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A Comparative Study of Pain and Wound Healing Outcomes Following Frenectomy Performed via Conventional Surgery versus ER,CR:YSGG Laser (Wavelength 2780 nm)

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ABSTRACT

Background and Objective: A high frenulum attachment can be associated with a wide range of dental problems, and in many cases, frenectomy becomes necessary. The aim of this study was to compare pain and wound healing following frenectomy using the conventional method versus the ER,CR:YSGG laser method (wavelength 2780 nm).

Methods: In the present comparative study, 20 non-smoking patients with an age range of 14 to 65 years were randomly assigned into two equal groups of 10 patients each: a control group undergoing conventional scalpel frenectomy, and a test group undergoing Er,Cr:YSGG laser frenectomy at a wavelength of 2780 nm. Pain and discomfort were assessed on the 7th day post-intervention using the Visual Analogue Scale (VAS). Additionally, wound healing and tissue repair status were observed and compared between the two groups on the 21st day after surgery.

Findings: The results demonstrated a significant difference in pain and discomfort between the two groups ($p=0.0001$). In the laser group, 100% of patients reported mild pain, whereas in the scalpel surgery group, 80% of patients experienced moderate pain and only 20% reported mild pain. The mean pain score was 5.0±1.33 in the surgical group and 0.6±0.14 in the laser group. Furthermore, the wound healing and tissue repair process was significantly better in the laser group compared to the scalpel group. At the 7-day assessment, the mean healing score was 1.7±0.67 in the surgical group versus 1.8±0.42 in the laser group ($p\leq0.04$). At the 21-day assessment, this difference was more pronounced, with mean healing scores of 3.1±0.57 in the surgical group and 4.3±0.48 in the laser group ($p\leq0.0001$).

Conclusion: Based on the findings of the present study, the use of an Er,Cr:YSGG laser (2780 nm) for frenectomy dramatically diminishes postoperative pain and discomfort compared to surgical frenectomy. Healing duration is markedly reduced in laser-assisted frenectomy compared to the conventional approach.

Keywords: *Laser, Frenectomy, Er,Cr:YSGG, VAS, Healing Outcome.*

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Introduction

Surgical techniques for optimizing mucosal support are often necessary in orthodontic and prosthetic treatment planning in order to maximize the orthodontic and prosthetic field (1). One such procedure, frenectomy, is performed in patients with a high frenal attachment, with the goal of preventing gingival recession and releasing tongue and lip movements (2). There are several drawbacks and limitations associated with the conventional surgical method used for frenectomy, such as patient anxiety, excessive intraoperative bleeding, and postoperative discomfort and pain. Given the limitations of traditional oral surgical methods and the expanding range of applications for dental lasers, the number of dental offices employing laser procedures has been increasing over time.

A variety of laser systems have been evaluated for the treatment of dentinal hypersensitivity. For instance, the efficacy of sodium perborate assisted by the Er:Cr;YSGG laser-induced photoacoustic streaming technique has been investigated with respect to enhancing the color of internally stained teeth (3-5). The precise and targeted interaction between laser energy and oral tissues produces a range of clinical benefits, including reduced tissue damage, decreased bleeding, and fewer surgical complications (6). In addition, several intraoperative advantages merit consideration, such as improved visualization of the surgical field, increased operating speed, and greater accuracy of the incision (7). Another notable advantage associated with laser use is the relatively low proportion of patients undergoing laser-assisted oral surgery who require locoregional anesthesia (8). Given that wavelengths in the range of 2780 nm to 2940 nm are characterized by high water absorption, erbium lasers are particularly well suited for soft tissue procedures, including frenectomy (9).

The objective of this study is to demonstrate the clinical benefits of laser-assisted surgical procedures in the pre-prosthetic and pre-orthodontic treatment stages. This is accomplished by conducting a comparative evaluation of the postoperative progression of frenectomy performed with a laser versus the conventional surgical approach.

Methods

This comparative study comprised 20 patients aged 14 to 65 years, recruited from the Nawar Mosa Dental Medicine Teaching Center (the Ethics Committee approved the study protocol under code 464 on 10/10/2023). Informed consent was obtained from all participants included in the study. The patients were randomly divided into two groups: 10 individuals in the test group (laser-assisted frenectomy) and 10 individuals in the control group (scalpel frenectomy). Inclusion criteria: (1) male or female patients with a high frenal attachment requiring removal, referred from the orthodontic and prosthetic departments of dental clinics; (2) participants must be willing to participate in the study, adhere to the doctor's instructions, and return for the scheduled follow-up visits. Exclusion criteria: individuals with underlying medical conditions; individuals who smoke excessively; individuals with poor oral hygiene. The laser-assisted frenectomy was performed using a 2780 nm Er,Cr:YSGG WaterLase laser system. The specific parameters for the Er,Cr:YSGG laser were established as follows: (1) Rapid Cut Mode: 4 W, 50 Hz, MZ5; and (2) Bandage Mode, used for biostimulation to accelerate wound healing: 1 W, 20 Hz, defocused. The standardized frenectomy protocol consisted of the following sequential steps, all performed with the Er,Cr:YSGG laser: (A) incision of the mucosal tissue in "Rapid Cut" mode; (B) excision of the terminal muscle fibers using a laser beam oriented perpendicularly to the frenum axis, with a full incision extending to the periosteum; (C) verification with a curette to confirm complete detachment of the muscular fibers; and (D) biostimulation in "laser bandage" mode using a defocused laser, with laser energy applied across the entire surgical field.

Postoperative pain and discomfort were quantified using a visual analogue scale over a 21-day period following the procedure, and healing outcome was assessed using the Landry healing index. Surgical wound healing was monitored at 7 and 21 days postoperatively. The healing period was recorded once complete removal of the fibrin layer was observed.

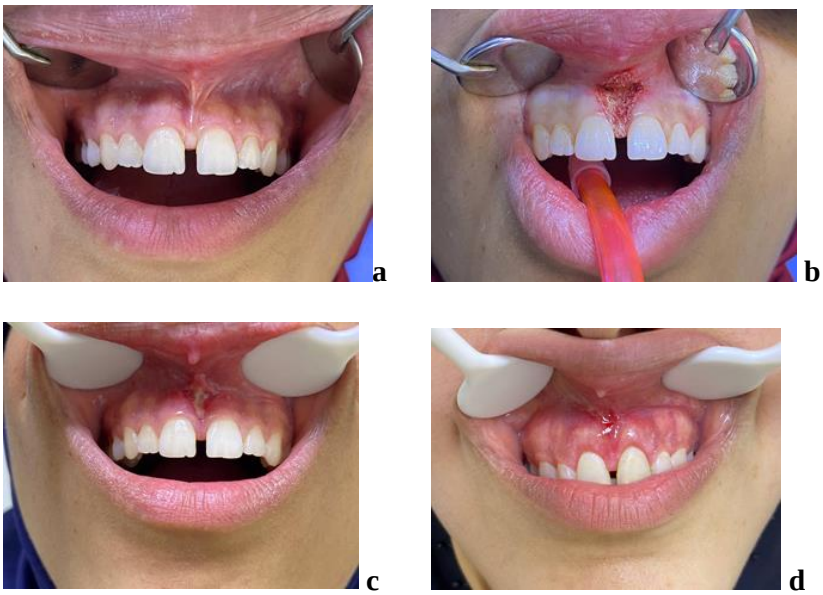
Statistical analysis: The chi-square (χ^2) test was used to compare the laser and control groups. Values of $p>0.05$ were considered statistically non-significant, whereas $p\leq0.05$ was considered statistically significant. Statistical analysis was performed using SPSS software (version 20).

Results

For all frenectomy procedures performed in the study cohort, Er,Cr:YSGG laser therapy was administered using a Waterlase iPlus system (Biolase Technology, Irvine, CA). The specific configuration of the laser parameters employed in both "Rapid Cut" mode and "Bandage" mode is illustrated in Figure 1 (a, b). Figure 2 presents a visual documentation of the clinical phases and follow-up assessments of a laser-assisted frenectomy procedure performed using a 2780 nm Er,Cr:YSGG laser (a, b, c, d).

a b

Figure 1. (a) Parameters for Rapid Cut mode, (b) parameters for Bandage and biostimulation mode



a b c d

Figure 2. (a) Preoperative photograph, (b) postoperative photograph and biostimulation, (c) 7-day follow-up, (d) 21-day follow-up

According to VAS index values for estimating pain and discomfort, 100% of the laser group experienced mild pain, while in the surgical group, 80% experienced moderate pain and 20% experienced mild pain. The p-value was significant (p=0.0001), as shown in Table 1.

Table 1. VAS index values for estimating pain and discomfort following surgical and laser procedures

VAS N(%)	VAS Range 1-3 mild	4-7 Moderate	8-10 severe	X^2 p-value	Mean±SD
Surgical group	2(20)	8(80)	0(0)	0.0001	5±1.33
Laser group	10(10)	0(0)	0(0)	0.0001	0.6±0.14

The healing outcomes in the laser group were also better than those in the surgical group (Figure 3), with a p-value of 0.041, which was also statistically significant, as shown in Table 2.

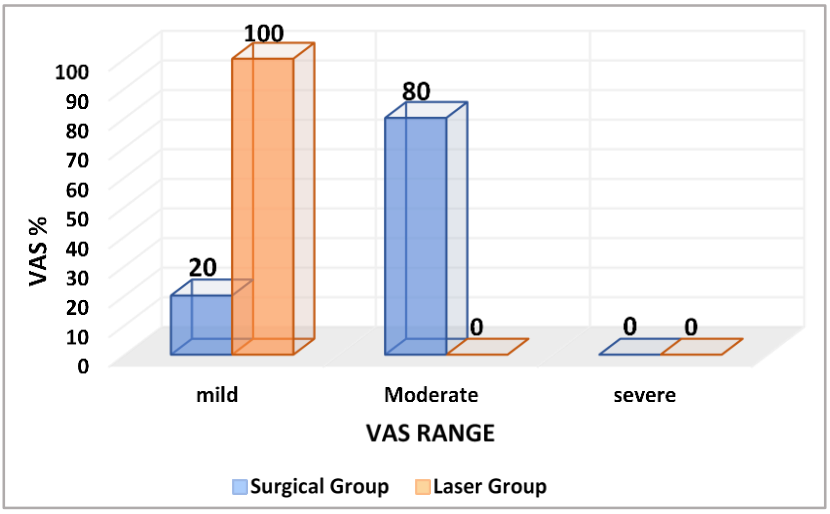


Figure 3. Percentage distribution of VAS index values and range between the surgical and laser groups

Table 2. Landry healing index scores recorded at 7 days following the procedure

LANDRY (HEALING) 7 DAYS	Landry (healing) 21 days 1 Very Bad	2 Bad	3 Good	4 Very good	5 excellent	X^2 p-value	Mean±SD
Surgical group	4(40)	5(50)	1(10)	0(0)	0(0)	0.0041	1.7±0.67
Laser group	2(20)	8(80)	0(0)	0(0)	0(0)	0.0041	1.8±0.42

The healing outcomes at 21 days were better in the laser group than in the surgical group (Figure 4), with a p-value of 0.0001, as shown in Table 3.

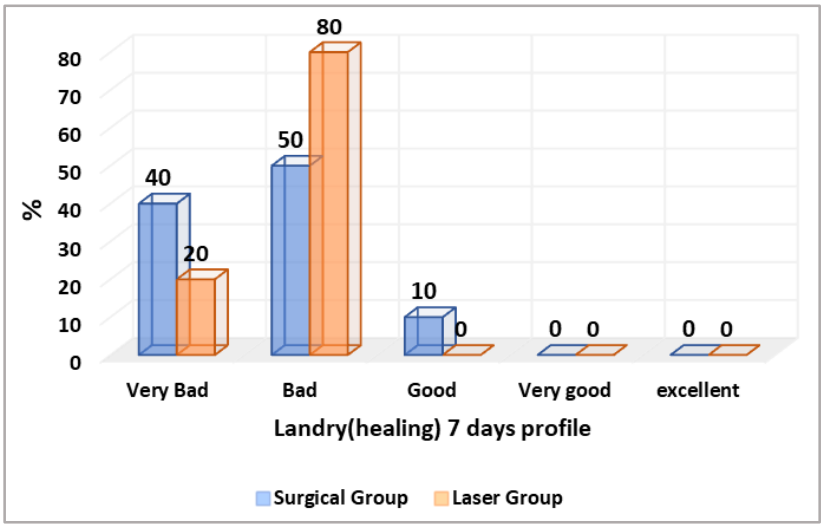


Figure 4. Percentage of healing outcomes based on the Landry healing index in the laser and surgical groups at the 7-day follow-up

Table 3. Independent samples t-test for Landry healing index values at 21 days after the procedure

	Landry (healing) 21 days						
LANDRY(HEALING) 21 DAYS	1 Very Bad	2 Bad	3 Good	4 Very good	5 excellent	**X^2 p-value**	**Mean±SD**
Surgical group	0(0)	0(0)	7(70)	3(30)	0(0)	0.0001	**3.1±0.57**
Laser group	0(0)	0(0)	0(0)	7(70)	3(30)	0.0001	**4.3±0.48**

Figure 5 shows the percentage distribution of Landry healing index values at the 21-day follow-up in the laser and surgical groups.

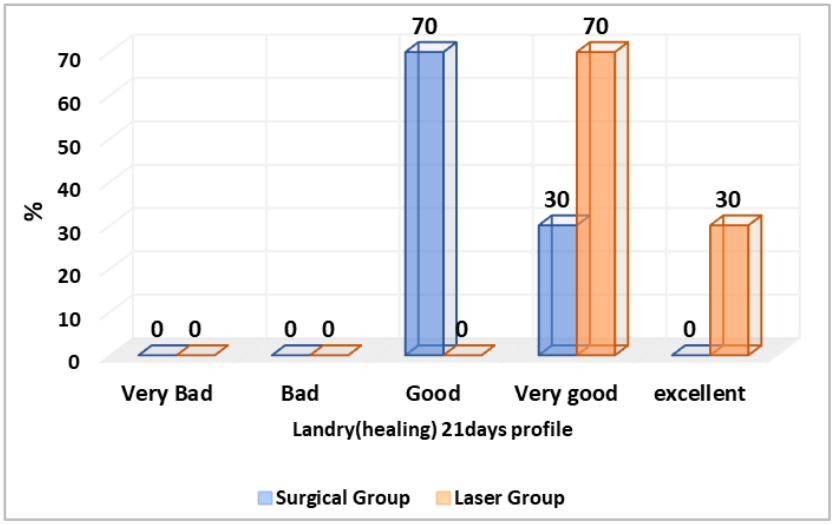


Figure 5. Percentage distribution of Landry healing index values at the 21-day follow-up

Discussion

When compared with the control group (scalpel technique), our test group (laser technique) demonstrated superior postoperative outcomes and faster healing times associated with the use of the laser-assisted technique for frenectomy. Notably, no postoperative edema was observed, and there was no evidence of an inflammatory response in the soft tissues. All patients in the laser group experienced only mild pain, and no cases of surgical site infection were recorded among patients receiving laser assistance. Our findings, in agreement with those of another study, demonstrated that the use of erbium lasers during frenectomy shortened the healing period and reduced postoperative pain and discomfort (10).

The rapid healing of surgical wounds following laser-assisted frenectomy may be attributed to the biostimulation effect, which is believed to enhance macrophage activity involved in the elimination of the fibrin layer, as well as to accelerate epithelization processes, a finding consistent with the study conducted by Wagner et al. (11). Furthermore, erbium lasers utilized in soft tissue surgery have been associated with several favorable characteristics, including reduced elevation of surface temperature, minimal alterations to the epithelization process, and the absence of vascular complications (12). For laser therapy to be considered genuinely beneficial, it must consistently produce positive, reliable, and reproducible clinical outcomes. It is therefore recommended that studies evaluating the efficacy of laser devices employed in oral surgical procedures contribute to the broader dissemination and accessibility of these novel, cutting-edge instruments. To further optimize this therapeutic approach, randomized controlled trials are needed to systematically evaluate the effects of various laser settings, as well as local and locoregional factors that may influence treatment outcomes.

The application of an Er,Cr:YSGG laser (2780 nm) for frenectomy results in a dramatic reduction in postoperative pain and discomfort when compared with conventional surgical frenectomy. Additionally, the healing period is substantially shorter in laser-assisted frenectomy than in the conventional surgical approach.

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