Research Article

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Low Level Laser Therapy (LLLT) an Asset to Extra Oral Wound Healing

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ABSTRACT

Aim: The aim of the study is to assess pain, wound infection and scar tissue appearance in the extraoral wound in the maxillofacial region using LLLT and to compare it to the region where no laser therapy was used.

Material and Methods: The study was performed on 20 patients in whom wound closure was done with 4-0 nylon sutures. Half of the closed wound was subjected to a diode laser of 1500 Hz frequency and 650 nm wavelength for 5 minutes and remaining half of the wound was considered as a control site. Patients were subjected to LLLT for the next seven days. The patients were assessed for postoperative pain and infection on day 1, 3 and 7 and for scar evaluation after one month postoperatively.

Results: No difference was observed in mean pain score between areas treated with LLLT and control site. 10% patients without LLLT (control group) presented with the infection on day 7, whereas none of the study group presented with infection. The study also found better cosmetic results in patients who were treated with LLLT by three independent observers when evaluated one month postoperatively.

Conclusions: LLLT has resulted in better cosmesis, curtailed the rate of infection and pain; thus, we can conclude that LLLT has been found to be impervious on cutaneous wounds.

Keywords: Low-level laser therapy, wound healing, laser.

INTRODUCTION

A wound/injury may be defined as a disruption in the continuity of a body tissue which may be caused by any physical, chemical or mechanical insult to the tissue or may be triggered by a pathological condition [1]. As a result of an injurious event, the body's defence mechanism gets activated to heal the injured tissue by stimulating a complex cascade of cellular and biochemical events. This process of healing can be divided into three distinct but overlapping phases: (1) hemostasis and inflammation, (2) proliferation, and (3) maturation or remodelling. Failure or prolongation of any one of the phases may cause delayed or nonhealing of the wound affecting the quality of life of the individual, posing emotional stigma and curbing them financially. The low-level laser is a time-tested, innovative therapy which has added perk on the healing of the wound.

Lasers were first introduced by Theodore Harold "Ted" Maiman, an American engineer and physicist in 1960s at Los angeles. In 1967 Hungarian

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physician, Endre Mester studied the biological effects of low power laser on rats, where the lasers were utilized to kill cancerous cells. He found that instead of killing the cancerous cell, laser-accelerated the wound healing, and the reason portrayed was the low power of the laser, which was insufficient to kill the cancerous cell. He was then considered as the grandfather of photobiomodulation or low-level laser therapy (LLLT) [3].

Photobiomodulation (PBM) or LLLT has now refined into a therapeutic procedure which includes light from lasers and light-emitting diodes (LEDs) as well as other light sources of the wavelength in the range of visual to infrared. It induces homeostasis and inflammation and increases the deposition of collagen, stimulates the tissue granulation and revascularize the wound, thereby improvising wound healing[4,5]. The power used is usually low, i.e. <500 mW which is neither sufficient to cause any structural change nor does it cause any elevation in the temperature of the area being targeted [6]. This characteristic of LLLT of not inducing ablation and producing heat makes it different from other treatments modalities[7,8] and has been found to be successfully used for pain relief, in tendinopathies, nerve injuries, osteoarthritis and promoting wound healing.[4] The power lower or higher to this range has found to produce opposing effect.[9]

The wavelengths of the light source are also a very important factor in determining the healing, wavelength ranging from 632.8 nm to 1000 nm provides better healing so it can be safely used for cutaneous wound healing.[10] Kuffler et al. [11] noted that wavelengths in the 500–700 nm range are appropriate for superficial tissue injury treatment, while wavelengths between 800 and 1000 nm are appropriate for deeper tissues injuries. In our study, we had used low-level laser of wavelength 650 nm for extraoral wound healing.

Although LLLT is widely used for various ailments, it remains controversial as therapy because of various reasons, like poorly understood biochemical mechanisms, several variables like the wavelength, power, probe design, time duration of application of laser and investigator bias affecting the outcomes.[4] These conflicting results have provoked us to investigate whether LLLT is really an asset to wound healing or not?

Aims and objectives

The aim of the study was to compare extra-oral wound healing in the maxillofacial region with and without Low-Level Laser therapy. The objectives of the study were to compare pain between two equally divided areas of the same wound under evaluation, to assess the relative rate of wound infection and to compare the appearance of scar between LLLT treated & untreated wound area.

MATERIAL AND METHODS

Patients reporting to the department with extra-oral lacerated wounds in the maxillofacial area which required to be closed with sutures were studied. The patients included in the study were in the age group of 18-50 years. Patients suffering from systemic illness, pregnant women and patients with head and spinal injuries were excluded from the study.

Methods

Informed written consent was obtained from the enrolled patients. Wound closure was done with 4-0 monofilament nylon suture (ETHILON®) using simple interrupted suturing technique following strict sterile method. Analgesics and antibiotics were prescribed. Standardized digital photos were recorded prior to LLLT. Half of the sutured wound was covered with sterile gauze to act as control & other half was subjected to LLLT, which acted as a study site.

LLLT was given using the LLLT machine (Figure 1), keeping the 2mm gap between the treatment head of the laser probe and the wound. The laser used had a frequency of 1500 Hz and 650 nm wavelength. The treatment time was 5 min. Both subject and administrator used laser safety goggles during treatment. Standardized digital photos were taken. Patients were given LLLT from day 1 to day 7. Wound assessment was done on days 1, 3 &7 and pictures were taken. The sutures were removed after an interval of 7 days.

The patients were assessed for postoperative pain, infection and appearance of the scar.

a) Patients were asked to score the intensity of postoperative pain on days 1, 3 and 7 after low laser therapy on a 10 point Numerical Rating

scale (NRS) with 0 representing no pain and 10 representing maximum pain.

b) The presence or absence of infection was recorded by the single observer on 1st, 3rd and 7th postoperative days. The criteria for this parameter was the presence of pus discharge from the sutured wound. In the presence of any discharge, the wound was debrided, irrigated and dressed

c) The scar was evaluated only after a follow up of 1month postoperatively, by three blinded observers on a numerical scale of 10. Scores were categorized as: 0 and 1 = Poor, 2 – 4 = Acceptable, 5 – 7 = Good and 8 – 10 = Excellent. The average of the three scores for each sample assessed was then taken to establish the mean scores for each group.

Fig 1: Low Level Laser Therapy machine.

The data obtained were subjected to statistical analysis through the Chi-square test (χ^2), ANOVA and Student's 't' test using SPSS 16.0 software.

RESULTS

Total 20 patients were enrolled in the study in whom healing outcomes of sutured wounds in the maxillofacial area was assessed. Each wound was divided into two halves one half was subjected to LLLT (study site) and the other half as control. 25% of the total study sample were female patients, and males constituted 75% of the study sample. The mean age of the patients was 29.9 years.

Assessment of Pain showed that the Mean Pain Scores in the Study Patients on Day 1 was 7.2±2.42, on Day 3 it was 4.15±2.70 and on Day 7: 0.35±0.58 (Table 1) Patients did not appreciate any difference in pain in two parts of the divided wound.

(i) Sutured wound in the patient; (ii) LLLT being applied;

(iii) One month postoperatively

Fig 2: Patient with and without LLLT

Table 1: Pain scores on assessment days.

Patient no.	Day 1	Day 3	Day 7
01	7	5	0
02	10	8	1
03	8	5	0
04	10	8	1
05	5	1	0
06	8	4	0
07	5	2	0
08	8	5	1
09	10	8	0
10	10	8	1
11	5	5	0
12	8	5	0
13	10	5	1
14	5	0	0
15	2	0	0
16	10	5	2
17	5	1	0
18	5	1	0
19	8	5	0
20	5	2	0
Mean	7.2	4.15	0.35
SD	2.42	2.70	0.58

Table 2: Percentage of infection.

Presence of infection - Percentage						
Day	Day 1		Day 3		Day 7	
Study/Control Site	With LLLT	Without LLLT	With LLLT	Without LLLT	With LLLT	Without LLLT
Percentage (%)	0	0	0	10	0	10

Table 3: Scar grading mean values.

	Scar grading 1 month post op					
Observer	Observer 1		Observer 2		Observer 3	
Study/ Control Site	With LLLT	Without	With LLLT	Without	With LLLT	Without
Mean	7.2	5.8	6.7	5.2	6.8	5.6
Standard Deviation	1.01	0.89	1.02	0.78	1.06	0.69
T	4.65		5.21		5.66	
P	< 0.0001		< 0.0001		<0.0001	

Assessment of Infection showed 10% of the patients without LLLT (control) presented with an infection on day seven, whereas no infection was observed on study or LLLT site. (Table 2)

Assessment of Scar appearance showed that at 1st post-op month scar grading as observed by observer 1 in cases with LLLT was 7.2±1.01 and in without LLLT was 5.8±0.89. Scar grading by observer 2 in cases with LLLT was 6.7±1.02 and in cases without LLLT was 5.2±0.78. Grading, as observed by observer 3 in cases with LLLT was 6.8±1.06 and in cases without LLLT was 5.6±0.69. (Table 3)

DISCUSSION

We conducted a prospective study to evaluate the role of LLLT in extra-oral wound healing and assessed its role in postoperative pain, wound infection and cosmetic outcome. The male to female ratio enrolled in our study was 3:1

Mean pain scores of the patients in our study showed improvement over the week, but no difference in pain was found between areas treated with LLLT and conventional suturing. The results are consistent with the study done by Heidari et al[12] in 2014 who conducted a clinical trial on the effect of laser on wound healing and postoperative pain following free gingival graft and found no significant difference between the VAS pain score between the study and control groups, but he found that for the first 3 hours after the procedure the laser group showed greater VAS pain score. Suter et al[13] in 2017 stated in his systemic review on benefits of lasers in recurrent aphthous stomatitis that highly significant reduction in pain immediately after LLLT was observed in five studies out of six studies and pain relief after few days of treatment was found in all. Haslerud et al. (2015) [14] and Doyle et al[15] in 2016 independently studied the effects of LLLT on pain associated with tendinopathy and found significant pain reduction in tendinopathy. Ojea et al. [16] in 2016 conducted a randomized clinical trial on patients with gastric bypass surgery and found that LLLT leads to a reduction in inflammation, seroma and pain. Takenori et al[17] in 2016 in their randomized, double-blind clinical trial in athletes after sports injury found that LLLT provided pain relief immediately by 28.74% and concluded that it was effective for pain relief in 75% of participants he studied.

Our study found that none of the patients with wound site treated with LLLT presented with infection after seven days. 10% of the patients presented with an infection on the control or non-LLLT site. The result was consistent with the study performed by Reza et al. [18] in 2016 who studied the effect of LLLT in diabetic rats with third-degree burn wounds that were infected with *Staphylococcus aureus* (*S. aureus*) and stated that the size of the wound and microbial count was significantly less in LLLT group and microscopically new blood vessel, collagen deposition and macrophages invasion was sufficiently high in LLLT group which led to the conclusion that LLLT undoubtedly improves wound healing. The results of our study were against the study done by Pereira et al. [19] 2014 who compared the effects of LLLT on in vitro bacterial growth and in vivo in infected wounds in rats and found no statistically significant variation in bacterial count LLLT and control group but the deposition of type I and III collagen in the wounds of the LLLT group was significantly increased on day four. Nussbaum et al[20] in 2014 also found no beneficial effect of LLLT on infected rat wounds.

Our study also found better cosmetic results in patients who were treated with LLLT by three independent observers when evaluated one month postoperatively. The results of which are consistent with Freitas et al. [21] (2013) found significant scar reduction in the LLLT group, and as the scar age increases, thickness of scar was reduced in LLLT

treated wound. Ojea et al. [20] in 2016 had also found a reduction in cicatrization in surgical wounds after bariatric surgery. Gaida et al. [22] in 2004 studied the effect of LLLT on burn scar and reported that laser, when used twice a week for eight weeks, had a beneficial yet limited effect on burn scars taking into consideration the pain, pruritus and macroscopic appearance of the scar.

CONCLUSION

From the result of our study, we can now conclude that LLLT is an asset to the medical professional, physiotherapist and to the general public for relieving pains, wound healing, joint ache, scar contracture etc.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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