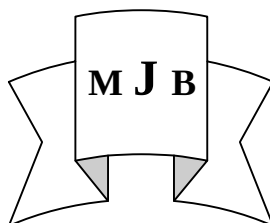


The Evaluation of Low Level Laser Therapy Using the Diode Laser in Enhancement of Episiotomy Wound Healing

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Abstract

Objectives: This study aimed to evaluate the effect of low level laser therapy (biostimulation) using the diode laser with wavelength of (790-805) nm in promotion and enhancement of wound healing of episiotomy.

Women, materials and methods: thirty women (22 of them were primipara) with episiotomy wound were selected and divided into three groups, 1st group (group No.1: control group) given antibiotics without laser therapy, in the 2nd group (group No.2) the wound exposed to laser therapy (4 sessions, each session with energy density 8 joule /cm² every other day) and antibiotics for 1 week, and in the 3rd group (group No.3) the wounds were exposed to laser therapy (4 sessions, the same as in the 2nd group) but without antibiotics.

Results: Those patients who exposed to LLLT showed significant reduction in the level of pain and tenderness after the 1st laser exposure, and rapid healing process that occur within seven (7) days, and the results were about to be equal in both (group II & group III), while group I showed prolonged period of healing (9-11) days with moderate to severe pain and tenderness that interfered with their sitting and walking and one case ended with dehiscent wound.

Conclusions: LLLT can be used to enhance surgical wound healing, & to induce analgesic effects if proper wavelength, energy density and exposure time are selected.

تقييم أشعة الليزر ذات القدرة الواطئة باستخدام ليزر الدايدود في تحفيز التئام جرح قص العجان

الخلاصة

أجريت هذه الدراسة لمعرفة تأثير أشعة الليزر ذات القدرة الواطئة باستخدام ليزر الدايدود (٧٩٠-٨٠٥) نانومتر وبكثافة طاقة حوالي [٨ جول/سم^٢] في تحفيز التئام وتسريع شفاء الجروح الجراحية (جرح قص العجان).

تم اختيار ثلاثين امرأة لديهن جرح قص العجان الذي تم خياطته بعد الولادة مباشرة وجميعهن يعانين من آلام بالإضافة إلى علامات التهاب في موضع الجرح.

تم تقسيم النساء إلى ثلاثة مجاميع:

لمجموعة الأولى و هي المجموعة القياسية تم علاجهن بواسطة المضادات الحيوية فقط دون إخضاعهن إلى أشعة الليزر ولمدة أسبوع واحد، والمجموعة الثانية تم علاجهن بواسطة المضادات الحيوية مع أشعة الليزر الواطئة القدرة وعلى شكل أربعة جرعات علاجية الواحدة بعد الأخرى (كل يومين جرعة علاجية بكثافة طاقة ٨ جول لكل سنتيمتر مربع ولمدة ١٠ ثوان للمنطقة الواحدة)، أما المجموعة الثالثة فتم علاجهن مثل المجموعة الثانية بأشعة الليزر ولكن بدون إعطائهن المضادات الحيوية ولقد كانت النتائج كالتالي:

في المجموعة الثانية و الثالثة لاحظنا إن النتائج كانت جيدة جدا حيث كان التئام الجروح سريع جدا مقارنة بالمجموعة الأولى و ظهر ذلك بعد جرعة الليزر الأولى مباشرة مع قلة في حدة الألم ولم يكن هناك آثار لالتهابات بكتيرية في الجروح حتى بدون استخدام المضادات الحيوية.

الاستنتاج: من هذه الدراسة يمكن القول بأن أشعة الليزر ذات القدرة الواطئة يمكن أن تستخدم في تحفيز وتسريع شفاء الجروح الجراحية بالإضافة إلى كونها عامل جيد في تخفيف الإحساس بالألم في موضع الجرح.

Introduction

Photobiostimulation:

PMester and his group embarked on a series of animal, in an extension of early experiments on mice in 1968, all studies showed a photobiostimulation effect on the rate of tissue repair in various experimentally induced wounds as a result of low power He-Ne laser irradiation, and as a result of successful, clinical trials on small numbers of patients suffering from chronic unhealed wounds and sores of various etiologies which had previously been found to be unresponsive to other treatments.[1]

The main uses of photobiostimulation in medicine are wound healing, Soft tissue injuries, like muscle tears, haematoma and tendinopathies, pain relief, arthritic conditions of various aetiologies like small joint of the hands or feet.

Due to its pain relieving and wound-healing properties, LLLT has many uses, such as for treatment of pressure sores in bed-ridden patients, and for enhanced post-operative wound healing and pain relief. The effect of LLLT is such that; it can accelerate remodeling of scar tissues and "give a more cosmetically acceptable result" to postoperative scarring [2].

There are number of potential clinical uses of LLLT such as those in medical, dental, pediatric, osteopathic, and cosmetic applications.

Trelles et al (1987) reviewed the use of local irradiation with LLLT to elicit the following types of effects [3]:

1. Biostimulatory effects in ulcers, granulomas, burns, septic wounds, and trauma to superficial tissues.
2. Stimulation of local cell metabolism in damaged tissues in vivo and in vitro.
3. Stimulates activity of local tissue enzymes.

4. Enhanced scar formation, and tissue regeneration, mitogenic activity and osteogenic activity.

Other therapeutic effects of LLLT are; analgesic, antiexudative, antihemorrhagic, antineuralgic, antiedematous, antiseptic, anti-inflammatory, antispasmodic and vasodilator.

Possible mechanisms of Biostimulation: are

- 1.) Stimulation of the respiratory chain components.

- 2.) Effect on Ca^{+2} and c-AMP

- 3.) Photophysical effects

Irradiation of cells at certain dose parameters, can activate some of the native components, in this way specific biochemical reactions as well as whole cellular metabolism can be altered. Photobiological reactions involve the absorption of a specific wavelength of light by; the photoreceptors (chromophores) and photosensitizer molecules; which can lead to a measurable biological effect in certain circumstances, these molecules must be a part of a key structure that can regulate a metabolic pathway. When irradiation of mitochondria induces changes in cellular homeostasis, it entails a cascade of reactions and proposes a number of changes in the components of the respiratory chain (e.g. cytochromes, cytochrome oxides, and flavine dehydrogenase), which are primary photoreceptors or chromophores, and thus able to absorb light at appropriate wavelengths. This causes short-term activation of the respiratory chain; leading to changes in redox status of both mitochondria and cytoplasm and turn the activation of the electron transport chain results in enhanced synthesis of ATP. Furthermore, laser irradiation also affects hydrogen ion levels in the cells, this coupled with an increase in ATP causing activation of other membrane ion carriers such as Na^{+} - K^{+} carriers

and alters the flow of Ca^{+2} ion between mitochondria and cytoplasm.

The variation of such parameters is a necessary component in the control of proliferative activity of the cells [4]. LLLT have been reported to modulate various biologic processes such as; mitochondrial respiration and ATP synthesis, accelerate wound healing and promote muscle regeneration, in addition to pain attenuation or removal when using this therapy.

Women Material and Method

This study was done in the private clinic between July 2006 and February 2007, using diode laser (790-805)nm in an effort for enhancement of healing of episiotomy wound by means of biostimulation. Thirty six female patients with episiotomy were treated in this study, six of them discontinued the treatment sessions and therefore discounted from the study and only 30 women completed the full course of the treatment. 22 of them were primipara and 8 were multipara, all of them were experiencing the symptoms

of episiotomy that are taken in this study as part of the evaluation criteria.

The evaluation criteria are:

1. Pain which was severe and interfere with walking and sitting.
2. Tenderness.
3. Clinical evidence of inflammation like: exudation, edema and erythema of the wound.

The thirty women were divided into three groups table (1):

The 1st group:

Was the control group (10 women) they were given systemic antibiotics only without laser exposure.

The 2nd group:

(10 women) the patients were given laser therapy with systemic antibiotic.

The 3rd group:

(10 women) the patients were given laser therapy without antibiotics.

The antibiotics that were used are keflin capsule 250 mg four times daily together with metronidazole 500 mg twice daily for one week, with instruction of the women about the local hygiene.

Table 1 patient's groups and their types of treatment:

Group no.	Antibiotics	Laser
1 (10 women)	+ve	-ve
2 (10 women)	+ve	+ve
3 (10 women)	-ve	+ve

Table 2 The severity of symptoms and signs before treatment:

Group no.	Pain	Tenderness	Oedema	Redness	Exudates
1	Severe	Severe	Moderate	Slight	+ve
2	Severe	Severe	Moderate	Slight	+ve
3	Severe	Severe	Moderate	Slight	+ve

Laser system specifications:

Laser system class: -----IV

IR laser: -----semiconductor diodes Ga Al As CW

Laser parameters that were used in this study:

Diode laser wavelength ----- (790-805) nm

Power ----- 1 W

Spot size ----- 8mm

Energy density----- 8 J/cm²

Time of exposure ----- (10) second for each spot

**Figure 1** diode laser [K-laser 4]

Patient was put in lithotomy position, exposing the introitus in order to inspect and apply the laser treatment. Before that a piece of sterile cotton was pushed in the vagina to prevent the contamination of the working field by vaginal discharge or blood. The length of the skin part of the episiotomy was ranging between (3 to 4) centimeters, the wound was exposed to laser irradiation, one spot after another using spot size of 0,8 cm.

Each patient received 4 sessions of LLLT, one session every other day, starting from the 1st day after labor, & the patients were followed for 12 days.

Follow up criteria were:

1. Pain
2. Tenderness.
3. Oedema around the wound.
4. Discharge from the wound.
5. Cardinal signs of healing of the wound.

Safety measures:

Because it is high power laser 1W, it is considered class 4 laser, the laser therapy was given to the women in an isolated room.

After the terminal end of the probe was placed on the treated tissue then the manual switch was pushed to start the treatment. Protective eye wear was also worn by the operator.

Results

The study was depending on comparison between two groups of patients (group 2 and group 3) with the control group which was group one.

The assessment parameters were the degree of pain, degree of tenderness, oedema & swelling, and presence of discharge(exudates)

The 1st group:

Showed that the patient continued to have pain and tenderness even at the 10th day and after that, with the

persistence of oedema and redness for 6-7 days, one of them ended with opened wound (dehiscent) due to infection.

The 2nd group:

The patients experienced obvious improvement of symptoms like pain and tenderness after the 1st session of the treatment.

After the 2nd exposure only mild pain was present, slight oedema, mild tenderness, with little exudates.

After the 3rd session all the signs and symptoms were improved except a very mild tenderness which disappeared completely after the 4th session.

The 3rd group:

The pain and tenderness became moderate after the 1st exposure to

LLLT, mild oedema, exudates persisted. After the 2nd exposure the pain and tenderness were improved more, very slight oedema (except for 1 case in which the oedema was moderate with signs of infection), but with persistent exudates.

After the 3rd session very mild pain was present and still little tenderness, while the patient who had signs of infection became little bit better the oedema was mild, moderate tenderness, little discharge, slight redness.

After the 4th session this patient had very slight oedema, mild tenderness, no exudates, so 5th session was given for her to enhance the healing process while other wounds healed completely.

Table 3 Results of each group 2 days after the 2nd laser exposure (5th day):

Group no.	Pain	Tenderness	Oedema	Redness	Exudates
1 (without LLLT)	Moderate	Moderate	+ve	+ve	+ve
2	mild	mild	Very slight	-ve	Very slight
3	mild	mild	Very slight	mild	+ve

After the 2nd exposure as seen in table (3) there is dramatic reduction in the pain and tenderness in the 2nd and 3rd groups in comparison to the control

group (group 1), the oedema further reduced (diminished inflammatory reaction).

Table 4 Results of each group 2 days after the 3rd exposure (7th day):

Group no.	Pain	Tenderness	Oedema	Redness	Exudates
1 (without LLLT)	Moderate	Moderate	+ve (70%)	+ve (60%)	+ve (60%)
2	-ve	Very mild	Very slight	-ve	-ve (100%)
3	Very mild	Very mild (80%)	Very slight (80%)	-ve	-ve (100%)

On the 7th day the wounds were dry in the (100%) of the 2nd group and (100%) of the 3rd group, with slight tenderness and only very slight oedema (clinically healed wounds). While in the control group (group 1) the wounds still painful and inflamed table (4).

On day 11 the laser treated groups completely healed while the control group still having mild pain, mild tenderness, mild oedema and discharge from the wound in (40%) and one case ended with dehiscent wound.

Discussion

In this study the use of the Ga Al As (diode laser) with wavelength of (790-805) nm as a source of LLLT was based on the following:

The 790-805 nm wavelength emission produces several effects both in the superficial and deep layers of the skin because of the particular characteristic of this wavelength; which is the ability of deep penetration that allow to transfer more than 20% of the applied energy on the skin tissue to the deeper structures to enhance deeper biostimulation effect (enhanced wound healing), in addition to the property of pain relief by rising the perceptive threshold of sensitive nerve endings which result in a lower sensitivity to pain.

This study was designed to see the effect of LLLT on the process of healing of episiotomy wound. The pain and tenderness changed from severe to moderate after the 1st exposure to laser; that the women continued to have the treatment mainly because of analgesic effect, which helped the women to return back to their usual domestic activity as early as possible.

In this study the duration of wound healing was (7) days and this in agreement with the results of Hopkins *et al.* (2004) [5], and Al-Watban F and Zhang X. (1996), [6].

Regarding the energy density, Baxter,(1994) used diode laser in sport injuries and he used it in hospitals for promotion of postoperative wound healing and for pain relief, he found that energy density is the most important factor in the treatment (in determining the tissue reaction) to get the desired effects [7].

In this study the used energy density was (8 J/cm²) and this is in agreement with the results of Hopkins *et al.* (2004) [5], while in (1983) Mashiko used 830 nm laser, using energy density (2 J/cm²) every two days to treat skin wounds in guinea pig, it showed increased rate of healing [8].

Laakso *et al* in (1994) said that (5 J/cm²) is the upper limit of therapeutic window [9]. The great disparity in the results of these studies may be explained by the fact that most of these studies were done either in animal design or invitro design which are quite different from the invivo human body.

The most acceptable explanation of the beneficial effect of LLLT in the acceleration of wound healing is the effect of laser on mitochondria and on the reactions of the components of the respiratory chain (e.g. cytochrome oxidase, flavine dehydrogenase) which absorb the laser light at appropriate wavelengths, and the activated electron transport chain result in enhanced synthesis of ATP.

Lasers also affect the level of hydrogen ions in the cell, which act with the elevated ATP as activator of other membrane ion carriers like sodium and potassium and alter the flow of calcium ion between mitochondria and cytoplasm.

The changes in the ion concentration will further affect cell metabolism and development by influencing the cyclic nucleotide level which is involved in the events leading to initiation of DNA

synthesis; which could lead to cellular activation and the formation of granulation tissue [10- 12].

Further more in vitro studies have shown an increase in fibroblast proliferation after laser irradiation Boulton *et al* (1986) suggested that LLLT therapy may facilitate fibroplasia and therefore facilitate the repair phase of healing, in which the strength of the granulation tissue would be affected [13]

Facilitated wound contraction by LLLT; may also be supported by work from Pourreau-Schneider *et al* (1990) and Spector *et al* (1999), who reported that laser irradiation transforms fibroblasts into myofibroblasts [14,15] respectively. Myofibroblasts which are directly involved in granulation tissue contraction; and when increased in number could lead to facilitated wound contraction (reducing the size during the repair phase of soft tissue healing).

In this study it can be seen that the signs and symptoms of inflammatory reaction were reduced dramatically after the 1st exposure to the LLLT which prove that the laser irradiation can cause diminished inflammatory reaction and this in agreement with Inoue *et al* (1989) [16] and Mester *et al* (1989) who suggested that laser therapy might affect the immune component cells by suppressing some undesirable immunoreactions and so contribute to the stimulation of wound healing [17].

The clinical trials with humans [18, 19, 20] and further work with animals that supported the use of LLLT to facilitate wound healing [21, 22] are so many, but the matter is complicated by the fact that light absorption may be specific to cell and tissue type, reducing the ability to generalize the results of animal data to human wounds [7].

Regarding the pain relief, it can be explained by the effect of LLLT on the

level of serotonin and acetylcholine which play an important role in the analgesic effect [23, 24]. Walker (1983) who mentioned that the level of 5-hydroxy indoleacetic acid (5-HIAA) which is a metabolite of serotonin (5-HT) excreted in high level in those patients experiencing pain relief as a result of laser treatment [23].

Conclusion and Recommendation

1- LLLT can be used to enhance surgical wound healing, and to induce analgesic effect if proper wavelength, energy density and exposure time were selected.

2- It is better to work with larger number of women to get accurate statistical data.

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