Histological Gingival Assessment after Conventional and Laser Gingivectomy

Rada T. Kazakova¹, Georgi T. Tomov², Christo K. Kissov¹, Angelina P. Vlahova¹, Stefan Ch. Zlatev¹, Svitlana Y. Bachurska³

¹ Department of Prosthetic Dentistry, Faculty of Dental Medicine, Medical University of Plovdiv, Plovdiv, Bulgaria
² Department of Periodontology and Oral Mucosa Diseases, Oral Pathology Division, Faculty of Dental Medicine, Medical University of Plovdiv, Plovdiv, Bulgaria
³ Department of Clinical Pathology, Medical University of Plovdiv, Plovdiv, Bulgaria

Correspondence:
Rada Kazakova, Department of Prosthetic Dentistry, Faculty of Dental Medicine, Medical University of Plovdiv, 3 Hristo Botev Blvd, Plovdiv, Bulgaria
E-mail: radakazakova@gmail.com
Tel: +359 889 567102

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Background: Gingivectomy is a procedure often performed in everyday clinical practice using numerous instruments.

Aim: To evaluate and compare the gingival cut surface after gingivectomy with 6 different surgical instruments – a surgical scalpel, an Er:YAG laser, a CO₂ laser, a ceramic bur, an electrocautery device, and a diode laser.

Materials and methods: Gingivectomy using the above listed instruments was performed in 18 patients. The histological samples excised with a surgical scalpel were assigned as a control group and the other five types – as test groups. The following histological parameters were measured: coagulation layer thickness (in μm); presence or absence of a microscopic rupture and presence or absence of hemostasis in-depth.

Results: The best instrument of the above listed ones which demonstrated excellent results is the CO₂ laser. The Er:YAG laser has a thin coagulation layer and lack of hemostasis in-depth. The diode laser has the widest coagulation layer which is an advantage from a clinical point of view. Electrocautery proved to be as effective as the diode laser, but it should not be used around metal restorations. The ceramic bur has less pronounced hemostasis in-depth.

Conclusions: Modern dentistry uses a wide variety of methods that are designed to be applied in everyday practice. Good knowledge of the ways to use them, their advantages and disadvantages is essential to obtaining the optimal result depending on the clinical case.

BACKGROUND

Gingivectomy is a procedure often performed in everyday clinical practice. It aims mainly to reduce the periodontal pocket height and to expose a larger gingivo-incisal length of the clinical crown prior to the prosthetic restoration. The devices used in performing gingivectomy can be divided into two main groups: conventional – a scalpel, a ceramic bur, an electrocautery device; and modern – different types of surgical lasers. A histological assessment is needed to compare and evaluate the results after the procedure in order to choose the best instrument depending on the clinical case.

AIM

The aim of the current research was to evaluate and compare the gingival cut surface after resection with 6 different surgical instruments.

MATERIALS AND METHODS

Histological samples from gingival tissue were taken from 18 patients (age range 18 to 28 years). One sample was taken from each of the patients using one of these surgical instruments: a surgical scalpel, an Er:YAG laser, a CO₂ laser, a ceramic bur, an electrocautery device and a diode laser.

The histological samples excised with a surgical scalpel (blade #15c, Hu Friedy) were assigned as a control group and the other five types – as test groups. The following histological parameters were measured: coagulation layer thickness (in μm); presence or absence of a microscopic rupture and presence or absence of hemostasis in-depth.

The gingivectomy of the test groups was per-
formed using the following instruments:

The Er:YAG laser with a wavelength of 2940 nm (LiteTouch; Syneron Dental). A thin chisel tip (AS71972, tip diameter – 0.8 mm, length – 17 mm) is used in a contact mode with an incessant brushing motion and a 15° angle to the root surface. The settings are: Gingivectomy, 300 mJ, 18 Hz (5.4 W) with 40% water cooling. The time of treatment varies and depends on the diameter of the tooth cervix. The spot size (beam diameter) – 2.5 mm at source; the laser power is 9.69 W and the peak pulse power – 252 W. The spot diameter is 2.100 W/cm² and the energy density – 496 J/cm².

The diode laser also evaporates the tissue up to the bleeding points’ level. The wavelength is 810 nm (FOX, A.R.C. Lasers GmbH). The tip is activated by holding it on a special black paper before starting the procedure. The settings are: gingivectomy, 1.5 W, continuous mode, without water cooling. The mode is contact, the fibre diameter and the spot size (beam diameter) – 300 µm. The power density is 2100 W/cm² and the energy density – 496 J/cm².

The CO₂ laser is a CW laser and is held at an angle of 8° to the long axis of the tooth, at a distance of 10 mm from the tooth. The duration of the procedure is 30 sec. The laser (DSE, Korea) settings are: wavelength – 10600 nm, Ultra Dream Pulse mode with a peak pulse power – 252 W, duration – 200 µs, repetition rate – 5 ms (200Hz), mode – Implant 2nd Surgery, noncontact focused mode, without water cooling. The mode is contact, the fibre diameter and the spot size (beam diameter) – 300 µm. The power density is 1074 W/cm² and the energy density – 661 J/cm².

For the ceramic bur technique (Tissue Trimmer – NTI) a turbine handpiece (NSK, Ti-Max Z 900 L, 300 000 rpm) without water cooling is used. The bur cuts only soft tissue without interfering with the bone or the hard dental tissues. It cuts with its top and side surfaces, so that it can be angled in different directions depending on what the clinician wants to achieve. Coagulation, and therefore hemostasis, is achieved due to the temperature rise. Stopping at one spot is avoided as it may cause carbonization of the tissue.

After the excisions the samples were fixed in 10% formalin. The biopsies were then immersed in paraffin and cut in 5-µm-wide slices. Olympus CH30 light microscope with 4x and 10x magnification and a macrometric system Obejktmikrometer and Okularmikrometer (Carl-Zeiss Jena) were used for the pathomorphologic examination.

The research was approved by the Ethical Committee of the Medical University, Plovdiv and all the patients signed an informed consent. The research data were analysed using SPSS ver. 19. The differences were considered statistically significant at α<0.05. The following methods were used: descriptive analysis – one-dimensional and two-dimensional frequency distribution tables; nonparametric analysis – Mann-Whitney, U-test, Kruskal-Wallis one-way analysis; logistic-regression analysis – to determine the occurrence risk (OR) of an event.

RESULTS

**Fig. 1** shows the presence or absence of a microscopic rupture in the gingiva. The control group with the surgical scalpel demonstrated no rupture. On the contrary, all of the biopsies excised with an electrocautery device and a diode laser were microscopically ruptured. 55.6% of the ceramic bur biopsies and 33.3% of the Er:YAG laser and CO₂ laser samples were microscopically ruptured. As far as hemostasis in-depth is concerned (**Fig. 2**), it was present in all histological samples excised with a CO₂ laser, electrocautery and a diode laser. Ceramic bur and Er:YAG laser biopsies showed no hemostasis, while it was present in 22.2% in the examined scalpel biopsies.

**Fig. 3** shows the width of the coagulation layer in µm. The control samples expectedly showed no coagulation layer (**Fig. 4**). The Er:YAG biopsies demonstrated 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 CO₂ laser – 165.11±36.440 µm (**Fig. 7**). The electrocautery presented with a much wider layer – 743.89±69.497 µm, and the widest one belonged to the diode laser samples – 948.33±170.990 µm (**Fig. 9**). The differences were statistically significant.
DISCUSSION

CO₂ laser showed firm hemostasis, minimal microscopic rupture and a thin coagulation layer, thus considered to be an advantageous laser wavelength in terms of surgical incision.³,⁶,⁸,¹⁶. Therefore, the expected healing process is faster and with fewer side effects – pain, oedema and erythema.²⁰,²¹ Its disadvantage is the high cost.⁶ The Er:YAG laser also has advantages – a thin coagulation layer and lack of hemostasis in-depth.⁶ The main plus point

Figure 1. Microscopic rupture of the tissue depending on the instrument used.

Figure 2. Hemostasis in-depth depending on the instrument used.

Figure 3. Coagulation layer width in μm depending on the instrument used.
Figure 4. Scalpel histological samples. Left – 40x magnification, Right – 100x magnification. The cut surface is smooth; there is no microscopic rupture, coagulation and hemostasis in-depth.

Figure 5. Er:YAG histological samples. Left – 40x magnification, Right – 100x magnification. The cut surface is microscopically ruptured in 33.3% of the samples; there is no hemostasis in-depth and a very thin coagulation layer (47.9±36.44 μm).

Figure 6. CO₂ histological samples. Left – 40x magnification, Right – 100x magnification. Microscopic rupture is present in 33.3% of the biopsies; there is hemostasis in-depth and a thin coagulation layer (165.11±36.440 μm).

Figure 7. CO₂ histological samples. Left – 40x magnification, Right – 100x magnification. Microscopic rupture is present in 33.3% of the biopsies; there is hemostasis in-depth and a thin coagulation layer (165.11±36.440 μm).
compared to the others is the water cooling, which make manipulations more gentle and the healing – accelerated.²⁻⁵,²² It main disadvantage is its high cost.⁶ The diode laser also has some advantages, although its results compared to the others are less well represented.¹⁻¹,⁷,¹⁷ The coagulation and hemostasis in-depth are well expressed and, despite the microscopic rupture, they are clinical advantages because of the lack of bleeding.¹⁸,¹⁹ This allows the clinician to continue with the prosthetic procedures like taking an impression.¹⁰ This conclusion applies to the other lasers as well. The electrocautery device demonstrates competitive results compared to the lasers.²,⁴ Its advantages are that it is less expensive, cuts not only with its tip and the manipulation is performed faster than the diode laser for example.¹¹,¹⁵ Its disadvantages, which are advantages for the laser, are that it should not be used around metal restorations, the smell of burning is more intrusive and the tactile sense is less pronounced.⁹ The ceramic bur also demonstrates excellent advantages – it is less expensive than the other instruments and the coagulation layer is similar to that from the lasers. The less pronounced hemostasis in-depth is a disadvantage, which can complicate the clinical procedures.

Female patients in the present study presented with a 4 times higher risk or gingival microscopic rupture than men. Their hemostasis is less pronounced than that of the male patients, which is a factor requiring a special selection of the surgical methods.

CONCLUSIONS

Dental lasers demonstrated a number of advantages in terms of their clinical and technical characteristics for soft tissue surgery compared to the traditional instruments. Due to their excellent coagulation, minimal microscopic rupture and faster healing, they perform optimal clinical results. The thorough examination of conventional and contemporary surgical instruments – their benefits and drawbacks, is essential to obtaining the optimal result depending on the clinical case.

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Гистологическая оценка дёсен после традиционной и лазерной гингивэктомии

Рада Т. Казакова¹, Георги Т. Томов², Христо К. Кисов¹, Ангелина П. Влахова¹, Стефан Ч. Златев¹, Свитлана Бачурска³

¹ Кафедра ортопедической дентальной медицины, Факультет дентальной медицины, Медицинский университет - Пловдив, Пловдив, Болгария
² Кафедра пародонтологии и заболеваний слизистой оболочки полости рта, Секция оральной патологии, Факультет дентальной медицины, Медицинский университет - Пловдив, Пловдив, Болгария
³ Кафедра клинической патологии, Медицинский университет - Пловдив, Пловдив, Болгария

Адрес для корреспонденции: Рада Казакова, Кафедра ортопедической дентальной медицины, Факультет дентальной медицины, Институт медицины, бул. „Христо Ботев“ № 3, 4000, Пловдив, Болгария
E-mail: radakazakova@gmail.com
tel: +359 889 567102

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Ключевые слова: гингивэктомия, удлинение короны, лазер

Введение: Гингивэктомия - это процедура, часто выполняемая в повседневной клинической практике с использованием различных инструментов.

Цель: Провести оценку и сравнить поверхность разреза десны после гингивэктомии с применением шести различных хирургических инструментов - хирургического скальпеля, Er: YAG лазера, СО2-лазера, керамического бора, электроскальпеля и диодного лазера.

Материалы и методы: Гингивэктомия была выполнена с использованием вышеупомянутых инструментов 18 пациентам. Гистологические образцы, вырезанные хирургическим скальпелем, составили контрольную группу, а остальные пять - экспериментальные группы. Были измерены следующие гистологические параметры: толщина слоя коагуляции (в μm); наличие или отсутствие микроскопического разрыва и наличие или отсутствие глубокого гемостаза.

Результаты: Лучшим инструментом среди вышеупомянутых, который демонстрирует превосходные результаты, является СО2-лазер. Er: YAG-лазер имеет тонкий слой коагуляции и отсутствие глубокого гемостаза. У диодного лазера самый широкий слой коагуляции, что является преимуществом с клинической точки зрения. Электроскальпель оказался столь же эффективным, как и диодный лазер, но не должен использоваться в области металлических реставрационных конструкций. Керамический бор имеет менее выраженный глубокий гемостаз.

Выводы: Современная стоматология использует широкий спектр методов, предназначенных для применения в повседневной практике. Знание того, как их использовать, их преимущества и недостатки имеет решающее значение для достижения оптимального результата в зависимости от клинического случая.