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Low Level Laser Versus Polarized Light Therapy on Oral Mucositis in Cancer Patients Receiving Chemotherapy

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Abstract:Purpose: to evaluate the efficacy of low level laser versus polarized light 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:-** thirty 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 15 patients received the low level laser in addition to the routine medical care of oral mucositis. Group (B) received the Bioptron light therapy (BLT)in addition to the routine medical care of oral mucositis, duration of laser or BLT application was 10 minutes applied daily for 30 days. **Results and conclusion:-** Results showed that application of both low level laser and BLT had a valuable healing effects on oral mucositis in cancer patients receiving chemotherapy. But low level laser was more effective and beneficial than BLT as evidenced by the highly significant decreases of the WHO oral mucositis scale and the common toxicity criteria scale.
Key words: Low level laser, Bioptron light 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, [1,2,3,4,5,6.]

The symptoms of this condition were first described in detail by Allen and Hines in 1940. It is characterized by orthostatic edema, tenderness, and increased risk of hematoma development. This disproportionate increase in leg circumference in relation to a slender torso cannot be reversed by physical exercise or diet. The course of the disease is progressive. In the past ten years liposuction has become an establish method for treating lipoedema, [7,8,9, 10.11,12.]

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, [5,8,12,13.]

Many randomized controlled trials comparing agents prescribed to treat oral mucositis in people receiving chemotherapy or radiotherapy or both were done. Their outcomes were oral mucositis, time to heal mucositis, oral pain, and duration of pain control, dysphagia, systemic infection, and amount of analgesia, length of hospitalization, cost and quality of life, [4,6, 9,10,11, 12.]

The efficacy of soft laser in the management of iatrogenic oral mucositis has been evaluated during the last two decades. Its effectiveness and level of recommendation got stronger with time. Oral mucositis increased in patients treated with chemotherapy and / or radiotherapy for head and neck cancer. The laser is an outgrowth of a suggestion made by Albert Einstein in 1916 that under the proper circumstances atoms could release excess energy as light—either spontaneously or when stimulated by light. German physicist Rudolf Walther Ladenburg first observed stimulated emission in 1928, although at the time it seemed to have no practical use In 1951 Charles H. Townes, then at Columbia University in New York City, thought of a way to generate stimulated emission at microwave frequencies,[13,14, 15,16.]

At the end of 1953, he demonstrated a working device that focused ammonia molecules in a resonant microwave cavity, where they emitted a pure microwave frequency. Townes named the device a maser, for “microwave amplification by the stimulated emission of radiation.” AleksandrMikhaylovich Prokhorov and NikolayGennadiyevich Basov of the P.N. Lebedev Physical Institute in Moscow independently described the theory of maser operation. For their work all three shared the 1964 Nobel Prize for Physics. An intense burst of maser research followed in the mid-1950s, but masers found only a limited range of applications as low-noise microwave amplifiers and atomic clocks. In 1957 Townes proposed to his brother-in-law and former postdoctoral student at Columbia University, Arthur L. Schawlow (then at Bell Laboratories), that they try to extend maser action to the much shorter wavelengths of infrared or visible light. Townes also had discussions with a graduate student at Columbia University, Gordon Gould, who quickly developed his own laser ideas, [17,18, 19.]

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, [20,21,22, 23.]

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, [24,26,27,28.]

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,[22,23,24,26,29,30.]

Bioptron light therapy system has a low energy density (fluency) of an average of 2.4 J/cm². Bioptron light reaches the area to be treated with a constant, steady intensity; this energy density has biostimulative effects. With Bioptron light therapy, the energy density dosage can be precisely determined. Furthermore, the effect exerted by light is also defined by its power density. As it is measured at the skin's surface, it varies depending both on the intensity of the light's source and its distance from the area to be treated, the specific power density of Bioptron light is approximately 40 mW/cm² at a treatment distance of 10 cm; this is equivalent to an energy density (fluency) of an average of 2.4 J/ cm² per minute. These properties of Bioptron light allow it to penetrate the surface of the skin with minimum heating effect, no damage to skin and no known side-effects, [20,22,24,27,30.]

Material and Methods

Subjects:

This study was carried out on thirty cancer patients receiving chemotherapy (Males and Females) who have 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) composed of 15 patients received the low level laser in addition to the routine medical care of oral mucositis. Group (B) received the Bioptron light therapy (BLT)in addition to the routine medical care of oral mucositis, duration of laser or BLT application was 10 minutes applied daily for 30 days.

Instrumentation:

In this study the measuring equipment werethe WHO oral mucositis scale (OMS) and the Common toxicity criteria scale (CTCS), while the therapeutic equipment wasthe Helium- Neon laser unit (632.8 nm) and the Bioptron Compact III polarized light therapy system (PAG-860 manufactured in Switzerland), [7,12,15,18,22,23,30.]

Procedure

Evaluation:

1-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,[3,7,10,12.]

2-**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 were used before treatment (First record) and after one month of treatment (second record) to measure improvement in the oral mucositis , [2,5,7,9,10.]

1- Treatment procedures of the low level laser:

After placing patient in suitable comfortable sitting position, the treated area was cleaned at first by saline rinse and betadine, the probe of GA-AS laser was stabilized in horizontal alignment opposite to the patient but the beam of laser must be in perpendicular direction to the selected treatment points in a contact mode and each treated point was subjected to 90 seconds laser irradiation for a session of 10 minutes, where the treated points are the following: considered as 1cm²/application point, in a contact mode. Irradiated regions were the selected treatment points are the following: considered as 1cm²/application point: one point in the right jugal mucosa, one point in the left jugal mucosa, one point in the internal mucosa of inferior lip, one point on sublingual caruncles and one point on the tongue (5 points multiplied in 2 minutes for each point = 10 minutes),[13,14,15,17,18, 19,].

2- Treatment procedures of the BLT:

After placing patient in suitable comfortable sitting position, the treated area was cleaned at first by saline rinse and betadine, the plug of the BLT unit was inserted into the main current supply; the on/off switch was switched on and the light beam was pointed 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 from the surface of it (oral mucositis lesion) and applying the BLT for about 10 minutes, daily for 30 days. After the end of the treatment switch the device off, and then cheek the treated area. The selected treatment points were the following: considered as 1cm²/application point: one point in the right jugal mucosa, one point in the left jugal mucosa, one point in the internal mucosa of inferior lip, one point on sublingual caruncles and one point on the tongue (5 points multiplied in 2 minutes for each point = 10 minutes), [20,21,22,23,24, 26, 28, 30.]

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 monthas 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,[25.]

Results

As shown in table (1) and figure (1), the mean value of the OMSbefore laser treatment was (2.700± 0.411)degrees in the first study group, while after treatment was (1.065± 0.446)degrees. These results revealed a highly significant reduction in OMS (P<0.0001). While in the second study group, the mean value of the OMSbefore BLT treatment was (2.698± 0.409)degrees, while after treatment was (2.313.± 0.401)degrees. These results revealed significant decrease in the OMS (P <0.05).

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

	Before treatment		**After Treatment**		**Mean difference**	**T-value**	**P.value**	**Level of significance**
	Mean	**SD**	**Mean**	**SD**				
Laser Group	2.700	0.411	1.065	0.446	1.63500	7.24	0.0001	Highlysignificant decrease
BLT Group	2.698	0.409	2.313	0.401	0.385000	2.60	0.015	Significant decrease

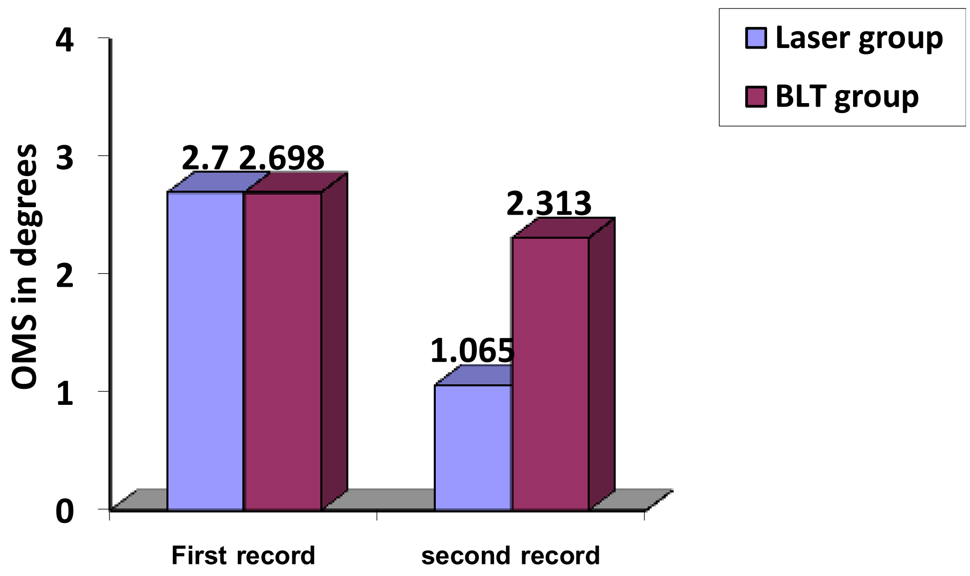

Fig (1): Mean values of the OMS before and after treatment in both groups.

As shown in table (2) and figure (2), the mean value of the Common toxicity criteria scale (CTCS) in degrees before laser treatment was (3.556± 0.122) degrees in the first study group, while after treatment was (1.300 ± 0.155) degrees. These results revealed a highly significant reduction in CTCS (P<0.0001), while in the second study group, the mean value of the CTCS before BLT treatment was (3.552± 0.119) degrees, while after treatment was (3.436± 0.111) degrees, these results revealed significant decrease in the CTCS (P<0.05).

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

	Before treatment		After treatment		Mean difference	T-value	P.value	Level of significance
	Mean	SD	Mean	SD				
Study group	3.556	0.122	1.300	0.155	2.25600	44.30	0.0001	Highly Significant decrease
Control group	3.552	0.119	3.436	0.111	0.116000	2.76	0.010	Significant decrease

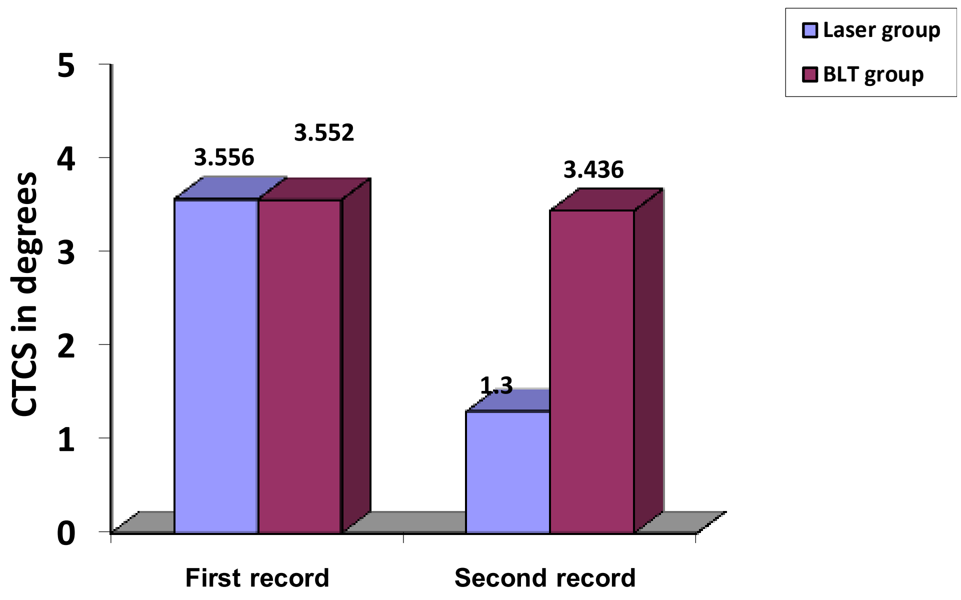

Fig (2): Mean values of CTCS of the 2 records in both groups.

Discussion

Mucositis is a painful and debilitating side effect of radiation therapy (RT) for head and neck cancers and is exacerbated by concomitant chemotherapy. Mucositis lesions, characterized by ulceration and pseudomembranous formations, occur in the oral cavity, oropharynx, and hypopharynx. Oral mucositis is a consistent finding in patients treated for oral cavity and/or oropharynx tumors, but the reported incidence and severity are less among individuals treated for larynx or hypopharynx cancers. However, nonoral mucosal lesions are not easily observed; thus, it is likely that the frequency of mucositis of the hypopharynx is underreported,[4, 6,8,10.]

Lesions develop most commonly on the nonkeratinized mucosa of the floor of the mouth, tongue, cheek, and soft palate and are accompanied by symptoms that range from mild burning to severe; these clinical changes have important systemic implications for myelosuppressed patients who have had bone marrow transplantation, including risk of microbial invasion with serious regional or systemic infections, mastication and deglutition may be intolerable, requiring parenteral nutrition. Current management of such oral mucositis is directed at palliation and infection prevention and treatment, [1,3, 6,9,12.]

Ordinary light is incoherent or out of phase; light waves start at different times and move in all directions. Laser light, however, is coherent because it is the result of stimulated emission. All the waves produced by the laser are lined up or in phase with each other. The crests and troughs of each wave line up exactly and reinforce each other. The new light wave starts out exactly in phase with the photon that stimulated it. Helium-neon laser effects on wound healing typically have been positive for treated cohorts, but many of these studies were not controlled. Conflicting data have been documented in both controlled and anecdotal studies. For example, a controlled study of helium-neon laser effects on aphthous ulcers demonstrated no benefit. In the current trial we investigated the clinical effects of helium-neon laser on prevention and reduction of severity of conditioning-induced oral mucositis for head and neck cancer patients receiving chemotherapy and / or radiotherapy as well as in bone marrow transplantation patients, [13,14, 15.]

Laser light emitted from a laser has fundamental characteristics, which distinguishes it from natural light. Laser produced light is extremely intense, coherent, monochromatic and highly collimated. Wavelengths are typically released in the portion of the electromagnetic spectrum that extends through the ultraviolet, visible, and infrared regions. Laser light contains a high concentration of energy per unit area of the beam. Lasers that emit only a few milliwatts (mW) of power can produce a highly intense beam 1-2 millimeters in diameter that will not diverge over a very long distance. Although lasers produce highly intense light, only a few types of lasers are truly powerful because intensity is defined as power per unit area. By comparison, an ordinary light bulb is more powerful than a typical laser, but the light is not collimated and consequently spreads out. For example, the light irradiance from a 1 mW He-Ne laser can be one billion times greater than that from a 100 W incandescent light bulb.[16,17, 18,19.]

Unlike ordinary light, which is composed of all the colors of the spectrum, laser light is composed of only one color. All the light waves in the beam are composed of the same wavelength. Each laser produces its own characteristic color of light. Some lasers are tunable and can be adjusted to produce several different colors, but they can emit only one color at a time. Laser light is approximately 10 million times more monochromatic than conventional light sources.[14,16, 18,19.]

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 [,20, 21, 22,23.]

Bioptron light therapy 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.[24, 26,27,28,.]

The biostimulative effects of Bioptron light are the result of synergy between different mechanisms of action as; harmonize the metabolic processes, reinforce the human defence system, stimulate regenerative and reparative processes of the entire organism, promote wound healing and relieve pain or decrease its intensity. The scientific mechanisms underlying various light therapy treatments are still under investigation. However, in general scientists have identified various biological effects that can be initiated and achieved as a result of light stimulation. These include; stimulation of neoangiogenesis, improvement of circulation, increasing the process of phagocytosis, stimulation and activation of ATP production, enhancement of important specific enzymes involved in cell regeneration, increasing the activity of lymphatic system, activation of fibroblast activity and increasing the production of collagen, increasing DNA and RNA production and reducing the excitability of nervous tissue as well as increasing the muscle relaxation[, 21,23, 26,29,30.]

The findings of the present study showed non-significant differences in the pre-treatment records of both OMS and CTCS between the mean values of the first and the second studygroups.

Results of the first study group revealed a highly significant decreases in the mean values of OMS and CTCS, after application of the low level laser, when compared against the pre-application results, while results of the second study group revealed a only significant decreases in the mean values of OMS and CTCS, after application of the BLT, when compared against the pre-application results

Significant differences showed in the first and second studygroups were consistent with those observed and recorded by Carnel et al, [1]2010; Young et al., [13]2009; Antonio et al., [14]; Damante et al., [15]; Okamoto et al., [16]; Namer et al., [17]; Novoselova et al.,[18]; Georges et al., [19]; Garrison and Valiant, [20]; Gigot, [21]; Iordanou et al., [22]; Kubasova et al., [23]; Naja et al., ,[24]; Sakurai et al., [26]; Samoilova et al., [27]; Sattayut et al.,[28]; Simic et al., [29]; and Smithy,[30].

Results of this study support the expectation that application of both the low level laser and BLT had a valuable effects on the oral mucositis in cancer patients receiving chemotherapy. But low level laser was more effective and beneficial than BLT as evidenced by the highly significant decreases of the WHO oral mucositis scale and the common toxicity criteria scale.

Conclusion

Applicationof both the low level laser and BLT had a valuable effects on the oral mucositis in cancer patients receiving chemotherapy. But low level laser was more effective and beneficial than BLT as evidenced by the highly significant decreases of the WHO oral mucositis scale and the common toxicity criteria scale.

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