



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

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Abstract: we studied the effect of low level laser therapy (LLLT) using diode laser with wavelength of (790-805) nm in promotion and enhancement of wound healing of episiotomy and to evaluate the analgesic effect of LLLT in reducing the pain sensation caused by the episiotomy wounds. Nineteen women 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 wounds were exposed to laser therapy (4 sessions, each session with energy density of 19.90 J /cm² every other day) and systemic antibiotics were prescribed for 1 week. 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. Those women who exposed to laser therapy showed significant reduction in the level of pain and tenderness after the 1st laser exposure. Rapid healing process occurred within seven days. The results were about to be equal in both (group 2 and group 3), while group 1 showed prolonged period of healing (9-11) days with moderate to severe pain and tenderness that interfered with their sitting and walking. One case ended with dehiscent wound. In conclusion LLLT can be used to enhance episiotomy wound healing, and to induce analgesic effect if proper wavelength, energy density and exposure time were selected.

Introduction

Biostimulation is also called low level laser therapy (LLLT) or low intensity laser therapy (LILT) which is believed to occur at very low irradiance. The roots of LLLT are both wide and deep. LLLT (photobiomodulation) can have both *stimulative* and *inhibitory* effect within the irradiated tissues, each of which can be used in a number of therapeutic applications. The earliest experimental application of LLLT in medicine was first reported in 1968 by Endre Mester in Hungary who described the use of ruby and argon lasers in the promotion of healing of chronic ulcers. LLLT is undoubtedly successful in treating trophic ulcers and indolent wounds of diverse etiology, when traditional drug treatment is of low efficiency (Ohshiro, and Shirono, 1992).

Due to its pain relieving and wound-healing properties, LLLT has many uses in hospitals and private clinics, such as for the 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 (Clark, 1985).

Trelles et al (1987) reviewed the use of local irradiation with LLLT to elicit the following types of effects (Trelles, et al., 1991):

- 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. Enhanced scar formation, and tissue

regeneration, mitogenic activity and osteogenic activity. Other therapeutic effects of LLLT are: Analgesic, antiexudative, antihemorrhagic, antineuralgic, antioedematous, antiseptic, anti-inflammatory, antispasmodic and vasodilator. The Possible mechanisms of Biostimulation can be one of the following: stimulation of the respiratory chain components, effect on Ca^{+2} and c-AMP and photophysical effects

Irradiation of cells at certain laser 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) that are primary photoreceptors or chromophores, and thus are 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 (Fitz-Ritson, 2001).

The variation of such parameters is a necessary component in the control of proliferative activity of the cells. 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 (Fitz-Ritson, 2001).

Women, Materials and Method

This study was done in a private clinic, in the period (July 2006- October 2006), using (790-805) nm diode laser, Figure 1, in an effort for the enhancement of healing of episiotomy wound by means of biostimulation. Nineteen women with episiotomy were treated in this study. 15 of them were primipara and 4 were multipara; all of them were experiencing the symptoms of episiotomy that are taken in this study as part of the evaluation criteria. Evaluation criteria were:

Pain which was severe and interfere with walking and sitting. Tenderness. Clinical evidence of inflammation like: exudation, oedema and redness of the wound. Table 1.

Table 1: Severity of symptoms and signs associated with episiotomy.

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

Table 2: Woman's groups and types of treatment:

Group no.	Antibiotics	Laser
1(7 patients)	+ve	-ve
2(6 patients)	+ve	+ve
3(6 patients)	-ve	+ve

The nineteen women were divided into three groups as listed in Table 2:

Group No.1:

Control group (7 women) they were given systemic antibiotics only without laser exposure.

Group No.2:

(six women) were given laser therapy, with systemic antibiotic.

Group No.3:

(six women) were given laser therapy without antibiotics. The antibiotics that were used are amoxicillin capsule 500 mg three times daily together with metronidazole 500 mg twice daily for one week.



Fig: (1) Diode laser [K-laser 4]

Laser dose parameters for the diode laser used in this study were with a wavelength of (790-805) nm, output power of 1 W, spot size of 0.4mm, energy density of 19.9 J/cm² and, time of exposure of 10s for each spot.

Procedure

The woman was put in lithotomy position, exposing the interoitus in order to inspect and apply the laser treatment. Before that a piece of sterile cotton was pushed into 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) cm. The wound was exposed to laser irradiation; one spot after another using spot size of 0.8 cm (which was measured on the wound by means of a graduated wooden spatula).

The energy density for each spot of treatment was 19.90J/cm² per session, and the treatment was for 10 seconds per each spot per session. The terminal end of the probe was placed 2 mm away from the skin surface i.e. (indirect mode of application of laser therapy)

Each woman received 4 sessions of LLLT,

one session every other day, starting from the 1st day after labor, and the women were followed for 11 days. The follow up evaluation criteria were, Pain, tenderness, oedema around the wound, discharge from the wound and cardinal signs of healing of the wound.

Results

The study depends on comparison of two groups of women (Group 2 and Group 3) with Group 1 as a control group. The assessment parameters were the degree of pain, degree of tenderness, oedema and swelling, and the presence of discharge (exudates).

Group No.1

The results show that the women continued to have pain and tenderness even in the 10th day and after, with the persistence of oedema and redness for 6-7 days, and one of them ended with opened wound (dehiscent) due to infection.

Group No.2

The women experienced progressive improvement of symptoms like pain and tenderness after the first session of the treatment.

The pain and tenderness changed to moderate after the first laser exposure, the oedema also decreased dramatically, while the exudates persist. After the second exposure only mild pain was present, slight oedema, mild tenderness, with little exudates. After the third session all the signs and symptoms were improved except a very mild tenderness which disappeared completely after the fourth session.

Group No.3

The pain and tenderness became moderate after the first exposure to LLLT, mild oedema, and exudates persisted. After the second exposure the pain and tenderness were improved more, very slight oedema (except for 1 case in which the oedema was moderate), but with persistent exudates.

After the third 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, and slight redness.

After the fourth session this patient had very slight oedema, mild tenderness, no exudates and a fifth session was given for her to enhance the healing process while other wounds healed completely.

After the second exposure to laser, Table 3, there is dramatic reduction in the pain and tenderness in the Group 2 and Group 3 in

comparison to the control group (Group 1); the oedema further is reduced (diminished inflammatory-reaction).

Table (3) Results of each group, 2 days after the second laser exposure (fifth day):

Group No.	Pain	Tenderness	Oedema	Redness	Exudates
1	moderate	moderate	+ve	+ve	+ve
2	mild	mild	very slight	-ve	very slight
3	mild	mild	very slight	mild	+ve

On the 7th day the wounds were dry in the (100%) of the Group (2), and (83%) of the Group (3), 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.

Table (4) Results of each group, two days after the third exposure (seventh day):

Group no.	Pain	Tenderness	Oedema	Redness	Exudate
1	moderate	moderate	+ ve (71%)	+ ve (57%)	+ve (57%)
2	- ve	very mild	very slight	-ve	-ve (0%)
3	very mild	very mild (17%)	very slight (17%)	-ve	-ve (17%)

Discussion and Conclusion

In this study, the use of the GaAlAs (diode laser) with wavelength of (790-805) nm as a source of LLLT was on the following bases: 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 perceptible threshold of sensitive nerve endings which result in a lower sensitivity to pain. This study was designed to investigate the effect of LLLT on the process of healing of episiotomy wound. The pain and tenderness changed from severe to moderate after the first exposure to laser, that 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 equal to seven days and this in agreement with the results of Hopkins (Hopkins, et al., 2004) and Al-Watban and Zhang (Al-Watban and Zhang, 1996).

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 (David, 1994).

In this study the energy density used was (19.9 J/cm²) and this is in agreement with the results of Hopkins (Hopkins, et al., 2004), while in (1983) Mashiko used 830 nm laser, with energy density of (2 J/cm²) every two days to treat skin wounds in guinea pig, it showed increased rate of healing, (Mashinko and Shimamoto, 1983). Zarkovic in (1991) diode laser of 50 watt pulsed power for 210s daily for seven days, applied to opened skin, and he saw

that the rate of healing of that wound was increased (Zarkovic, 1991). Laakso et al in (1994) mentioned that (5 J/cm^2) is the upper limit of therapeutic window (Laakso, et al., 1994). 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 in vivo 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 absorbs 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 (Passarella, 1988), Braveman, et al., (1989), Lutz and Rainer, (1998).

Furthermore, vitro studies show an increase in fibroblast proliferation after laser irradiation Abergel *et al.*(1984) and 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 (Abergel, et al., 1984 and Boulton, and Marshall, 1986) respectively. 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 (Pourreau-Schneider, et al., (1990) and Spector, and Axford, (1999) respectively. Myofibroblasts which are directly involved in granulation tissue contraction and when increased in number could lead to facilitated wound contraction (a myofibroblast is a modified fibroblast with ultrastructural and functional properties of fibroblasts and muscle cells). Cytoplasmic fibrils of actomyosin allow for contraction of myofibroblasts, pulling on the borders of the

wound and 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 first exposure to the LLLT which prove that the laser irradiation can cause diminished inflammatory reaction and this in agreement with Inoue (Inoue, *et al.*, 1989) and Mester (Mester and Mester, 1989) who suggested that laser light therapy might affect the immune component cells by suppressing some undesirable immunoreactions and so contribute to the stimulation of wound healing (Mester and Mester, 1989).

The clinical trials with humans (Chromey, 1992, Gogia *et al.*, 1988) and Schindl, et al., (1997) and further work with animals that supported the use of LLLT to facilitate wound healing (Dyson and Young, 1986) Mester and Jaszgagi-Nagi,(1973) 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 (David, 1994). 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 (Walker, 1983) and Zarkovic, et al., (1989). 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 .

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

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الخلاصة اجريت هذه الدراسة لمعرفة تأثير أشعة الليزر ذات القدرة الواطئة باستخدام ليزر الداويد (790-805) نانومتر وبكثافة طاقة حوالي 19.90 جول/سم² في تحفيز التئام وتسريع شفاء الجروح الجراحية (جرح قص العجان). تم اختيار تسع عشرة امرأة لديهن جرح قص العجان الذي تم خياطته بعد الولادة مباشرة وجميعهن يعانين من آلام بالاضافة الى علامات التهاب في موضع الجرح. تم تقسيم النساء الى ثلاثة مجاميع: المجموعة الاولى و هي المجموعة القياسية تم علاجهن بواسطة المضادات الحيوية فقط ولمدة اسبوع واحد دون اخضاعهن الى اشعة الليزر. والمجموعة الثانية تم علاجهن بواسطة المضادات الحيوية مع اشعة الليزر الواطئة القدرة وعلى شكل اربعة جرعات علاجية الواحدة بعد الاخرى (كل يومين جرعة علاجية: كثافة الطاقة 19.90 جول/ سنتيمتر مربع ولمدة 10 ثوان للمنطقة العلاجية الواحدة). اما المجموعة الثالثة فد تم علاجهن مثل المجموعة الثانية بأشعة الليزر ولكن بدون اعطائهن المضادات الحيوية. وكانت النتائج كالتالي: في المجموعة الثانية و الثالثة لاحظنا ان النتائج كانت جيدة جدا حيث كان التئام الجروح سريع (خلال سبعة أيام) مقارنة بالمجموعة الاولى (9-11) يوم. وقد ظهر تأثير أشعة الليزر بعد الجرعة الاولى مباشرة مع قلة في حدة الالم 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 ان تستخدم في تحفيز وتسريع شفاء الجروح (جرح قص العجان) مع امكانية منع حصول الالتهابات البكتيرية. بالاضافة الى كونها عامل جيد في تخفيف الاحساس بالالم في موضع الجرح.