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Research Article

Evaluation of Pain and Clinical Repair in Patients Submitted to Diode (808 nm) or Er:Cr:YSGG Lasers or Conventional Technique Frenectomy

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Abstract

Objective: The aim of this study was to make a quantitative evaluation of the pain level in patients, using the Visual Analogue Scale (VAS), as well as the quantitative symptomatology and clinical repair in patients submitted to three different surgery techniques to perform labial frenectomy: using Diode laser (high power), Er,Cr:YSGG laser and the conventional technique performed with a scalpel.

Methodology: Eighteen patients indicated for frenectomy were randomly distributed into three groups by lottery. Surgeries were performed and the patients were clinically and visually evaluated by means of photographic analysis, by 3 calibrated blind examiners. The parameters analyzed were good, average or poor tissue repair. The Visual Analogue Scale (VAS) was used to grade the post-operative painful symptomatology. Post-operative follow-up was rated according to immediate pain, and at time intervals of 72h, 1 week, 15 days and 1 month after the surgical procedure was performed.

Results: In the immediate clinical results, there was intense bleeding in the control group, and after 2 weeks, clinical repair in all groups exhibited gingival tissue with a healthy appearance, at the stage of epithelialization. There was no statistically significant difference among the groups considering pain and clinical repair.

Conclusion: Tissue repair was similar in all groups, showing a significant difference when the Control Group and the diode Group were compared. All techniques were effective for performing frenoplasty.

Keywords: *Semiconductor Lasers; Oral Surgical Procedures; Oral Surgery; Post-operative Pain; Wound Healing*

Abbreviations

Nd:YAG: *Neodymium*-Doped Yttrium Aluminum Garnet Laser; Er:YAG: Erbium-Doped Yttrium Aluminum Garnet Laser; Er,Cr:YSGG: Erbium, Chromium-Doped Yttrium, Scandium, Gallium and Garnet

Introduction

Low frenum insertion, excessively close to the gingival margin, predisposes the patient to gingival recession due to persistent drag on the tissue in the area, which promotes root exposure [1,2]. This condition favors the accumulation of biofilm, which is harmful to

the periodontal tissues and stimulates the occurrence of diastemas with consequences in orthodontic, speech therapy, prosthetic or esthetic treatments [3]. Therefore, frenectomy or frenotomy treatment is recommended for complete or partial removal of the frenum [4]. The conventional surgical technique, in which a surgical scalpel is used, was the forerunner of electrosurgery. In this context, the high power laser technique appeared on the scene in soft tissue surgery, with the advantages of being more efficient, having more incision and ablation power, in addition to producing good biological and clinical responses [5-8]. Since 1976, when the FDA first approved the dental use of CO_2 laser, several surgical lasers were introduced, such as Nd:YAG, Argon, Er:YAG, Er,Cr:YSGG and Diode [8-11].

The enhanced frenum removal technique, (when well performed) is expected to reduce pain and improve soft tissue repair. Studies have shown that tissue repair involves physical and chemical processes, the optimization of which still needs to be better understood [12,13]. Researches with Er:YAG and Er,Cr:YSGG lasers have shown good interaction with soft and hard tissue, and have been shown to be effective for ablation, vaporization, excision and oral tissue hemostasis. Furthermore, their good performance has been demonstrated even in bone surgery, provided that the recommended parameters are considered [8,14,15]. Notably, Er,Cr:YSGG laser has shown to be accurate for the removal of ranulas, papillomatous and fibromatous lesions, conferring speed and simplicity to the procedures [16-18].

Although biologically safe, little is known about the postoperative levels of pain and healing of this technology. This gap has been observed in the literature on high power Diode lasers, which only describes the surgical efficiency; excellent absorption by hemoglobin, melanin and collagen; vaporization, curettage, coagulation and hemostasis; the low performance in bone tissue surgery, and the anti-bacterial effect in periodontal pockets [6-8].

According to the International Association for the Study of Pain (IASP), pain is an unpleasant, sensitive and emotional subjective feeling, associated with real or potential tissue lesions [19]. It is described as a multidimensional phenomenon which involves physiological, sensitive, cognitive, affective, behavioral, and sociocultural aspects [20]. Because it is an experience that includes various domains, its measurement is complex. Therefore, unidimensional instruments are preferred to represent the experience of pain more accurately and avoid mistakes. The Visual Analogue Scale (VAS) was selected because it is easily understood and extensively used in dentistry, in addition to being reliable when compared with the numeric, behavioral or Ong-Baker scales [21,22].

In post-operative pain studies, there appear to be no researches that make comparisons between frenectomies performed with laser and conventional techniques.

Aim of the Study

The aim of this study was to quantify the level of post-operative pain using the VAS and to qualify symptomatology and tissue repair in patients submitted to three different lip frenectomy techniques: using high power Diode laser, Er,Cr:YSGG laser and the conventional surgical scalpel.

Materials and Methods

The initial sample consisted of 21 patients with surgical indication for frenectomy. Of these, three were excluded due to absence in the return visits. The remaining 18 patients ranged from 24 to 60 years of age (mean age 40.8 years), of whom 13 were women, and 5 men. The study was conducted in the Special Dental Laser Laboratory of the University of São Paulo (LELO/USP), with the approval of the Research Ethics Committee of the university, registered under the number FR-253913,15/2010. A formal term of free and informed consent was signed under specific terms by each participant. Exclusion criteria barred patients making use of controlled medications, with systemic or psychiatric conditions and under the age of 18 because these factors could interfere in the responses or in other information. For evaluation and diagnosis, anamnesis, clinical periodontal and radiographic examinations were performed. Patients were instructed about oral hygiene, postoperative care and told to contact their surgeon in case of need.

The study procedures were performed with the use of high-power Diode laser, with the following parameters: 808 nm infrared emission, (recommended by the manufacturer DMC Equipments, São Carlos-Brazil), operating in pulsed or continuous modes. Beam delivery was mediated by 300 μm optical fiber. A model 841-PE (Irvine - USA) power and energy meters was used to assess the equipment. Diode laser fiber was activated by Detecto® (commercial carbon paper, Niterói-Brazil).

Waterlase Er,Cr:YSGG laser (Milennium, Biolase, San Clemente-USA) was also applied, with the following parameters: emission in 2.78 μm, 20 Hz frequency and power variation from 0 to 6W, with the use of a sapphire tip attached to the handpiece (Lot 40092 Mod G-4mm Qty:1EA). Power assessment was previously performed

with the above-mentioned equipment (Project CEPID/CEPOF FAPESP PROCESS 98/14270-80).

All surgical procedures started with pre-preparation of the site, including water and pumice stone prophylaxis followed by 0.12% chlorhexidine di-gluconate mouth rinse. Topical Local anesthesia consisted of topical administration of benzocaine (Topex®, New Jersey-USA) and lidocaine 2% with adrenaline 1: 100.000 (DFL, Rio de Janeiro-Brazil) for local infiltration. Ice was locally applied for 5 minutes at the end.

Group 1: Conventional surgical technique, by clamping the frenum with Kelly hemostat (Golgran®, São Caetano do Sul-Brazil) and performing the incision with a scalpel blade number 15 (Swann Morton®, Sheffield-England). Two perpendicular incisions and one parallel were made for complete removal of the frenum. Hemostasis and suture were performed only for the upper frenums, on conclusion of the frenectomy.

Group 2: Modified surgical technique using Diode laser previously cleaved and activated by using carbon paper, performed with 300 µm laser fiber. Laser parameters were established in continuous mode, at 2W, 120 mJ power and 60 to 90 J/cm^2 energy densities. The fiber was kept in perpendicular contact with the frenum during incision, in a sweeping motion until complete removal of the frenum.

Group 3: Modified surgical technique using Er,Cr:YGSS laser, in pulsed mode, 2W, 100 mJ, 20 Hz, 79,6 J/cm^2 energy density, 11% air and 7% water cooling, and a sapphire tip attached to the handpiece (9 - 4 400 µm model). Incision and tissue removal were performed with the tip in perpendicular position, keeping a distance of 1 mm from the surface, and avoiding any contact.

All patients were advised to use soft toothbrushes for hygiene and avoid mouth rinses that could harm the wound. Patients with symptoms of pain had to report to the surgeon prior to using any medication. The postoperative diet restricted acid or spicy food that could harm the wound, for a period of 7 days.

Postoperative pain evaluation was performed by means of VAS, where the far left extremity represented the absence of pain reference (no. 0) and on the opposite extremity No. 10, was the maximum pain level reference. The patients' real expression, away from the interpretations or influence of third parties, was made feasible with this tool, consisting of a form that the patients were requested to fill out at the end of the procedure. Patients turned in the forms with numbered levels of pain after 7 days, during their return visits. At the end, markings on the scale were converted to numbers by an unbiased person, not involved in the research, and submitted for further statistical analysis.

For clinical evaluation, patients were visually examined relative to the following aspects: bleeding; healing; scar tissue quality in trans-operative, immediate postoperative periods, and time intervals of 72 hours, 15 days and 1 month of postoperative phases.

As regards monitoring of healing, an examiner not involved in the study took digital pictures that were used for healing quality assessment. Pictures were taken preferably in the same period of the day, with patient positioned on the dental chair inclined at 60° and 90°, with the operation light off. An automatic digital camera with flash (Cyber-shot Sony 10 Megapixels) was used to take pictures at a distance of 10 cm from the lip, at two focal distances 1X and 1.6 zoom. In total, 4 chronological time intervals of healing were selected for taking the photographic records: 3, 7, 15 and 30 days. Three blind, pre-calibrated evaluators were designated to describe the healing level according to three pre-established categories: good, average, and bad. To select the patients with best healing results, pictures of all patients from the three Groups of surgery techniques were analyzed using the KAPPA test.

Results and Discussion

Results

Results and discussion must illustrate and interpret the reliable results of the study. The following data resulted from VAS forms filled by the patients of each group.

The analysis of pain showed that when the pain reports were compared with the postoperative time-intervals, peaks of pain were observed three hours after surgery in the three groups. In 48 hours, a low level of pain could be observed in all the groups. Although lower levels of pain were shown in the table for the lasers groups, this did not confirm statistical significance among the groups because the big error bar indicated high mismatch among the data collected from the sample.

Intra-group analysis, in each group, in each period, was also performed to check statistically significant pain differences. It was concluded that data was non-parametric and dependent. Friedman ANOVA test was applied because it allowed multiple comparisons for dependent and non-normal data. According to the results, any

statistically significant difference was only considered between at least two measurements from the conventional group.

Group	p
Diode	0.48
Er,Cr:YSGG	0.19
Conventional	0.0001

Table 1: *P values from Friedman ANOVA test.*

The Wilcoxon test for paired data was used for distinguishing groups of data that differed from the others, as shown in table 2. However, this remained inconclusive.

	0	5 min	1h	3h	24h	48h	72h
5 min	0.65						
1h	0.58	0.65					
3h	0.58	0.65	0.80				
24h	0.73	1	1.85	0.65			
48h	0.75	1	0.58	0.58	0.73		
72h	0.75	1	0.58	0.58	0.73	0.65	
1 week	0.75	1	0.58	0.58	0.73	0.65	0.65

Table 2: *P value from Wilcoxon test for paired data, corrected by Ryan-Holm step down Bonferroni procedure.*

Group results were compared with the aim of identifying any possible statistically significant differences. Pain levels throughout time reported by patients from each group were compared, together with the total number of individual answers within VAS. In this way, answers from each postoperative period were added, and so were the numerical value within VAS for each patient, and these were compared among each the total value obtained from each group. For this purpose, it was assumed that data were non-parametric and independent, therefore, it was necessary to use the Kruskal-Wallis analysis of variance followed by Ryam-Holm Bonferroni step down correction for multiple comparisons, as shown in table 3. No statistically significant differences were found in any of the groups, with the p value for the test being equal to 0.08.

In table 4, from the postoperative pictures it could be observed that the percentage classified as "good healing" was predominantly from the Er, Cr:YSGG laser group. Diode laser obtained the highest values in "average" and "bad" healing classifications.

Time	P	Corrected p
5 min	0.11	0.55
1h	0.045	0.32
3h	0.17	0.68
24h	0.08	0.48
48h	0.85	0.85
72h	0.65	1.3
1 week	0.33	0.99

Table 3: *P values from Kruskal-Wallis test ANOVA corrected by Ryan-Holm step down Bonferroni.*

Treatment	Classification	Data percentage
Er,Cr:YSGG	Good	60%
	Average	40%
	Bad	0%
Diode	Good	17%
	Average	33%
	Bad	50%
Conventional	Good	33%
	Average	67%
	Bad	0%

Table 4: *Percentage of good, average and bad results according to type of treatment.*

To calculate the statistical difference among the surgical methods, the chi-square method was applied, as shown in table 5. The effectiveness of tissue excision was evident in the Groups in which laser was applied. Hemostasis achieved by Diode laser outperformed the Er, Cr:YSGG, but there were small areas around the wound that showed carbonization, which were absent in the Er, Cr:YSGG laser group.

In general, the use of laser allowed a privileged view of the surgical site; decrease in surgical time; decreased use of surgical instruments and no need for suturing. Er, Cr:YSGG laser was outstanding as the method that enabled fast epithelization after the first postoperative week, although the recently formed tissue had an immature aspect. Whereas Diode laser exhibited a broad fibrin

Technique	Classification	P value
Er,Cr:YSGG X Diode	Good	0.14
	Average	0.82
	Bad	0.06
Er,Cr:YSGG X Conventional	Good	0.38
	Average	0.82
	Bad	1
Conventional X Diode	Good	0.50
	Average	0.25
	Bad	0.046

Table 5: *P value from Q2 test for all studied treatments.*

grid covering the wound, which required a longer healing period of two weeks, nevertheless it was an effective process.

No edema or exacerbated inflammation were observed in any of the techniques. Another advantage shown by the laser technique was full gingival and mucosal healing, with no signs of reinsertion of the frenum, which was something that commonly used to occur when the conventional technique was applied. This difference was more evident in the 30 day postoperative evaluation. In general, ´the patients' perception of the technique was satisfactory, as the majority of them considered it a fast procedure, with short bleeding and fast healing.

Discussion

Commercial use of high-power Diode laser only started in the nineties. There has been great expansion in the use of this laser in soft tissue surgery since its distinguished hemostasis and antibacterial properties were studied. The ability to reach sites that were difficult to access, such as periodontal pockets, and in endodontics this is also among its notable properties since the energy is delivered via optic fiber [7,23,24]. Therefore, the choice of Diode laser for comparison with the other techniques was justified.

Hemostasis promoted by high power Diode laser and Er, Cr:YSGG behaved in different levels. High power Diode laser produced more thermal damage due to the fact it was operated in continuous mode. Er,Cr:YSGG had a lower power of hemostasis but caused less heat damage because it was operated in pulsed mode. Both lasers have good antibacterial capacity [25,26]. None of the 12 patients showed signs of inflammation or wound contamination in the postoperative periods, which was not fully observed in the conventional group, in which two cases of inflammation in the suture areas were reported.

The thermal effect inherent to the high-power diode laser may be aggressive to the tissues and delay healing process. Some studies have used immunohistochemistry to demonstrate evidence of thermal damage [27]. This type of injury was observed in these studies [5,8], in which more extensive frenums, with a more fibrous anatomy were treated, thus they demanded a longer surgery time. A few years ago, there were not many studies that compared the effects of conventional and laser techniques, however, laser had previously been shown to be outstanding as an alternative for oral surgery as opposed to conventional surgery [28,29].

For this reason, the present study evaluated the action of two wavelengths and conventional surgery and their consequences related to pain symptomatology and clinical repair.

There are reports in the literature saying that laser cuts are less traumatic with relatively good healing. Tissue removal is homogeneous, and hemostasis is promoted by superficial clotting. Another convenience that has made laser popular is related to the reduction of pain and edema, as well as its analgesic and anti-inflammatory properties [30]. The sample participants of this study seemed to be very comfortable with the use of high-power lasers.

In daily clinical practice, pain control in dental treatment is of extreme importance for the physical and emotional well-being of the patient, and it is at the same level of significance as the effectiveness of the treatment itself. Laser incisions in soft tissue are followed by lower pain levels in postoperative periods when compared with the conventional technique, therefore requiring lower doses of anesthetics [31,32].

Laser incisions promote protein denaturation that function as a biological surgical dressing by forming a protective serum fibrinous clot [5,7]. This characteristic was present in all the patients of the laser groups: a serum fibrinous clot covering the surgical site, which was more evident in the diode group.

Frenectomy is a procedure that involves the complete removal of the lip frenum. Conventional surgery performed in the control group involved a scalpel and blade for frenum removal, delimiting the wound in a triangular shape, characterized by intense bleed-

ing during the procedure. Hemostasis obtained by compression is mandatory in this technique, and so is suturing, with the ultimate goal of closing the lesion. Some patients reported postoperative pain, little edema, discomfort when speaking, opening the mouth and eating, due to the presence of the stitches. In the literature there are many reports that use of the conventional technique triggered postoperative symptoms of pain and bleeding, as well as discomfort caused by sutures and the taste of blood [33,34], which increases malaise during postoperative period [29,31].

In contrast, laser frenectomy offered advantages, such as: minimal postoperative pain and edema; better quality tissue healing; minimal scar tissue formation at the end of the healing process (6 months later); reduced surgery time and no need for suturing, when compared with the conventional method. Some studies have confirmed the conclusion that laser surgery speeded up the healing of the surgical wound, reducing the size of the scar, when compared with conventional surgery [7,8,16,34]. However, this study found no statistical differences related to level of clinical repair. In the Er,Cr:YSGG group, no damage to the surrounding tissues was observed, however, two patients in the diode group suffered this type of complication. Although patients from the laser groups reported a lower degree of pain, this difference was not statistically noticeable.

Notwithstanding the technical superiority of the lasers, the cost of the apparatus is still a major obstacle. Er,Cr:YSGG laser has various indications for soft, hard and bone tissue procedures, however, this is a costly technology if compared with diode laser. Due to its size, it is an apparatus that is difficult to transport, and its price is set by the international market.

Diode laser is manufactured in Brazil, which allows its price to be established according to local currency and maintenance costs are more affordable. It is portable equipment due to the fact it uses optic fiber as means of delivery. This physical feature of the diode laser also has impact on the cost of the equipment, moreover, considering that the sapphire tips of the Er,Cr:YSGG laser are more expensive.

The choice between the conventional and laser technique for frenectomy must be made rationally and sensibly because each technique has its own particularities. Good results require wide and previous knowledge of the structures involved, being familiar with the surgical steps, tools or equipment and the right surgical planning.

Professionals who were directly involved in the experiments were under the impression that the use of laser was better accepted by the patients due to the following aspects: fast intra-operative time; minimal postoperative pain and bleeding and absence of suturing as a wound closure procedure [4,7,30,34].

Conclusion

The three techniques behaved efficiently in frenectomy surgery. The intervention in patients with special needs (children, diabetics, mentally disabled, psychotic, etc.) requires fast and less invasive procedures that cause less anxiety and involves a simpler and more comfortable postoperative period. Therefore, depending on the availability of the laser equipment, the laser technique is a more suitable treatment, depending on the group of individuals for whom the treatment is intended to be used.

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Conflict of Interest

The authors declare that they have no known competing interests or personal relationships that could have appeared to influence the work reported in this paper.

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