ORIGINAL ARTICLE

Low Level Diode Laser Therapy On Wound Healing Post Gingivectomy

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ABSTRACT

Aim: To evaluate the effect of low-level diode laser therapy on wound healing after gingivectomy.
Methods: Forty patients (male and female) with ages ranging from 20-40 years received gingivectomy participated in this study. They were selected randomly from dental outpatient clinic at Badr university in Cairo and randomly divided into 2 equal groups in number, one study group (A) and control one (B). The study group (A)was irradiated with Gallium Arsenide (GaAs) laser of wavelength 850 nm for 4 sessions on day 0, day 3, day 7 and day 14 post gingivectomy.The control group (B) who received placebo laser.Assessment of healing was done before starting the first session (day 0), day 7, day 14 (after session) and follow up assessment (day 21).The healing assessed by photographic method by applying image J software and Landry index.
Results: The results of this study support that the low-level diode laser therapy was significantly effective on wound healing in patients after gingivectomy. There was a highly significant difference between two groups after the treatment. **Conclusion**: It was concluded that the low-level diode laser therapy is an effective method for increasing wound healing after gingivectomy.
Keywords: Low level diode laser therapy, Wound healing, Gingivectomy.

INTRODUCTION

Gingival enlargement or hyperplasiais that the overgrowth of the gingiva characterized by an accumulation of the connective tissue with presence of increased number of cells[1]. Gingival enlargement affects patient's esthetics if present in the anterior maxillary or mandibular areas and leads to accumulation of plaque so gingival enlargement treated conventionally with Gingivoplasty or Gingivectomy operation. Gingivectomy is the removal of diseased gingiva and elimination of suprabony pocket. Gingivoplasty is the reshaping of the gingiva to create physiological contours to the gingiva in the absence of periodontal pockets[2].

Healing of gingivectomy wound is known to take by secondary intention and it takes about 4 weeks for complete epithelialization and about 7 weeks for connective tissue maturation[3]. Wound-healing process after scalpel gingivectomy is a slow phenomenon and the scalpel gingivectomy method can be performed either using gingivectomy knives (e.g., Kirkland knife and Orbans knife) or using surgical blades[4].

Low level laser therapy (LLLT) is represented by using the light for improving tissue healing, decreasing tissue inflammation, and controlling the pain[5]. Diode laser are most commonly used lasers in dentistry and the most commonly used wavelengths are 810 and 980nm[6].

MATERIAL AND METHODS

This study was cross-sectional included 40 patients; the dentist referred them from dental outpatient clinic at Badr University in Cairo after receiving Gingivectomy in the maxillary and mandibular anterior region. Their ages ranged from 20 to 40 years and committed to maintain oral hygiene. They were free from any systemic diseases including diabetes, immune system deficiency, etc. The pregnant women, smokers, patients with a clear nutrition disorder and the degree of gingival inflammation was recorded by gingival index if it exceeded1, they were excluded from the study. Every patient applied informed consent before starting the study. The Ethical Committee of the faculty of physical therapy ,Cairo University , Egypt approved the protocol of this study.

The wound healing was evaluated through photographic method by using “Image J software “for wound surface area assessment that the rate of change in wound size is the best way to quantify progress in wound healing[7]. Analyzing digital images with Image J estimates wound area with excellent reliability. This method provides a free, rapid, and accurate way to measure wounds and could routinely be used to document wound healing in daily clinical practice[8]. All the pictures included in this study were taken with the camera of OPPO F11 which has a camera of 48 megapixels and 5 megapixels with macro lens option in the mobile using flash. Photographs were taken placing a ruler next to the wound and parallel with the healthy skin **(8)**. The ruler used was with a well-known size, and then used the software to make the correspondence to the numbers of pixels. Photographs were visualized with Image J software. Wound area measurement was carried out as (Fig. 1).Wound was assessed immediately (before the first session), day 7, day14 (after the session) and follow-up on day 21(Fig. 2).

The healing also assessed by Landry index that the healing index (HI) scores healing on the basis of redness, presence of granulation tissues, bleeding, suppuration, and epithelialization. A score of 1–5 was given with score 1 for very poor healing, 2 for poor healing, 3 for good healing, 4 for very good healing and 5 being excellent healing of the tissues. Higher is the score, better is the healing. This

index scores the surgical wound based on the clinical examination[9].

Wound was assessed immediately (before the first session), day7, day 14 (after the session) and follow-up on day 21[10].

In outpatient physical therapy clinic at Badr university in Cairo from March to December 2020. The forty patients who received Gingivectomy were divided into two equal groups in number, one study group (A) and control one (B). All patients received usual treatments including antibiotics, analgesics and anti-inflammatory drugs and instructed to maintain oral hygiene.

The Group A (study group),patients were irradiated with low level diode laser therapy (GaAs)(Chattanooga, model 27841, USA) for 4 sessions on day 0, day 3, day 7 and day 14[11]. The therapist placed a cheek retractor in the patient mouth to retract the lips and cheeks. Patient was asked to wear glasses to protect his eye. Patient was irradiated with low level diode laser therapy with wavelength 850 nm and power of 200 mw in continuous mode. A dose of 4 j/cm^{2}was delivered and the total time was determined in accordance with each patient wound size with laser probe applied perpendicular for scanning an area about 1 cm^{2}with non-contact method 10 mm away from the wound site[5].

The Group B (control group), patients were treated with placebo laser for 4 sessions on day 0, day 3, day 7 and day 14 as the therapist set the device parameters without turning it on to convince the patient with the credibility of the session[11].

Statistical analysis: Descriptive statistics and unpaired t-test were conducted for comparison of the mean age between groups. Chi- squared was carried out for comparison of sex distribution between groups. ANOVA with repeated measures was conducted for comparison of wound surface area between day 0, 7, 14, and 21 in each group and Friedman test was carried out for comparison of Landry index between day 0, 7, 14, and 21 in each group and was followed by Wilcoxon Signed Ranks for pairwise comparison. Unpaired t test for comparison of wound surface area between groups. Mann–Whitney U test was conducted for comparison of median values of Landry index between groups. The level of significance for all statistical tests was set at $p < 0.05$. All statistical analysis was conducted through SPSS version 25.

RESULTS

Subject characteristics: There was no significant difference between groups in age and sex distribution ($p>0.05$).The mean±SD age of the study group was 30.55±7.76 years and the mean±SD age of the control group was 29.5±5.5 years. The sex distribution of the study group revealed that there were 15 females (75%) while the number of males was 5(25%) and the sex distribution of the control group revealed that there were 13 females (65%) while the number of males was 7(35%).

Effect of treatment on wound surface area and Landry index

Between group comparison: There was no significant difference in wound surface area between the study and control groups at day 0 ($p = 0.65$). There was a significant decrease in wound surface area of the study group at day 7, 14 and 21 compared with that of the control group ($p < 0.001$) (Table 1).

There was no significant difference in median value of Landry index between the study and control groups at day 0 ($p=1$). There was a significant increase in the median value of Landry index of the study group at day 7, 14 and 21 compared with that of the control group ($p < 0.001$) (Table 2).

Within group comparison: Within-group comparison revealed a significant decrease in wound surface area in both groups at day 7, 14 and 21 compared with day 0 ($p < 0.001$), a significant decrease in wound surface area at day 14 and 21 compared with day 7 ($p < 0.001$) and a significant decrease in wound surface area at day 21 compared with day 14 ($p < 0.001$) (Table 3).

There was a significant increase in median value of Landry index of the study group at day 7, 14 and 21 compared with day 0 ($p < 0.001$), a significant increase in Landry index at day 14 and 21 compared with day 7 ($p<0.01$) and a significant increase in Landry index at day 21 compared with day 14 ($p<0.05$). While in the control group there was a significant increase in median value of Landry index at day 7, 14 and 21 compared with day 0 ($p < 0.001$), no significant difference in Landry index between day 7 and 14 ($p = 0.1$) and a significant increase in Landry index at day 21 compared with day 7 and 14 ($p < 0.001$) (Table 4).

Table 1: Mean wound surface area at day 0, 7, 14 and 21 of the study and control groups

Wound surface area (mm²)	**Day 0**	**Day 7**	**Day 14**	**Day 21**
	mean ± SD	**mean ± SD**	**mean ± SD**	**mean ± SD**
Study group	33.41 ± 6.35	7.75 ± 3.38	3.47 ± 1.46	1.3 ± 0.65
Control group	34.32 ± 6.6	23.84 ± 4.95	14.7 ± 3.06	7.96 ± 1.7
MD	-0.91	-16.09	-11.23	-6.66
t- value	-0.44	-11.99	-14.78	-16.33
	p = 0.65	**p = 0.001**	**p = 0.001**	**p = 0.001**

SD, Standard deviation; MD, Mean difference; p-value, Level of significance

Table 2: Median Landry index at day 0, 7, 14 and 21 of the study and control groups

Landry index	**Day 0**	**Day 7**	**Day 14**	**Day 21**
	Median (IQR)	**Median (IQR)**	**Median (IQR)**	**Median (IQR)**
Study group	2 (2,2)	4 (4.75,4)	5 (5,4)	5 (5,5)
Control group	2 (2,2)	3 (3,3)	3 (4,3)	4 (3,3)
U- value	200	22.5	25	40
	p = 1	**p = 0.001**	**p = 0.001**	**p = 0.001**

IQR, Interquartile range; U- value, Mann-Whitney test value; p-value, Level of significance

Table 3: Comparison of wound surface area between day 0, 7, 14 and 21 within the study and control groups.

	Study group			Control group		
	MD	% of change	P value	MD	% of change	P value
Day 0- Day 7	25.66	76.8	0.001	10.48	30.54	0.001
Day 0- Day 14	29.94	89.61	0.001	19.62	57.17	0.001
Day 0- Day 21	32.11	96.11	0.001	26.36	76.81	0.001
Day 7- Day 14	4.28	55.23	0.001	9.14	38.34	0.001
Day 7- Day 21	6.45	83.23	0.001	15.88	66.61	0.001
Day 14- Day 21	2.17	62.54	0.001	6.74	45.85	0.001

Mean difference; p-value, level of significance

Table 4: Comparison of Landry index between day 0, 7, 14 and 21 within the study and control groups.

	Study group		Control group	
	Z-value	p- value	Z-value	p- value
Day 0- Day 7	4.13	0.001	4.23	0.001
Day 0- Day 14	4.13	0.001	4.09	0.001
Day 0- Day 21	4.47	0.001	3.99	0.001
Day 7- Day 14	3.16	0.002	1.63	0.1
Day 7- Day 21	3.87	0.001	3.41	0.001
Day 14- Day 21	2.23	0.02	3.31	0.001

Z-value, Wilcoxon Signed Ranks Test value; p-value, level of significance

DISCUSSION

The aim of the study was to evaluate the effect of low-level diode laser therapy on wound healing post gingivectomy. The results of this study support that the low-level diode laser therapy was significantly effective on wound healing in patients post gingivectomy more than the medical treatment. There was a highly significant difference between two groups after the treatment.

The result of the present study agreed with Faria et al[12] reported that the laser-treated group had a faster recovery post gingivectomy and reduction of pocket depth compared to control group. Twenty patients irradiated with LLLT immediately post-surgery, 24h, 3rd day and 7th day. The difference between this study and the present study depended on laser parameters but both supported that LLLT had beneficial effect on wound healing after gingivectomy operation. The wavelength is an important parameter to evaluate laser effectiveness. In this study the wavelength was 685 nm, while in the present study was 850 nm. The power used in this study was 50 mw applied in a contact with the wound for 4 sessions on day 0, 24h, day 3 and day 7. On the other hand, the power in the present study was 200mw in a non-contact method 10 mm away from the wound site for 4 sessions on day 0, day 3, day 7 and day 14. The irradiated wounds underwent a better healing process than the wounds from the control group, because of higher collagen production leading to a better remodeling of the connective tissue and a reduction of the probing depth. The reduction of the probing depth in the early stages of healing is a very positive finding.

Also, the result of the present study agreed with kohale et al[13] conducted a study to assess the effect of LLLT on wound healing and patient's response after scalpel gingivectomy and results indicated that LLLT improved wound healing. Forty patients involved in the study, received laser therapy on day 0, day3 and day7 and healing assessed on day 3, day 7 and 1 month after surgery. The difference between this study and the present study was based on laser parameters but both accelerate wound healing of the gingiva after gingivectomy. In this study, although the power and the repetition of the laser were less than in the present study as the power was 100 mw and it had beneficial effect of the healing due to the large wavelength that was 940 nm. As the penetration depth increases with increasing wavelength **(14).** The study explained that the effectiveness of wound healing after LLLT as there were formation and proliferation of newer blood vessels and fibroblasts in the initial stages of wound healing. LLLT reduce inflammation by lowering the levels of prostaglandin E2, interleukin‑1 beta, tumor necrosis factor alpha, cellular influx of neutrophils and granulocytes, oxidative stress, edema, and bleeding.

Also, Reddy et al[15] compared the efficacy of low-level laser therapy, hyaluronic acid and herbal gel when used topically after a gingivectomy. They reported that there were statistically significant results observed in the low-level laser therapy group on wound healing more than hyaluronic acid and herbal gel groups. In this study 10 subjects received laser on day 1, day 3 and day 7 post surgery. However, laser power of this study was 50 mw for 3 min only with contact method, the LLLT group showed better results due to the large wavelength as it was 980 nm. On the other hand, the power in the present study was 200 mw in a non-contact method with 10 mm away from the wound site. The study explained that LLLT applied to soft tissues excited specific metabolic processes in healing wounds. The major changes observed include increased granulation tissue, early epithelialization, increased fibroblast proliferation, and matrix synthesis. Also, the histological evaluation showed more mature collagen fibers in the laser group.

Only few studies reported that low level diode laser therapy has not affect wound healing in patients post gingivectomy that observed and recorded by Damante et al. **(16)** reported that low-level laser therapy did not accelerate the healing of oral mucosa after gingivoplasty. The first difference between this study and the present study was the small sample size as 16 patients in the study with both sides gingivoplasty and one side used as control so that could affect negatively the results and might make a type of error. The second difference was the wavelength

670 nm while wavelength of the present study was 850nm and the penetration depth increase with increasing wavelength[14]**.** The third one was the power used in this study 15mw it was very small because penetration and absorption of laser light can also be affected by the power output, the greater the number of photons which penetrate the tissue at any time, the greater the number of photons will be present at any given depth and higher power densities with shorter irradiation times might be more efficient in the delivery of LLLT[17], while the power of the present study was 200 mw. The forth one was sessions interval in this study the laser was applied 48h for 1 week for a total of 4 sessions while the laser applied in the present study was applied for 2 weeks on day 0, day 3, day 7 and day 14, repeated irradiation increased the proliferation of fibroblasts[18]. The fifth and last difference was the healing assessed in this study after gingivoplasty and it was a simple surgical procedure, it had excellent post-operative outcome in most cases and healing was a very rapid process while the present study assessed the wound healing after gingivoplasty and gingivectomy operations which is more complex than gingivoplasty alone.

Also, the present study was disagreed with Hammadi and Ahmed[19] reported that low-level laser therapy did not accelerate oral mucosa healing after gingivectomy. The first difference between this study and the present study was the small sample size as 11 patients in the study with both sides gingivectomy so that might impair the results while in the present study 40 patients. The second one was sessions interval in this study the laser was applied 48h for 1 week for a total of 4 sessions while the laser applied in the present study was for 2 weeks on day 0, day 3, day 7 and day 14, repeated irradiation increased the proliferation of fibroblasts. The other differences were due to parameters of the LLLT used in the study, the wavelength of the laser therapy used in this study was 670 nm while the wavelength of the present study was 850 nm as the penetration depth increases with increasing wavelength. In this study they used contact method of the laser head with the wound that might be a source of infection for the wound site while in the present study the laser probe applied perpendicular in a non-contact method 10 mm away from the wound site. There was a lack of parameters of the low-level laser application in this study as they weren't discussed the amount of power and the application mode used in the study that could alter the results.

Our study was limited by many factors such as small sample size, physical and psychological conditions of the patients during the period of the treatment, possible human error`s application of measurement or therapeutic procedure, cooperation of the patient and maintenance of oral hygiene.

In the present study there was acceleration of wound healing by using low level diode laser therapy after gingivectomy by using these parameters and it is explained by that LLLT decreased bleeding after surgery and formed protective surface clot by acceleration of the hemostasis phase then promoted the granulation tissue to replace the surface clot. It accelerated the inflammatory phase by increasing the level of growth factors and cytokines, which are important to improve cell proliferation and migration. Fibroblasts migrate into the wound site from the surrounding tissue and endothelial cells proliferate from intact venules close to the wound and form new capillaries by the process of angiogenesis, so it increased the new connective tissue formation. And the migrated fibroblasts improved collagen formation and made a better organization for the gingival tissue. Finally, LLLT accelerated covering the wound and the injured gingiva became as pink as the normal gingiva[20].

CONCLUSION

It was concluded that the low-level diode laser therapy is an effective method for accelerating wound healing after gingivectomy surgery.

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Figure 1: Illustrates wound area measurement by open ImageJ software

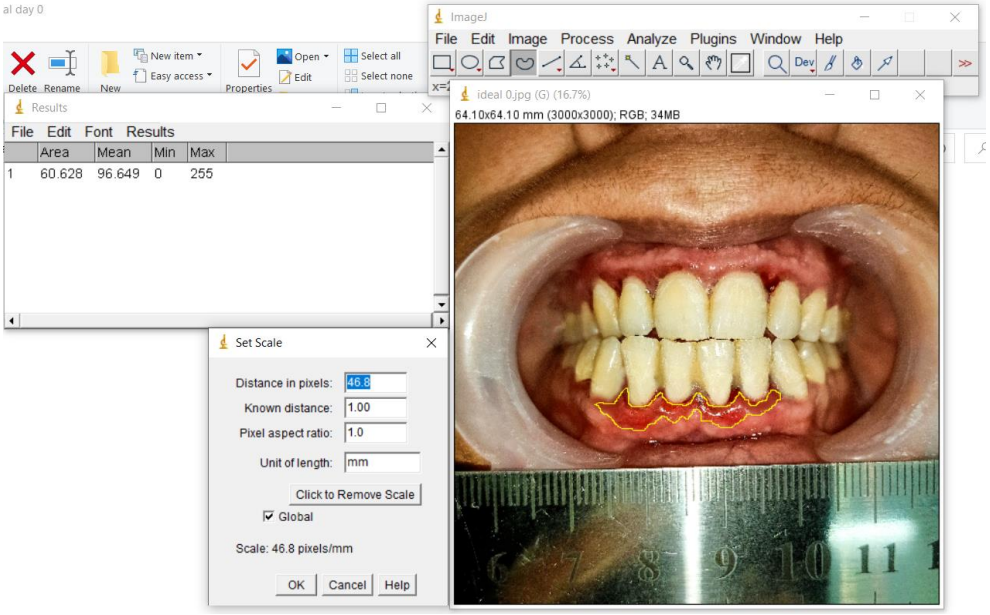
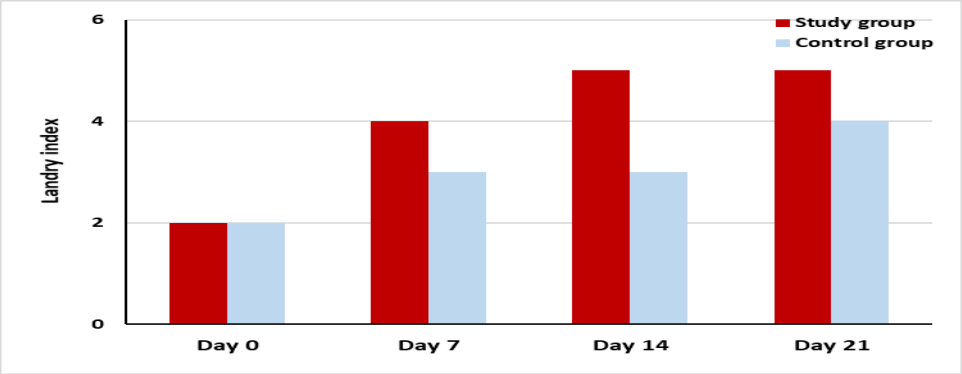


Figure 2: Wound healing by time from day 0 to day 21.

Fig. 3: Mean wound surface area at day 0, 7, 14 and 21 within the study and control groups.


Study group
Control group
Landry index
6
4
2
0
Day 0
Day 7
Day 14
Day 21