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Effect of polarized light therapy versus low level laser therapy on oral mucositis in cancer patients receiving chemotherapy

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***Abstract*---**Purpose: to evaluate the efficacy of polarized light therapy versus low level laser therapy on oral mucositis in cancer patients receiving chemotherapy. Methods of evaluation (Measurement of the WHO oral mucositis scale and the Common toxicity criteria scale). Methods: Forty cancer patients receiving chemotherapy (Males and Females) who had oral mucositis, ulceration pain and their ages ranged from 30 to 55 years were divided into two groups. Group (A) composed of 20 patients received the low level laser therapy (LLLT) in addition to the routine medical care of oral mucositis Group (B) composed of 20 patients received Bioptron light therapy (BLT) in addition to the routine medical care of oral mucositis, duration of the BLT or LLLT application was 10 minutes applied daily for 30 days. Results and conclusion: Results showed that application of both the BLT and the LLLT had a valuable healing effect on oral mucositis in cancer patients receiving chemotherapy as evidenced by the highly decreases of the WHO oral mucositis scale and the Common toxicity criteria scale. But low level laser therapy (LLLT) was more beneficial than the Bioptron light therapy (BLT).

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Keywords---Bioptron light therapy, Low level laser therapy, Oral mucositis, WHO oral mucositis scale and Common toxicity criteria scale.

Introduction

Oral mucositis (OM) is still a common and severe acute side-effect of many oncologic treatments, especially in patients treated for head and neck cancer. It may affect quality of life; require supportive care and impact treatment planning and its efficacy. Significant advancements have been made in the management of patients undergoing cancer chemotherapy and radiotherapy. However, many debilitating side effects such as vomiting, nausea, diarrhea, and mucositis remain critical issues that often delay or truncate therapy and impede recovery. Mucositis is a painful condition that significantly impairs chewing and swallowing. Previously referred to as "stomatitis" or "mouth sores," mucositis presents as redness and/or ulcerative sores in the soft tissues of the mouth. Mucositis is seen in patients with reduced white blood cell counts due to cancer chemotherapy and/or therapeutic irradiation, [1,2,5,7,8,10].

Oral mucositis is an important clinical problem because of the pain, the requirement for parenteral nutrition and the risk of mucosal infection and subsequent septicemia. In many patients undergoing myeloablative therapy, it is the recovery of the oral mucosa, rather than hematological function that delays the patient's discharge. New treatments are needed to reduce the duration and severity of mucositis, but these can only be developed once the natural history of mucositis has been described. Here, we report the clinical progress and multivariate analysis of the causes of oral mucositis in patients undergoing myeloablative therapy in a dedicated bone marrow transplantation unit, [11,13,14,15,16].

Neck cancer has a much greater incidence in certain parts of the world. Neck and head cancer are treated by chemotherapy or radiotherapy or both. But surgical treatment of neck cancer consisted of neck dissection which is defined as removal of lymph nodes of the neck. Recent data suggest that cancer and its treatment are associated with immune deficiency and that blood immune function is positively associated with progression. It has recently been demonstrated that major surgery reduces immune cells function and also cancer chemotherapy or radiotherapy causes oral mucositis and a decrease in leukocytes which are immune cells and an important part of the immune response to a foreign substance (antigen), [3,120,22,23,25].

Polarized light from low power lasers and non-laser devices has been used as a non-invasive therapy in the treatment of various musculoskeletal disorders, acceleration of wound healing and treatment of skin ulcers. Although the polarized light is known to have numerous photo-biostimulatory effects including cell proliferation, enhanced collagen synthesis, changes to the circulatory system and anti-inflammatory actions, the precise mechanism of its action still remains unclear. The available non-laser optical devices are the Bioptron products which emit a wide beam of polarized, non-coherent, polychromatic, low energy light that

contain wavelengths from the visible spectrum (480-700nm) and infrared radiation (700-3400nm); this range provides optimal penetration and stimulation of the tissues without the risk of DNA damage, ,[28, 29,32,33,34].

Bioptron light therapy (BLT) device emits light that is polarized, polychromatic, non-coherent and of low energy. The light emitted has a wide range of wavelengths (480-3400nm) and differs from laser light, which is mono-chromatic (of narrow wavelength), coherent, polarized and of high or low energy. Possible risk of burns is present with the laser therapy, while not possible with the Bioptron light therapy. User skills are essential in laser therapy, but not essential with the Bioptron light therapy. Higher costs are present with the laser therapy, but not with the Bioptron light therapy, in addition, treatment of large area is available with the Bioptron light therapy, ,[35,37,39].

Bioptron light therapy system emits light characterized by polarization, polychromacy, incoherency and low-energy; polarized light, its waves move (oscillate) on parallel planes. Linear polarization by reflection (the multi-layer mirror system, Brewster mirror), is very efficient and attains a polarization degree of 95%. Bioptron light therapy system encompasses the wavelength range from 480 nm to 3400 nm, this spectrum contains the visible light range and a proportion of infrared radiation (the electromagnetic spectrum of Bioptron light does not contain ultraviolet radiation). Bioptron light is incoherent or "out-of-phase" light, or in other words, the light waves are not synchronized, [18,19,21,24,30,31].

Laser is an acronym for light amplification by stimulated emission of radiation; it is a form of phototherapy which involves the application of monochromatic light over biological tissue to elicit a biomodulative effect within that tissue. Research into the role of low level laser therapy LLLT began in the late 1960s in Eastern Europe. The earliest experimental application of low power laser in medicine was reported in 1968 by Endre& Mester in Hungary who revealed that a ruby laser treatment accelerated healing of mechanical wounds and burns. Since the 60s the volume of research into LLLT has grown and has focused to assess the value of LLLT in wound repair. Low level laser light is different from natural light in that it is one precise color, it is coherent (it travel in a straight line), monochromatic (a single wavelength) and polarized (it concentrates its beam in a defined location. The Ga-As laser is pulsed wave with an average power output of 3mw and penetration depth of 10 cm as a result of its wave length which equal 904n. this laser have been most commonly used in lower doses for wound healing as they have deeper tissue penetration than the He-Ne laser. These lasers have the disadvantage that their light is invisible and therefore eye protection is required, [30, 36,38].

Material and Methods

Subjects

This study was carried out on forty cancer patients receiving chemotherapy (Males and Females) who had oral mucositis, ulceration and pain, their ages were ranged from 30 to 55 years, they were free from any immuno-deficiency disorders or disease that can affect healing process and influence the results and they were

selected randomly from patients of the National cancer Institute, Cairo university. Patients were randomly divided into 2 equal groups in number: **Group A: (BLT group):** This group was composed of 20 patients and represent the group who received the BLT in addition to the routine medical care of oral mucositis, ulceration and pain in neck cancer patients receiving chemotherapy. **Group B: (LLLT group):** This group was composed of 20 patients and represent the control group who received LLT and the routine medical care of oral mucositis, ulceration and pain in neck cancer patients receiving chemotherapy. Measurements were conducted before starting the treatment as a first record and at the end of the treatment as a second (final) record.

Instrumentation:

In this study the measuring equipment were, WHO oral mucositis scale (OMS) and the Common toxicity criteria scale (CTCS), [4,12,13,15,30].

Procedures
Evaluation:
Measurement procedures:

A- **WHO oral mucositis scale (OMS):** where grade 0 means none, grade 1 (mild grade) means soreness+/- erythema with no ulceration, grade 2 (moderate grade) means erythema and ulcers but patient can swallow solid diet, grade 3 (severe grade) means ulcers and extensive erythema but patient cannot swallow solid diet only liquid diet is possible and grade 4 (life-threatening grade) means mucositis to the extent that alimentation is not possible,[30, 38].

B- **Common toxicity criteria scale (CTCS):** where grade 0 means none, grade 1(mild grade) means painless ulcers, erythema or mild soreness in the absence of lesions, grade 2 (moderate grade) means painful erythema or ulcers but eating or swallowing possible, grade 3 (severe grade) means painful erythema, oedema or ulcers requiring intravenous hydration, grade 4 (life-threatening grade) means severe ulcerations or requiring parenteral or enteral nutritional support or prophylactic intubation and grade 5 (death) means death related to the toxicity, These tools of measurement will be used before treatment (First record) and after one month of treatment (second record) to measure improvement in the oral mucositis [30,35,38].

1- Treatment procedures for the BLT and LLLT: In this study the treatment protocol was presented under the following: Patients were given information about the measurement and treatment procedures as well as about the BLT and LLLT devices before the beginning of the treatment. Patients were asked to follow the oncologist and physical therapist instructions. Patient was asked to avoid predisposing factors as UV rays, crowding and unlearning places, hot and humid environment as well as smoking. Measurement procedures were applied for each patient as they were mentioned in the measurement section. Before therapy all patients were given their written informed consent form for the BLT and LLLT. Before the beginning of the treatment check the devices to be sure that, they were switched off. Place the patient in suitable comfortable position. The treated area was cleaned at first by saline rinse and betadine. BLT or LLLT devices preparation: the plug of the BLT and LLLT units was inserted into the main

current supply; the on/off switch was switched on. Then set the treatment parameters of BLT or LLLT. Application: point the light beam of BLT or LLLT at the area to be treated, holding the device at right angle (90°) perpendicular to the surface of the treated area and maintaining a distance of 10 cm for the BLT from the surface of it (oral mucositis lesion) and applying the BLT for about 10 minutes. Frequency of application: applied daily for 30 days. While distance of 5 mm for the LLLT from the surface of it (oral mucositis lesion), [5,8,11,16,20,21,30,38].

Data analysis

WHO oral mucositis scale (OMS) and the Common toxicity criteria scale (CTCS), were measured pre-treatment as a first record and after one month intervention as a second final record in both groups. Collected data were fed into computer for the statistical analysis; descriptive statistics as mean, standard deviation, minimum and maximum were calculated for each group. The t-test was done to compare the mean difference of the two groups before and after application and within each group. Alpha point of 0.05 was used as a level of significance,[17,26,27].

Results

As shown in table (1) and figure (1), the mean value of the of the WHO oral mucositis scale (OMS) in grades before treatment was (2.900 ± 0.153) in the LLLT group, while after treatment was (0.800 ± 0.250) grades. These results revealed a highly significant decrease (P < 0.0001). While in the BLT group, the mean value of the WHO oral mucositis scale (OMS) in grades before treatment was (2.850 ± 0.305) meters, while after treatment was (1.300 ± 0.0919) grades. These results revealed also a highly significant decrease in the WHO oral mucositis scale (OMS) in grades (P < 0.0001).

Table (1): Comparison of the mean values of the of the WHO oral mucositis scale (OMS) in grades before and after treatment in the two groups

	Before treatment		**After treatment**		**Mean difference**	**T-value**	**P.value**	**Level of significance**
	Mean	**SD**	**Mean**	**SD**				
LLLT Group	2.900	0.153	0.800	0.250	2.10000	32.04	0.0001	**Highly significant decrease**
BLT Group	2.850	0.305	1.300	0.0919	1.55000	21.76	0.0001	**Highly significant increase**

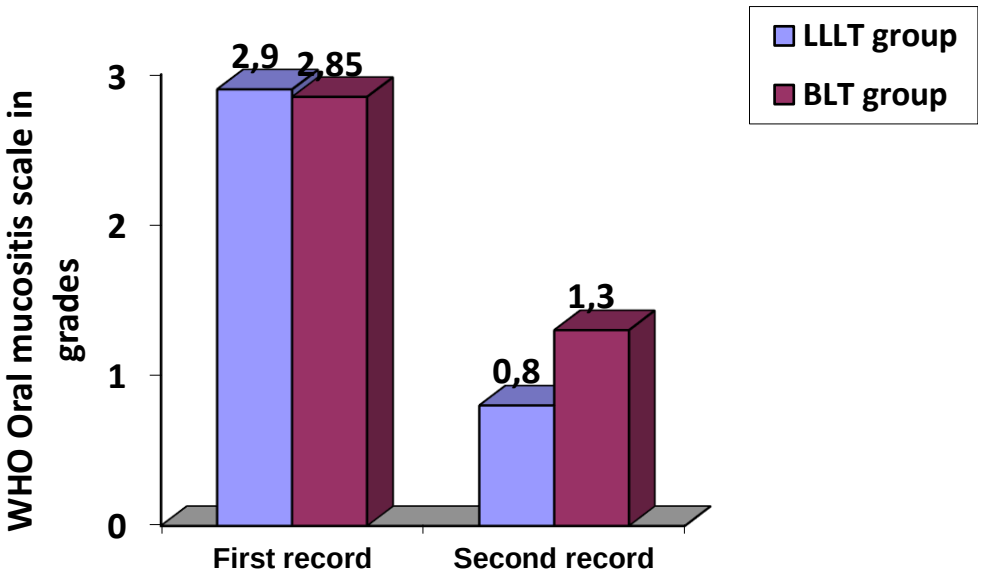

Fig (1): Mean values of the of the WHO oral mucositis scale (OMS) in grades before and after treatment in the two groups.

As shown in table (2) and figure (2), the mean value of the Common toxicity criteria scale (CTCS) in grades sit before treatment was (3.700 ± 0.404) in the LLLT group, while after treatment was (1.350 ± 0.481) grades. These results revealed a highly significant decrease, (P > 0.0001), while in the BLT group, the mean value of the Common toxicity criteria scale (CTCS) in grades before treatment was (3.650 ± 0.352) grades, but after treatment was (1.650 ± 0.414) grades, these results also revealed a highly significant reduction in the Common toxicity criteria scale (CTCS) in grades (P < 0.0001).

Table (2): Comparison of the mean values of the Common toxicity criteria scale (CTCS) in grades before and after treatment in the two groups

	Before treatment		**After treatment**		**Mean difference**	**T-value**	**P.value**	**Level of significance**
	Mean	**SD**	**Mean**	**SD**				
LLLT Group	3.700	0.404	1.350	0.481	2.35000	16.73	0.0001	Non-significant differences
BLT Group	3.650	0.352	1.650	0.414	2.0000	16.46	0.0001	Highly significant decrease

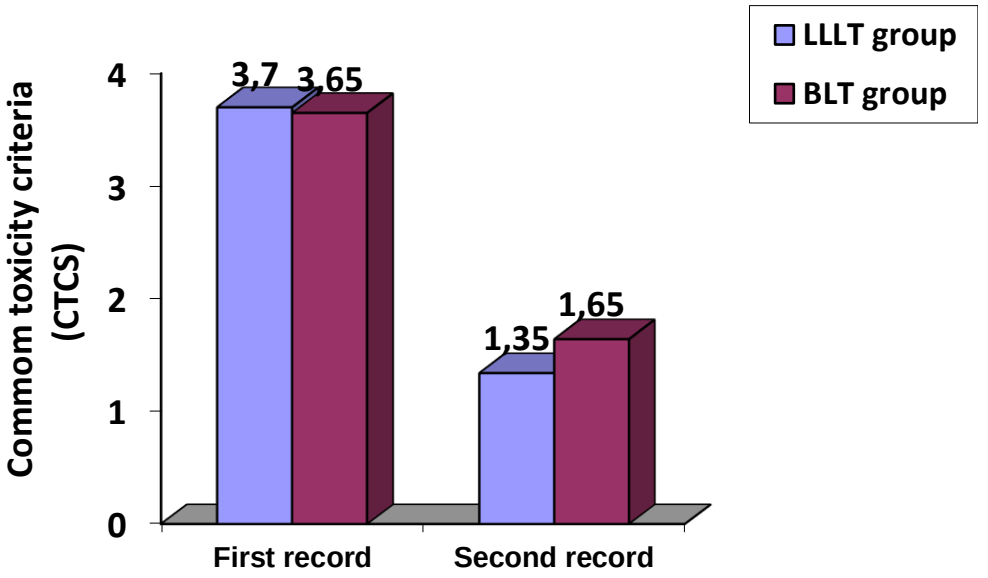

Fig (2): Mean values of the Common toxicity criteria scale (CTCS) in grades of the 2 records in both groups

Discussion

Simic et al., 2001 mentioned that bioptron light therapy system provides new insight into the management of leg ulcers, diabetic foot ulcers, burns, pressure ulcers and wounds following operation and injury. Patients are now able to receive innovative wound-care management. Bioptron light therapy could offer significant support in conjunction with standard wound-care. The success of light therapy on pain and functions may be due to a number of mechanisms, one of which may be through its positive effect on chondrocyte proliferation and matrix's synthesis. Also, significant stimulatory effect on fibroblast action and enhanced connective tissue repair were noted. These effects seem to be related to the biostimulative effect of light therapy at the cellular level. Normalization of microcirculation and speed of nerve transmission achieved have been reported to interrupt the vicious circle of origin and development of pain, [5,7,8,10].

Hemodialysis often involves fluid removal Clinical studies by Medenica and Lens, 2003 had demonstrated the effectiveness of polarized light therapy in healing of the 1st, 2nd, and 3rd grade pressure ulcers (decubitus). When polarized light treatment was added to the conventional ulcer therapy, rapid changes in appearance and size with complete healing in half of the cases and accelerated partial healing in the remaining cases appeared within 1-2 weeks. Bioptron light therapy has been used to treat the diabetic foot ulcers and clinical results have confirmed its positive influence on the affected and treated area. The ulcers gradually cleared, granulated and epithelialized during treatment. Healing time was substantially shortened and ulcer pain was lower compared to treatment

without Bioptron irradiation. Also, Bioptron light therapy is a very simple effective additional therapy in the treatment of surgical wounds, [7, 11, 15,18, 34].

Bolton and Young, 2008 mentioned that Pain is unpleasant sensation associated with actual or potential tissue injury. Pain occurring after tissue injury has a protective role, alerting the body and inducing rest to allow tissue regeneration. In chronic persistent pain this physiological function may be compromised. The pathophysiology of pain involves alteration pain-transmission pathways. Thus, knowledge of the normal physiology of these pathways is an essential prerequisite for understanding the mechanisms of acute and chronic pain, [8,11, 15,20,21, 22].

Thanks to the ability of Bioptron light therapy to penetrate into live tissue, this unit is suitable for the treatment of various conditions. It has been reported that significant pain reduction in chronic painful conditions (rheumatoid arthritis, shoulder and neck pain) could be achieved. In all these instances light therapy could help relieve pain and improve functionality. Very good results could be achieved in combination with classical treatment methods. Its beneficial influence could affect the patient's general condition, bringing relief from pain syndromes, [1, 7,9,13, 22].

Laser phototherapy uses radiation both in the visible (400 - 700 nm) and in the near-infrared (700 - 1000 nm) regions of the spectrum. When a photon is absorbed by a molecule, the electrons of that molecule are raised to a higher energy state. This excited molecule must lose its extra energy, and it can do this either by re-emitting a photon of longer wavelength (i.e., lower energy than the absorbed photon) as fluorescence or phosphorescence, or it can lose energy by giving off heat, or it can lose energy by undergoing photochemistry. Photobiological responses are the result of photochemical and/or photophysical changes produced by the absorption of non-ionizing radiation, [9,30, 38].

The findings of the present study showed that there was a highly significant decrease between the means of the second record OMS (2) and the first record OMS (1) ($P < 0.0001$). Findings of the present study showed that there was a highly significant decrease between the means of the second record OMS (2) and the first record OMS (1) ($P < 0.0001$). Findings of the present study showed that there was a highly significant decrease between the means of the second record CTCS (2) and the first record OMS (1) ($P < 0.0001$). The results of this study indicated that there was a highly significant decrease between the means of the second record CTCS (2) and the first record CTCS (1) ($P< 0.0001$).

Significant differences showed in the LLLT and BLT groups were consistent with those observed and recorded by Antonio et al., 2007; Asada et al., 2007; Ballyzek et al., 2005; Baxter et al., 2007; Bjordal et al., 2003; Bolton et al., 2007; Bolton and Young, 2008; Braams et al., 2006; Braun et al., 2009 2004; Carnel et al., 2010; Driver and Franklin, 2006; Eiffel, 2008; Epstein and Schubert, 2010; Gama,2008; Herbert et al., 2008; Hoeksema et al., 2002; Kiyoizumi, 2006; Lazarus et al., 2010; McGuire et al., 2011; Rocke et al., 2011; Shenep et al., 2010; Sonis et al., 2012 and Zerbe et al., 2012 .

Results of this study support the expectation that application of the low level laser therapy (LLLT) and Bioptron light therapy (BLT) on oral mucositis in cancer patients receiving chemotherapy had a valuable healing effects as manifested by the highly significant decreases in OMS and CTCS. But low level laser therapy (LLLT) was more beneficial than the Bioptron light therapy (BLT).

Conclusion

Application of the low level laser therapy (LLLT) and Bioptron light therapy (BLT) on oral mucositis in cancer patients receiving chemotherapy had a valuable healing effects as manifested by the highly significant decreases in OMS and CTCS. But low level laser therapy (LLLT) was more beneficial than the Bioptron light therapy (BLT).

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