *Ablation/evaporation*, and 3. *Hemostasis/coagulation.* Laser-emitting modes play a key role in increasing tissue temperature. The important principle of each mode is that laser energy affects the tissue for a certain period of time, causing thermal interaction. If the laser is used in a *pulsed mode*, the target tissue will have time for cooling before the next pulse. In a *continuous-wave mode*, the operator has to seize the laser action manually to obtain thermal rest of the tissue. Thin or delicate tissue has to be treated in a pulsed mode, so that the amount and speed of the tissue removal is less, but the chances of irreversible thermal damage to the target and adjacent tissue are minimal. Longer pulse intervals also help to avoid heat transfer to the surrounding tissue. Besides, light air cooling or airflow from the surgical aspiration will help cool the tissue. Similarly, when using hard-tissue lasers, water cooling will help prevent microfractures of the crystal structure and will reduce the likelihood of tissue charring. Thick and fibrous tissue, on the contrary, will need more energy to remove it. For the same reason, dental enamel, with its higher mineral content, requires more ablation power than soft carious tissue. In both cases, however, the use of too much heat energy will lead to a delay in recovery and an increase in postoperative discomfort.[5]

Lasers have a wide range of pulse parameters. To allow the tissue to cool, some lasers let the operator change the working time of the impulse, called *pulse width*.

Duty cycle, or also called *emission cycle*, is the time during which the laser is turned on and off. A 10% duty cycle means that the laser is on 10% of the time and is off the remaining 90% of the time. Thin, fragile tissues should be treated with short duty cycles, whereas thick tissues can be treated with longer cycles or continuous-wave mode.[5]

Different laser wavelengths are absorbed in varying degrees, mainly by water, pigments, blood, and minerals.[6] Therefore, laser energy can be reflected, absorbed, transmitted, or scattered, depending on the target tissue composition. The primary absorbents of the specific laser light are called *chromophores*.[5] Water, which is present in all biologic tissues, absorbs maximally the two erbium wavelengths, followed by the two CO_2 wavelengths. On the contrary, water allows passing of more short-wave lasers (eg, diode or Neodymium:YAG [Nd:YAG]). Tooth enamel consists mainly of hydroxyapatite and water. The apatite crystal absorbs the wavelengths of the CO_2 laser and interacts to a lesser extent with the erbium wavelengths. It does not interact with shorter wavelengths. Hemoglobin and the other blood components and pigments, such as melanin, absorb diode and Nd:YAG wavelengths to varying degrees.

Human dental tissues consist of a combination of ingredients, so that the clinician can choose the best laser for each treatment. For soft tissue treatment, it is possible to choose each one of the existing lasers because all the wavelengths are absorbed by one or another component of the soft tissues. For hard tissues treatment, erbium and 9.3 μm CO_2 lasers with very short pulse durations easily evaporate layers of calcified tissue with minimal thermal effect. Short-wave lasers (eg, diode or Nd:YAG) are essentially nonreactive to healthy tooth enamel. Therefore, reconstructing of gingival tissue near the tooth goes smoothly with these wavelengths. Conversely, if soft tissue enters a carious lesion, the erbium laser can remove the lesion and the soft tissue very efficiently, as long as the correct settings for each tissue are applied.[5]

Laser energy is bactericidal, which results in a sterile cut. Moreover, compared with other surgical means, postsurgical bacteriemia is greatly reduced and the healing process is accelerated due to the sealing of blood and lymph vessels.[7] A thorough understanding of laser physics is essential for a predictable outcome.[8]

SURGICAL LASER WAVELENGTHS

CO_2 laser wavelengths are 10,600 and 9300 nm and are emitted through an articulating arm or waveguide that ends with a handpiece. Most manufacturers of such lasers offer handpieces with different angles (straight and contra-angle), and different focal points to perform procedures such as evaporation, coagulation, or tissue modification.

Oral soft tissues contain 90% to 97% water. CO_2 lasers' wavelengths are strongly absorbed by water, similar to the erbium ones. Therefore, CO_2 lasers are highly efficient on soft tissues. Soft tissue excision and incision are performed at 100°C, at which intracellular and extracellular water evaporation causes ablation of the biologic tissue.[5] Considering the spot dimension, the reduced mobility of the handpiece and the focus distance, CO_2 laser use on small gingival margins for smile correction may result in irregular gingival profiles.

Erbium lasers currently present with two wavelengths—Erbium:YAG (Er:YAG) at 2940 nm and Erbium,Chromium:YSGG (Er,Cr:YSGG) at 2780 nm. Erbium laser wavelengths are transmitted through semiflexible hollow waveguides, low-OH^- fiberoptic cables, or articulated arms. All of them terminate in a handpiece that may use sapphire, quartz, or a hollow metal tip to transfer the energy to the target tissue.[5] These

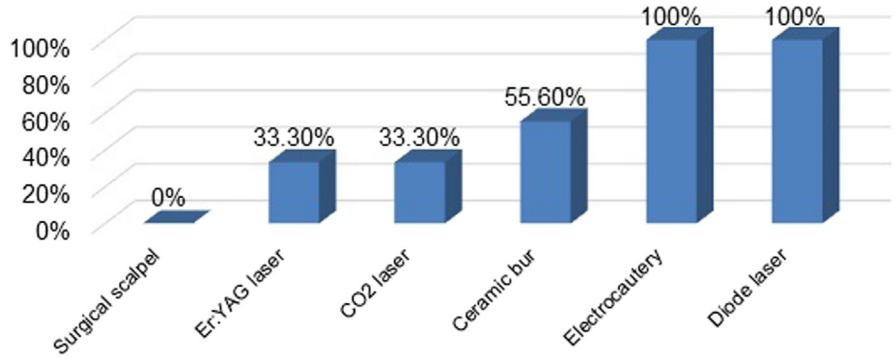

Fig. 1. Influence of the types of surgical instruments on the presence of gingival tissue rupture. (From: Kazakova RT, Tomov GT, Kissov CK, Vlahova AP, Zlatev SC, Bachurska SY. Histologic Gingival Assessment after Conventional and Laser Gingivectomy. Folia Med (Plovdiv). 2018 Dec 1;60(4):610-616. https://doi.org/10.2478/folmed-2018-0028.)

wavelengths are strongly absorbed by the water molecules in both soft and hard tissues. Erbium lasers cut soft tissue but with reduced hemostatic ability compared with other soft tissue lasers.[9] With the new technology, providing longer pulse duration and different wavelength configuration, the hemostatic ability has improved.

Erbium and CO_2 lasers with a wavelength of 9300 nm are safe for evaporation of damaged dental tissue. Patients may not even need traditional injection anesthesia, but this requirement is influenced more by the patient's perception of the dental treatment than by the procedure itself. Laser cavity preparation is less traumatic to the pulp tissues than the techniques that involve traditional rotary instruments. Vibration and heat, generated by the rotary instruments, which are the main reasons for the discomfort during the procedures, are less pronounced with erbium lasers.

In order to create higher bond strength, the final preparations have to be etched the conventional way. It is recommended to avoid the techniques that involve smear layer

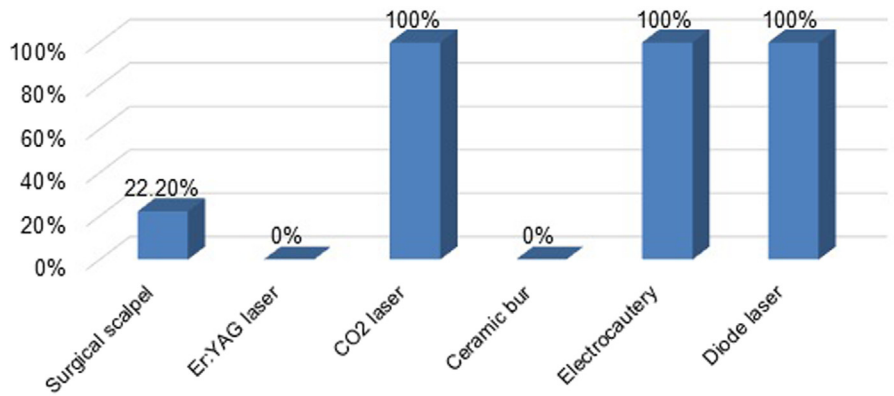

Fig. 2. Influence of the types of surgical instruments on the presence of hemostasis in the depth of the gingival tissue. (From: Kazakova RT, Tomov GT, Kissov CK, Vlahova AP, Zlatev SC, Bachurska SY. Histological Gingival Assessment after Conventional and Laser Gingivectomy. Folia Med (Plovdiv). 2018 Dec 1;60(4):610-616. https://doi.org/10.2478/folmed-2018-0028.)

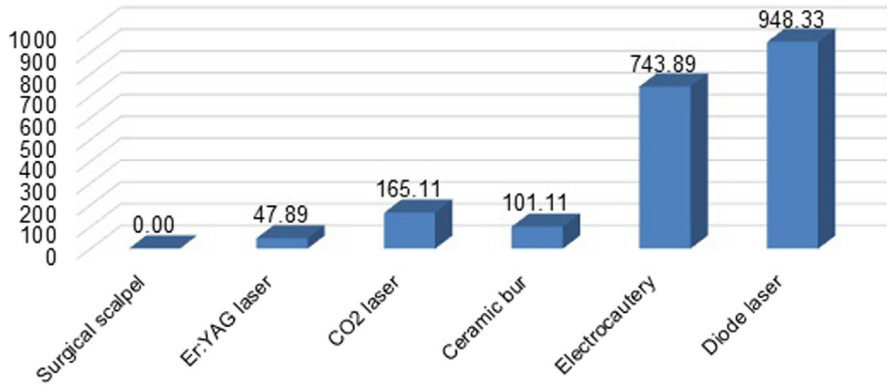

Fig. 3. Coagulation layer width in micrometer depending on the instrument used. (From: Kazakova RT, Tomov GT, Kissov CK, Vlahova AP, Zlatev SC, Bachurska SY. Histological Gingival Assessment after Conventional and Laser Gingivectomy. Folia Med (Plovdiv). 2018 Dec 1;60(4):610-616. https://doi.org/10.2478/folmed-2018-0028.)

adhesion because lasers remove it. One of the main disadvantages is that lasers with such wavelengths, as well as all the others, are not capable of removing gold or other metal crowns, ceramic, or amalgam restorations.[5] Nevertheless, erbium lasers are generally considered the more suitable devices for soft tissue remodeling in the oral cavity (including gingival tissue) because of their potential for faster healing and atraumatic, predictable, and easily repeatable treatments in esthetic zone.

Diode lasers emit in the wavelength between 810 and 1064 nm, and are compact and portable. They are used for soft tissue procedures and penetrate 2 to 3 mm in-depth, depending on the wavelength and tissue biotype. Wavelengths are absorbed by pigmented structures—*chromophores*, which makes them ideal for cutting melanotic or highly vascularized soft tissues, as well as for providing hemostasis. Their efficacy can be significantly increased by proper carbonization of the tip. This preparation allows evaporation with a limited peripheral damage of the nonpigmented tissue.[10] Surely, diode lasers are the most widely used in dentistry due to their small dimensions, most affordable cost, as well as for the contextual cut/hemostasis capability, leading to overall advantages especially in gingival cut, vascular lesion nonsurgical treatment, and oral mucosa lesions removal.[11–19]

Nd:YAG 1064 nm laser wavelengths can be used for numerous soft tissue procedures. As with diode and CO_2 lasers, the advantages of Nd:YAG lasers include relatively nonbleeding operative field, minimal edema, reduced surgical time, excellent coagulation, and reduced or no postoperative pain.

The main disadvantage of Nd:YAG lasers is the greater depth of penetration into the target tissue. Their wavelengths penetrate deep into the tissue because they are poorly absorbed by water—the main component of the gingiva. The clinician has to be aware of the risk of undesirable collateral tissue damage, of the underlying bone, or of the pulp tissue in particular. Tissue evaporation is slower compared with the other more absorbable wavelengths (eg, CO_2 lasers). The application of a topical photoabsorbent dye can reduce the absorption time of laser energy. Nd:YAG laser light with any wavelength, directed at the clinical crown or the root, is of particular importance. Pulp heating can be significant and cause inflammation and irreversible damage that can occur if inappropriate operating parameters are used.[20]

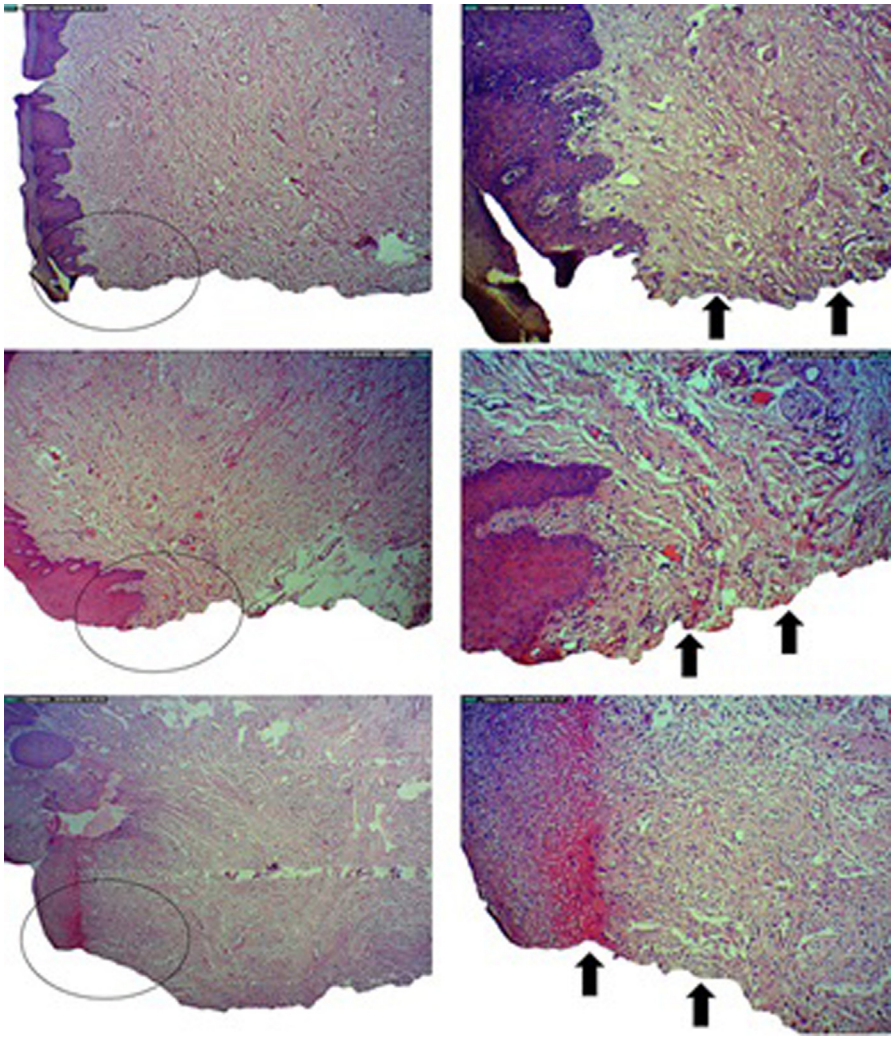

Fig. 4. Histologic specimens of gingiva excised with a scalpel (control group). Left—magnification 40 times, right—magnification 100 times. The arrows indicate the smooth cut surface. There is no rupture, coagulation, and hemostasis in-depth. (From: Kazakova RT, Tomov GT, Kissov CK, Vlahova AP, Zlatev SC, Bachurska SY. Histological Gingival Assessment after Conventional and Laser Gingivectomy. Folia Med (Plovdiv). 2018 Dec 1;60(4):610-616. https://doi.org/10.2478/folmed-2018-0028.)

GINGIVAL VERSUS COMBINED GINGIVAL AND OSSEOUS SURGERY

After evaluating the cause, arriving at the diagnosis and coming up with a treatment plan that involves raising the gingival margin, it is necessary to determine the extent of the surgery.[8] The choice of the periodontal surgical procedure depends on the gingival architecture, level of crestal bone, gingival biotype, and the amount of keratinized tissue.[21] Crown lengthening is a surgical procedure aiming at revealing a greater gingivo-incisal length of the tooth structure before the prosthetic restoration of the

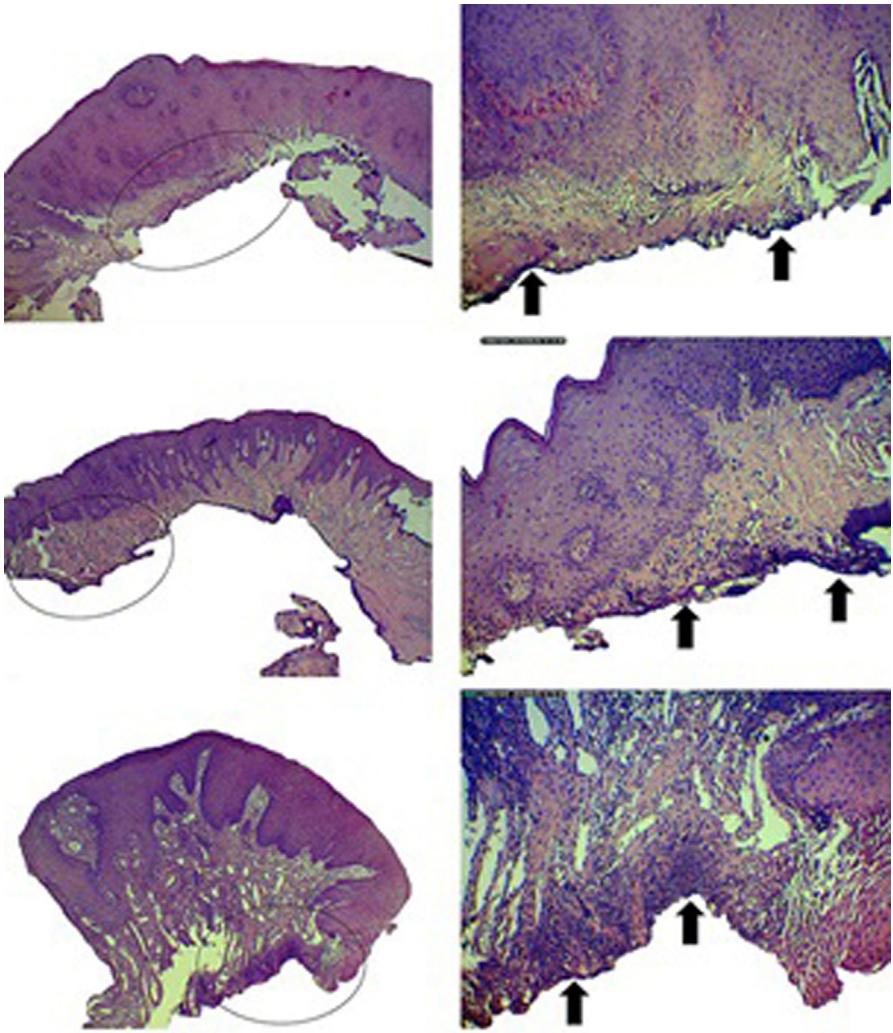

Fig. 5. Histologic specimens of gingiva excised with an Er:YAG laser. Left—magnification 40 times, right—magnification 100 times. The arrows indicate the cut surface. There is rupture in 33.3%, lack of hemostasis in-depth (due to the water cooling) and a very thin coagulation layer (47.9 $\pm$ 16.382 μm). (From: Kazakova RT, Tomov GT, Kissov CK, Vlahova AP, Zlatev SC, Bachurska SY. Histological Gingival Assessment after Conventional and Laser Gingivectomy. Folia Med (Plovdiv). 2018 Dec 1;60(4):610-616. https://doi.org/10.2478/folmed-2018-0028.)

tooth, which involves predictable disclosure of a small amount of gingival tissue alone—*soft tissue crown lengthening*, or both gingival tissue and alveolar bone—*osseous crown lengthening*. Traditional osseous crown lengthening techniques usually include full-thickness flap elevation, ostectomy, and osteoplasty, to determine the new gingival level.[4,22,23]

Soft tissue crown lengthening (gingivectomy) is excision of the gingival margin. Conventional methods for performing this procedure include the use of surgical scalpels, periodontal knives, or electrosurgery. In classic gingivectomy, excision is performed

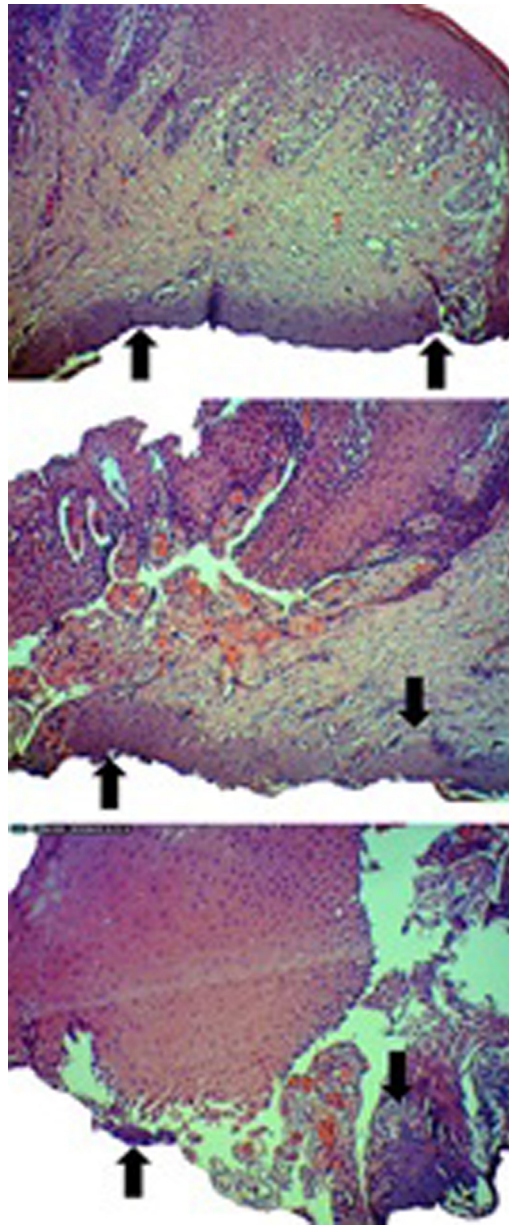

Fig. 6. Histologic specimens of gingiva excised with a ceramic bur. Magnification—100 times. The arrows indicate the cut surface. There is rupture in 55.6%, lack of hemostasis in-depth, and a very thin coagulation layer (101.11 $\pm$ 13.176 μm). (From: Kazakova RT, Tomov GT, Kissov CK, Vlahova AP, Zlatev SC, Bachurska SY. Histological Gingival Assessment after Conventional and Laser Gingivectomy. Folia Med (Plovdiv). 2018 Dec 1;60(4):610-616. https://doi.org/10.2478/folmed-2018-0028.)

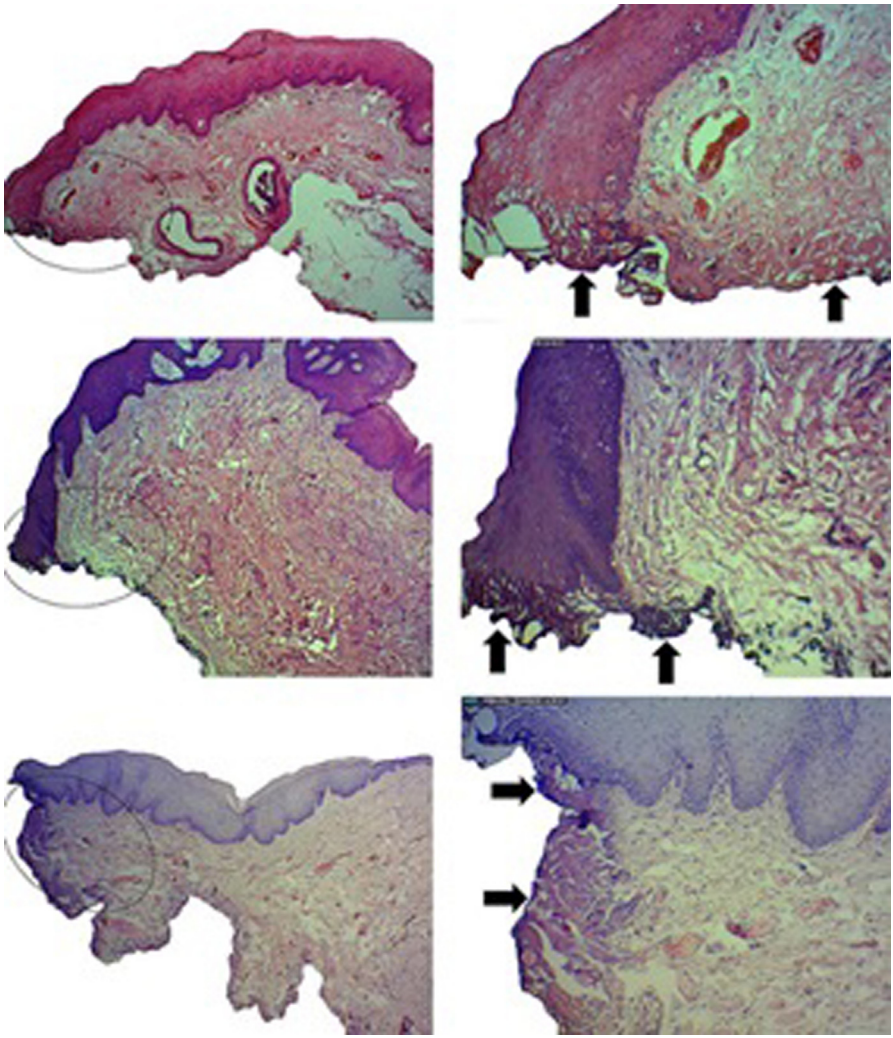

Fig. 7. Histologic specimens of gingiva excised with a CO_2 laser. Left—magnification 40 times, right—magnification 100 times. The arrows indicate the cut surface. There is rupture in 33.3%, presence of hemostasis in-depth, and a thin coagulation layer (165.11 ± 36.440 μm). (From: Kazakova RT, Tomov GT, Kissov CK, Vlahova AP, Zlatev SC, Bachurska SY. Histological Gingival Assessment after Conventional and Laser Gingivectomy. Folia Med (Plovdiv). 2018 Dec 1;60(4):610-616. https://doi.org/10.2478/folmed-2018-0028.)

apically of the marked bleeding points, but at least 2 mm coronally of the base of the epithelial attachment, to reduce the risk of root surface exposure and biologic width invasion.[8] APE treatment is designated for gingivectomy whenever 3 mm gingival tissue or greater exists from bone to gingival crest, and an adequate zone of attached gingiva will remain after surgery.[21] Gingival hyperplasia, drug-induced or due to hormonal changes, is indicated for soft tissue crown lengthening only.[24,25] Gingivectomy is also indicated for exposure of clear margins for impression taking (troughing).[26] Diode, erbium (Er:YAG and Er,Cr:YSGG), and CO_2 lasers are the most commonly used ones for soft tissue remodeling.

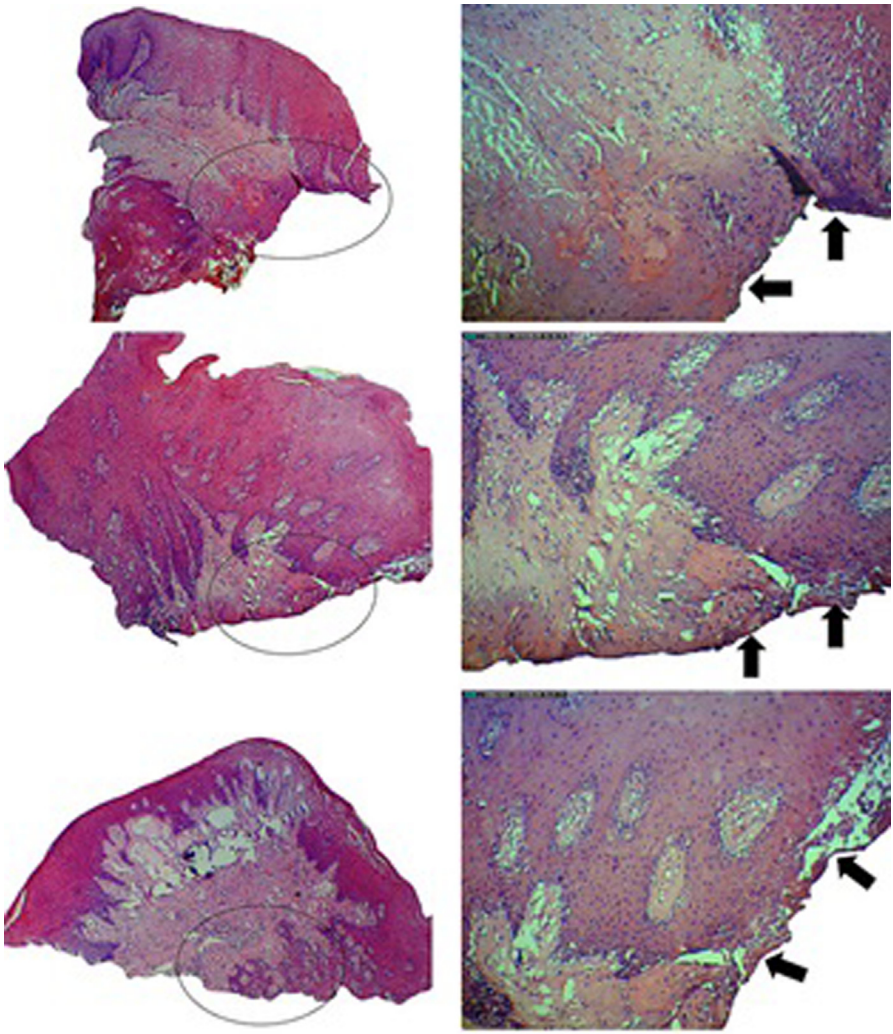

Fig. 8. Histologic specimens of gingiva excised with an electrocautery device. Left—magnification 40 times, right—magnification 100 times. The arrows indicate the cut surface. There is rupture, hemostasis in-depth, and a thick coagulation layer (743.89 $\pm$ 69.497 μm). (From: Kazakova RT, Tomov GT, Kissov CK, Vlahova AP, Zlatev SC, Bachurska SY. Histological Gingival Assessment after Conventional and Laser Gingivectomy. Folia Med (Plovdiv). 2018 Dec 1;60(4):610-616. https://doi.org/10.2478/folmed-2018-0028.)

Violating the biologic width in patients with "thick and flat periodontal biotype" results in a continuous inflammatory process, and doing so in patients with "thin and scalloped periodontal biotype" results in uncontrolled gingival recession.[8] If raising the free gingival margin to the required esthetic height results in invading the biologic width, then osseous modification is necessary—*bone crown lengthening*.[8] Creating a 3 mm distance from the alveolar ridge to the margin of the future restoration results in stable periodontal tissue at that level. The abovementioned distance was proved by Gargiulo and colleagues in 1961 and is based on the biologic width concept.[27]

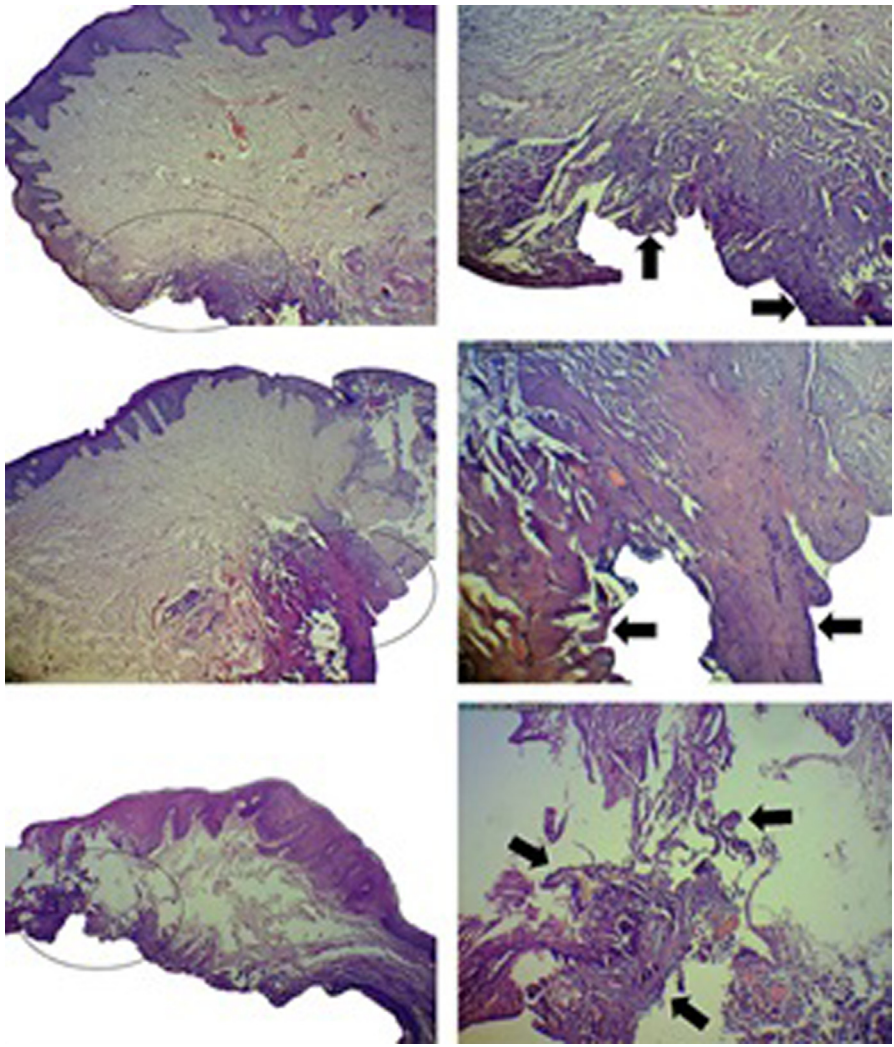

Fig. 9. Histologic specimens of gingiva excised with a diode laser. Left—magnification 40 times, right—magnification 100 times. The arrows indicate the cut surface. There is rupture, hemostasis in-depth, and a thick coagulation layer (948.33 ± 170.990 μm). (From: Kazakova RT, Tomov GT, Kissov CK, Vlahova AP, Zlatev SC, Bachurska SY. Histological Gingival Assessment after Conventional and Laser Gingivectomy. Folia Med (Plovdiv). 2018 Dec 1;60(4):610-616. https://doi.org/10.2478/folmed-2018-0028.)

Surgical crown lengthening can be performed after finishing the initial hygienic phase. In APE cases when osseous levels are close to or at the CEJ level, osseous crown lengthening is the adequate treatment solution.[21]

Flap elevation and the following ostectomy and osteoplasty is a traditional method of choice when the crown margin will invade the biologic width. The most commonly used instruments for this purpose are the rotary ones. Bone recontouring can be achieved conventionally with fissure or diamond burs and water cooling, with bone chisels, or piezoelectric bone surgery.[28,29] This technique reduces irregularities and

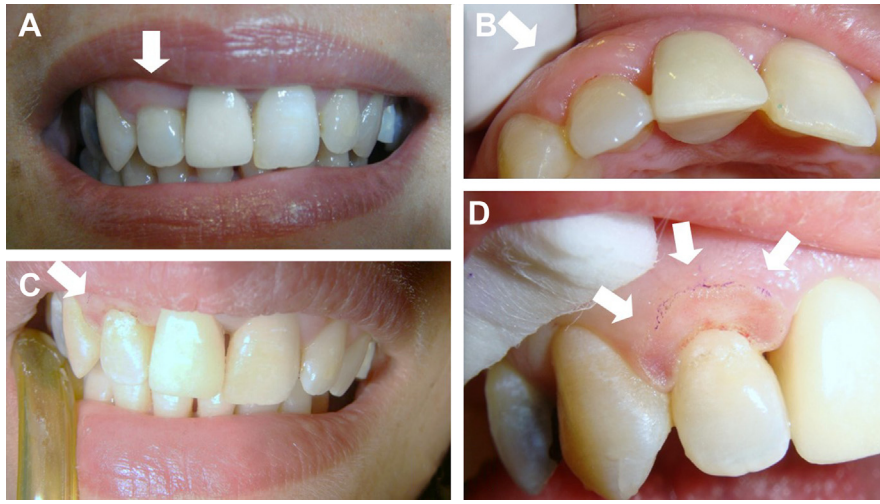

Fig. 10. Alteration of the smile line related to the abundant gingiva of tooth #7 (*A*, *B*). Gingival remodeling with an Er:YAG laser and its immediate clinical appearance (*C*, *D*). [From: Capodiferro S, Tempesta A, Limongelli L et al. Minimally invasive (flapless) crown lengthening by erbium:YAG laser in aesthetic zone [version 3; peer review: 2 approved]. F1000Research 2021, 9:1185 (https://doi.org/10.12688/f1000research.26008.3)]

creates a smooth tissue topography. Sufficient bone is removed in order to create a distance of 3 mm between the bone crest and the finish line of the future restoration. Possible side effects are increased gingival embrasures, root sensitivity, transitional mobility of the teeth and varying degrees of root resorption.[30]

Erbium lasers are more useful in local removal of bone tissue in order to create a new biologic width. By ensuring the careful removal of bone tissues along with the soft tissues in the closed flap technique, the clinician can create a biologic space for the final restoration and often take the impression at the same visit.[5] Erbium lasers have cutting tips handpieces with water cooling, which protect the surgical field from overheating, in contrast to the heat, generated by the rotary instruments' friction. Collateral thermal tissue damage is less with erbium lasers than with conventional techniques.

LASER-ASSISTED FLAPLESS CROWN LENGTHENING WITH BONE RECONTOURING

Because lasers cut with their ends, and not with their sides, a laser may be used in a novel approach to osseous crown lengthening. The so-called "flapless" osseous crown–lengthening procedure can be used to remodel the osseous crest and move it apically. The healing after Er:YAG bone surgery has been reported to be equivalent or faster than that after bur drilling or piezo surgery, and the healing rate observed after "flapless" crown lengthening is equally fast, usually with no evidence of the surgery after 2 weeks.[28,29,31,8] The excellent clinical outcomes in terms of minimal invasiveness, lack of intraoperative and postoperative complications and pain, fast and predictable healing are essentially related to the intrinsic proprieties of the Er:YAG laser light and to the generally recognized gentle laser-oral tissues interaction.[32]

GINGIVOPLASTY

Soft tissue esthetics' final stage is the design of the gingival tissues surrounding the tooth. The outline of the teeth (especially the anterior sextant) has to be bilaterally

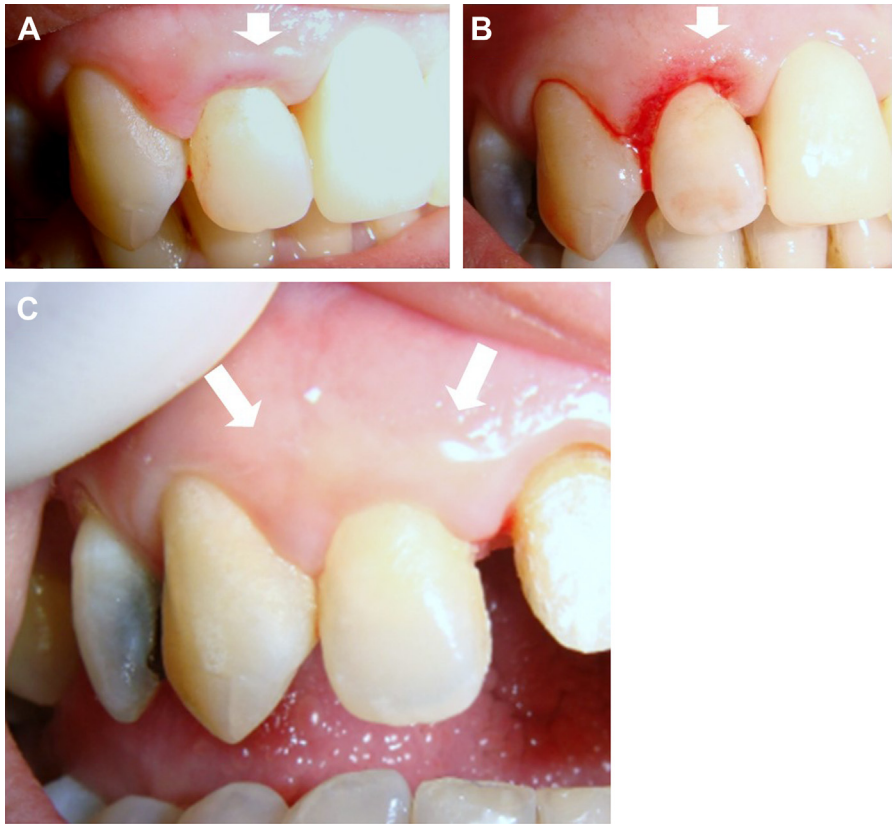

Fig. 11. Second stage after 7 days (*A*). Flapless (through the gingival sulcus) bone recontouring by Er:YAG laser (*B*), and its clinical appearance after 12 days (*C*). (From: Capodiferro S, Tempesta A, Limongelli L et al. Minimally invasive (flapless) crown lengthening by erbium:YAG laser in aesthetic zone [version 3; peer review: 2 approved]. F1000Research 2021, 9:1185 (https://doi.org/10.12688/f1000research.26008.3.)

symmetric.[8] The gingival trigones (zeniths) are the most gingival points of curvature along the free gingival margins of a tooth. They should be symmetric with the contralateral tooth and in harmony with the adjacent teeth. The position and shape of the interdental papilla must also be considered, especially in cases with diastemata closure. The clinician has to aim at natural appearance and proximal contours that are easy to clean and promote gingival health.[8]

LASER VERSUS CONVENTIONAL GINGIVECTOMY METHODS

In order to explain better the main advantages of laser use in gingival remodeling, it is fundamental to understand what happen to such tissues after laser light interaction. A clinical study conducted by Kazakova in 2017 included histologic specimens from the gingiva of patients aged 18 to 28 years. (*From* Kazakova R, et al. Histologic gingival assessment after conventional and laser gingivectomy. Folia Med 2018;60(4):610 to 6, *and* Kazakova R. Soft tissue crown lengthening methods. Laser crown lengthening. Lambert Academic Publishing, 2021).[23,33] The samples were excised from patients

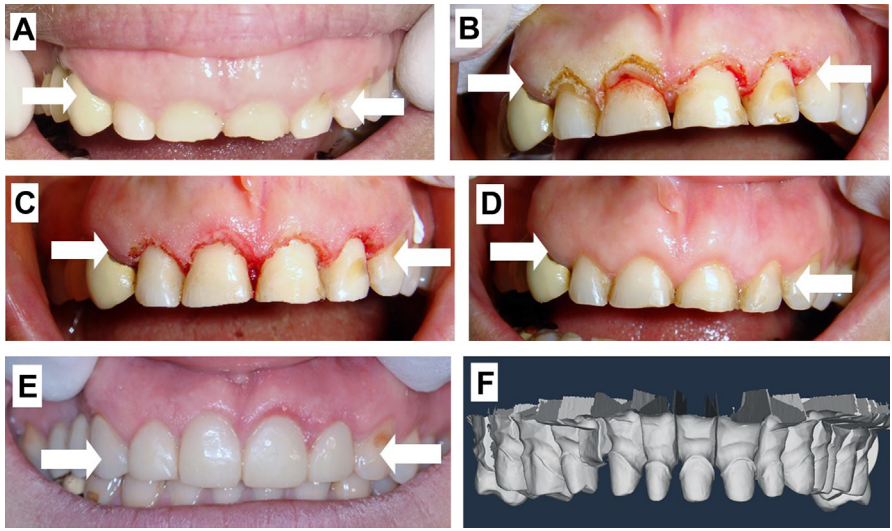

Fig. 12. Severe abrasion of incisors due to bruxism (*A*), Er:YAG laser-assisted gingivectomy (*B*), and contextual flapless bone remodeling (*C*). The clinical appearance after 14 days (*D*), and the following prosthetic rehabilitation (*E*, *F*). (From: Capodiferro S, Tempesta A, Limongelli L et al. Minimally invasive (flapless) crown lengthening by erbium:YAG laser in aesthetic zone [version 3; peer review: 2 approved]. F1000Research 2021, 9:1185 (https://doi.org/10.12688/f1000research.26008.3.)

undergoing soft tissue crown lengthening of the front teeth. One histologic specimen from the gingiva was taken from each patient, and the following surgical instruments were used for the separate surgical excisions:

1. Scalpel (control group)—blade #15c (Hu Friedy, USA).
2. Er:YAG laser—wavelength 2940 nm, Soft Tissue Mode, 50 mJ, 10 Hz (0.50 W altogether) with constant water cooling (LiteTouch, Syneron Dental, Israel).
3. CO_2 laser—wavelength 10,600 nm, in a pulsed mode, with peak pulse power—252 W, duration—200 μs, repetition rate—5 ms, Implant 2nd Surgery mode (DSE, Korea).
4. Ceramic bur—with turbine handpiece (NSK, Ti-Max Z 900 L, 300,000 rpm) without water cooling. (Tissue Trimmer, NTI).
5. Electrocautery device—working mode "Cut" (Kentamed, Bulgaria).
6. Diode laser—wavelength 810 nm, 8 W maximum power a continuous mode with a power of 1.5 W and, depending on the tissue, the power could be increased to 2 W if necessary (FOX, A.R.C. Lasers GmbH, Germany).

The histologic materials, treated with a surgical scalpel in the current study, served as a "control group," and the other 5 surgical instruments—as "test" groups.

After the excisions, the specimens were placed in 10% formalin solution for proper fixation. The biopsies were immersed in paraffin and sections of 5 μm were made. The Olympus CH30 light microscope with 4× and 10× magnifications and the Carl-Zeiss Jena micrometric system Objektmikrometer and Okularmikrometer were used for the pathomorphological study.

Fig. 1 depicts the presence or absence of a microscopic gingival rupture. The scalpel control group demonstrated no rupture. On the contrary, all of the biopsies excised with an electrocautery device and a diode laser were microscopically

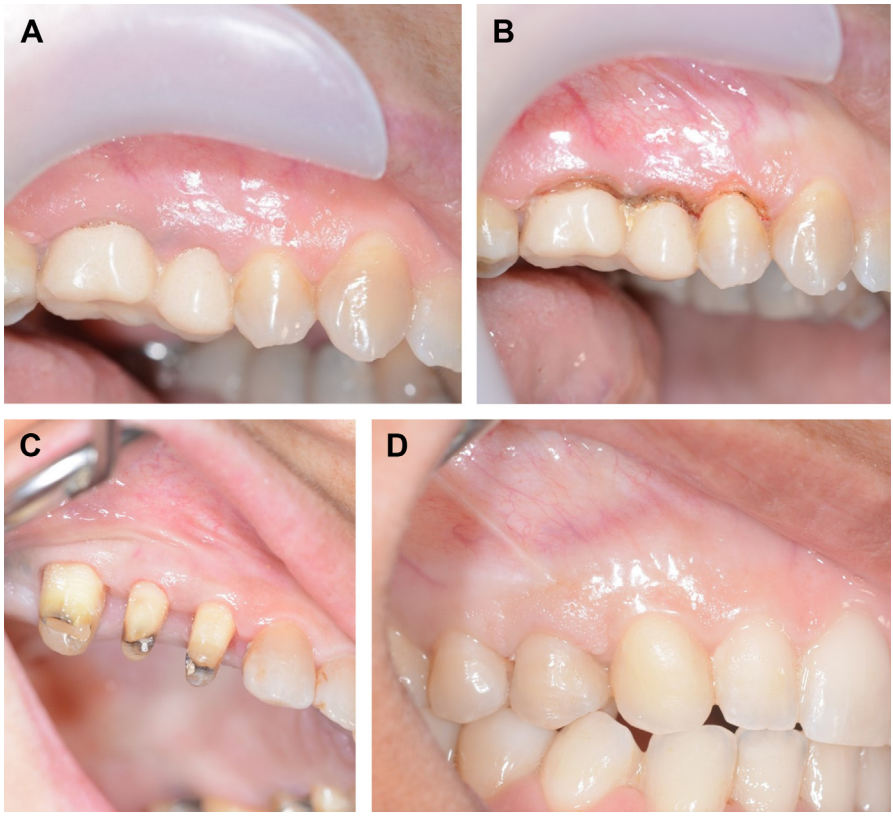

Fig. 13. Gingival remodeling around provisional crowns of teeth #3 and #4, as well as natural tooth #5, performed by diode laser (0.8 W; CW) as no bone recontouring was necessary (*A*). Crowns were exposed, as the smile line needed improvement (*B*). Provisional crowns were remodeled and stayed until to the complete healing, that occurred 8 days later (*C*). The appearance of the final restorations (*D*).

ruptured. A total of 55.6% of the ceramic bur biopsies and 33.3% of the Er:YAG laser and CO_2 laser samples were microscopically ruptured. Hemostasis in-depth was present in all histologic samples excised with a CO_2 laser, electrocautery, and a diode laser. In Fig. 2, ceramic bur and Er:YAG laser biopsies showed no hemostasis, whereas it was present in 22.2% in the examined scalpel biopsies. Fig. 3 demonstrates the width of the coagulation layer in μm. The control samples expectedly showed no coagulation layer (Fig. 4). The Er:YAG biopsies had the thinnest coagulation layer—47.9 ± 36.44 μm (Fig. 5), followed by the ceramic bur—101.11 ± 13.176 μm (Fig. 6) and the CO_2 laser—165.11 ± 36.440 μm (Fig. 7). The electrocautery device led to a much wider layer—743.89 ± 69.497 μm (Fig. 8), and the widest one belonged to the diode laser samples—948.33 ± 170.990 μm (Fig. 9-14). The differences were statistically significant.

CLINICAL CASES PRESENTATION

The following clinical cases are presented to better demonstrate the use of lasers in everyday practice in an outpatient setting.

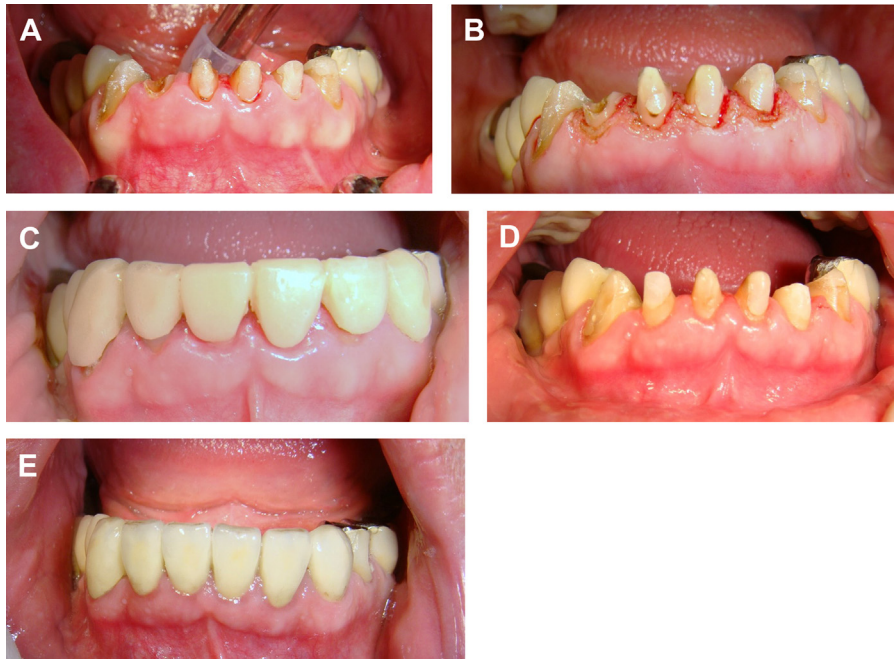

Fig. 14. Diode laser gingivectomy (0.8 W; CW) to improve smile line at the anterior mandible region for prosthetic purposes (*A*). Immediate postoperative appearance (*B*). Healing after 12 days showing good gingival stability (*C*, *D*). The final prosthetic rehabilitation (*E*). (From: Capodiferro, S. Gengivoplastica con laser a diodo rapidita efficacia mininvasita e predicibilita. Dental Tribune Italy, 2015 Sep 25. Available at: https://it.dental-tribune.com/news/gengivoplastica-con-laser-a-diodo-rapidita-efficacia-mininvasivita-e-predicibilita-2/-.)

DISCUSSION

Traditional scalpel techniques are used to resect tissue in order to provide access and visualization of the target site. Surgical incision with a scalpel may cause loss of gingival attachment with apical repositioning, hyperesthesia, asymmetrical gingival margins after healing due to a more or less unpredictable gingival retraction, as well as postoperative pain and discomfort, typically associated with periodontal surgery. Scalpels do not provide the hemostasis sought when working with highly vascularized tissue.[34] Thus, several other medical devices have been proposed to make the crown lengthening less invasive, including piezo surgery (bone remodeling) and electrocautery device (gingivectomy).[28 29] The use of electrosurgery showed a statistically significant gingival recession, as well as apical migration of the connective epithelium, essentially related to the high working temperature and the associated tissue damage. Deep soft tissue troughing near the bone may result in gingival recession, bone sequestration and necrosis, loss of bone height, involvement of the furcation from the inflammatory process, as well as increased tooth mobility. Electrosurgery is contraindicated around dental implants because of the risk of overheating and should not be used in patients with pacemakers, history of radiation to the jaws, poorly controlled (or uncontrolled) diabetes, blood dyscrasias, immunodeficiency conditions, other

diseases that cause a slow healing process.[22] Despite the potential of laser use in dentistry, Christensen reported that soft tissue excision with a surgical scalpel or electrosurgery is faster than the laser excision.[35] This could generally be true, but the creation of a perfect smile is usually not a fast process, as it requires good planning, attention, several clinical evaluations, perfection of previous procedures or modifications, and this as a rule of thumb means more overall time.

Generally, one of the numerous advantages of lasers is that they are safe to use around implants, metal restorations, as well as in patients with diabetes, on anticoagulant or antiaggregant therapy, and so forth. Laser use leads to minimal or no postoperative pain and can sometimes be selectively applied without anesthesia.[36] Lasers cut the gingival tissues, which results to less bleeding and GR.[37] Laser caused less hemorrhage and inflammation, as well as fast and painless gingival healing. Lasers also present with some other advantages: no or only contact anesthesia is needed; they do not damage hard dental tissues; they are safe to use around metal and metal-ceramic crowns, metal post-and-cores, implants, amalgam fillings; and lasers have a marketing advantage over patients. Faster healing is observed when the wounds made with traditional instruments or lasers are irradiated with Low Level Laser Therapy (LLLT) or Photoactivated Disinfection (PAD) is used.[38]

SUMMARY

Dental lasers demonstrate several advantages for soft tissue dental surgery compared with conventional surgical methods related to their technical characteristics. Due to the excellent coagulation, especially of the surgical lasers, reduced to no need of anesthesia or suturing and faster healing, they demonstrate optimal clinical results. Nevertheless, good knowledge of laser–tissue interaction is required in order to obtain the best predictable results without gingival recession or bone tissue damage.

CLINICS CARE POINTS

- in most cases where a modification of the gingival profile is necessary for aesthetic reasons, lasers simplify the procedures and make them less invasive than conventional surgery and also repeatable when necessary

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