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Efficacy of Polarized Light in the Treatment of Pressure Ulcers

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Abstract
Purpose: *to evaluate the efficacy of the polarized light therapy in accelerating pressure ulcers healing. Methods of evaluation (wound surface area and wound volume).*
Methods:- *Thirty patients (18 males and 12 females) with complete or incomplete spinal cord injury patients and complain from pressure ulcers were randomly divided into two groups. Group (A) received the polarized light therapy 10 minutes twice a day (session every 12 hours) for one month plus the regular wound care. Group (B) (Control group) received only the regular wound care.*
Results:- *Result showed that the polarized light therapy was effective in decreasing ulcer surface area and ulcer volume as well as improving healing of pressure ulcers.*
Conclusion: - *polarized light therapy was effective in accelerating pressure ulcer healing.*
Key words *(Polarized light therapy, Pressure ulcers, wound surface area and wound volume).*

Introduction

Pressure ulcers emerge as a result of direct pressure, causing tissue ischemia, friction, shear force or mechanical stress on the tissue. These factors in combination with numerous intrinsic factors increase risk and if appropriate action is not taken, tissue damage occurs. Although some variables are involved with pressure ulcers cases, it is clear that pressure over bony prominences and shearing force are the key of the etiological factors and main causes of the pressure ulcers problem. Superficial tissue ulceration can be caused by the effect of mechanical forces acting on the localized areas of skin and subcutaneous tissue. Whether the forces are of low intensity over prolonged periods of time or higher loads intermittently applied, the importance of the time factor has been recognized, [1,3,4, 6.]

The significance of the type of loading and its magnitude in the damage of tissue is, however, a matter of disagreement. This due in part to the fact that knowledge of the mechanical and physiological responses of tissue to pressure is limited because of an inability to measure the forces applied to the tissues. Any attempt

to describe the quantitative relationship between stress, strain, time and pertinent physiological factors is the estimable goal of many researchers, but is still a problem which has not been satisfactorily resolved. Currently it is only possible to make qualitative, or at best, quantitative prediction of pressure response. In fact, the ability to measure the conditions existing at the interface is limited, [8,9,11, 12.]

Pressure ulcers are a prevalent and potentially serious medical problem, particularly among population whose skin is more prone to breakdown, as elderly injuries and other co-morbidities as diabetes. Pressure ulcers occur in all age groups from children to young adults, from middle age to elderly. In the sitting dependent, 75% of all patients will experience breakdown, and by far the most common sites for these pressure ulcers are the ischium, coccyx and sacrum. Patients will have a recurrence of the same skin breakdown. Recent reports in plastic surgery journals showed that failure rates for flap surgeries ranged from 76% to 91%. Therefore, pressure ulcers, are a costly and recurring problem, [14,15,16,28.]

Pressure ulcers are areas of injured skin and tissue. They are usually caused by sitting or lying in one position for too long. This puts pressure on certain areas of the body. The pressure can reduce the blood supply to the skin and the tissues under the skin. When a change in position doesn't occur often enough and the blood supply gets too low, a sore may form. Pressure sores are also called bed sores, pressure ulcers and decubitus ulcers**.** Pressure ulcers can be serious, depending on how much the skin and tissues have been damaged .deep ulcer can go down into the muscle, or even to the bone. If pressure ulcers are not treated properly, they can become infected. An infection in a pressure ulcer can be serious. Pressure ulcers also hurt a lot and make it hard for a person to move around, [8,9, 16, 28.]

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, [2,5,7, 10,13.]

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, [18,19,20,21,22.]

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,[23,,24,25,26.]

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, [23,27,30.]

Material and Methods

Subjects:

Thirty volunteer patients (18 males and 12 females) with their ages were ranged from 30 to 50 years. They were diagnosed as complete or incomplete spinal cord injury by a neurologist in El-Kasr El-Aini, Cairo University Hospitals. They had sacral pressure ulcers classified between grade **2** and grade **3** according to the European Pressure Ulcer Advisory Panel. Subjects were randomly divided into two equal groups in number: **Group (1):** (the study group) **(Bioptron light therapy group).** This received the Bioptron light therapy (BLT) and the regular wound care. **Group (2):** (the control group): This received only the regular wound care.

Instrumentation:

In this study the measuring equipment were the ulcer surface area (USA) measurement in cm^2 and the ulcer volume measurement (UVM) in CC, while the therapeutic equipment was the Bioptron Compact III light therapy system (PAG-860) developed and produced by Bioptron AG, Switzerland, BLT is certificated for the quality assurance system (DEKRA certification GmbH) as a notified body of the European Union (Reg. No. 0124), [2,5,7,13,18.]

Procedures

Evaluation:

1- Measurement of ulcer surface area(USA): in cm^2

The measurement of wound surface area conducted by tracing method by a sterilized transparency film placed on the wound or ulcer area. The ulcer parameter was traced by using the fine tipped-transparency marker. Each wound area traced three times to establish measurement reliability. After tracing, the transparency film face, which faces the ulcer wound, was cleaned by a piece of cotton and alcohol. The carbon paper placed over the metric graph paper $1mm^2$. The traced transparency film was placed over a carbon paper with a white paper in between and transcribes the tracing on metric graph paper. The number of square millimeters on the metric graph paper within ulcer wound traced counted to determine the ulcer wound area. This area was converted to cm^2; the mean of the three trails calculated and considered as a wound surface area (USA). The measurements of ulcer surface area will be conducted pre-treatment as a first record and after 30 days (one month) as a second final record, [,6,9.]

2- Ulcer volume measurement (UVM): in CC.

The measurements of volume of the ulcer was conducted by isotonic solution by the following steps: The sore prepared and the surrounding skin was cleaned and dried. A transparent adhesive film was applied tightly over the sore and surrounding skin. The film was extended sufficiently beyond the same margin to ensure good adhesion. The ulcer then was filled with sterile physiological saline by injection through the film. Another needle was placed at the highest point of the ulcer to allow air to escape. The volume of solution required to fill the ulcer was recorded to indicate the volume of the ulcer. The measurements of ulcer surface area were conducted pre-treatment as a first record and after 30 days (one month) as a second final record, [11,14.]

Treatment: Steps of the BLT treatment procedures:

Position of the patient: Prone lying position is appropriate for sacral pressure ulcers. Wound preparation: the wound was cleaned at first. Some abscesses were opened and pockets of pus were drained via the surgeon, and necrotic tissue was removed. Scrubbing the wound with a soft tooth brush followed by hydrogen peroxide, saline rinse and betadine. BLT device preparation: the plug of the BLT unit was inserted into the main current supply; the on/off switch was switched on. Then set the treatment parameters of BLT. BLT application: point the light beam at the area to be treated, holding the device at right angle (90°) perpendicular to the surface of the pressure ulcer and maintaining a distance of 10 cm from the surface of the pressure ulcer and applying the BLT for about 10 minutes. Frequency of application: applied twice a day (session every 12 hours) for one month. Unplug the device after use and it is advisable to prolong the BLT for one or two weeks if wound closure occurred before the end of the treatment month in order to strengthen the treated area, [18,19,20,21.]

Data analysis:

ulcer surface area (USA) in cm^2 and ulcer volume measurement (UVM) in CC were measured pre-treatment as a first record and after 30 days (one month) 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, [17,29.]

Results

As shown in table (1) and figure (1), the mean value of the USA before treatment was (15.77 ± 5.85) cm^2 in the study group, while after treatment was (8.45 ± 3.58) cm^2. These results revealed a highly significant reduction in USA ($P < 0.0001$). While in the control group, the mean value of the USA before treatment was (15.76 ± 5.87) cm^2, while after treatment was (15.75 ± 5.81) cm^2. These results revealed non-significant difference in the USA ($P > 0.05$).

Table (1): Comparison of the mean values of ulcer surface area (USA) measurement in cm^2 before and after treatment in both groups

	Before treatment		After treatment		Mean difference	T-value	P.value	Level of significance
	Mean	SD	Mean	SD				
Study group	**15.77**	**5.85**	**8.45**	**3.58**	**7.32000**	4.13	0.0001	Highly significant
Control Group	**15.76**	**5.87**	**15.75**	**5.81**	**0.010000**	**0.00**	0.996	Non-significant

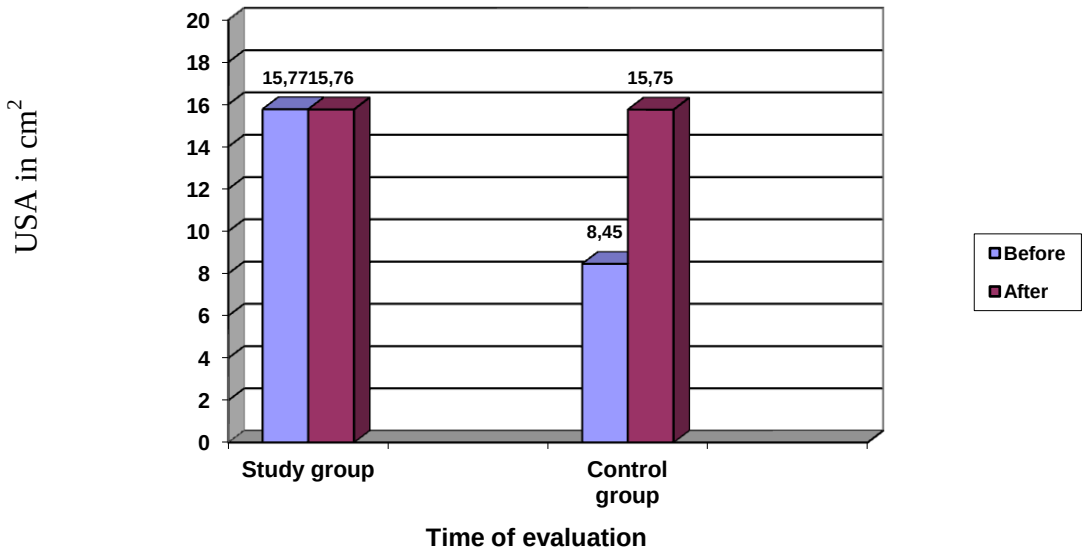

Fig (1): Mean values of the USA before and after treatment in both groups.

Also, as shown in table (2) and figure (2), the mean value of the ulcer volume measurement (UVM) in CC before treatment was (19.19 ± 8.15) CC in the study group, while after treatment was (8.66± 4.93) CC. These results revealed a highly significant reduction in UVM ($P < 0.0001$), while in the control group, the mean value of the UVM before treatment was (19.21 ± 8.23) CC, while after treatment was (19.20 ± 8.17) CC, these results revealed non-significant difference in the UVM ($P < 0.05$).

Table (2): Comparison of the mean values of UVM before and after treatment in both group

	Before treatment		After treatment		Mean difference	T-value	P.value	Level of significance
	Mean	SD	Mean	SD				
Study group	**19.19**	**8.15**	**8.66**	**4.93**	10.5300	4.28	0.0001	Highly significant
Control group	**19.21**	**8.23**	**19.20**	**8.17**	0.010000	0.00	0.997	Non-significant

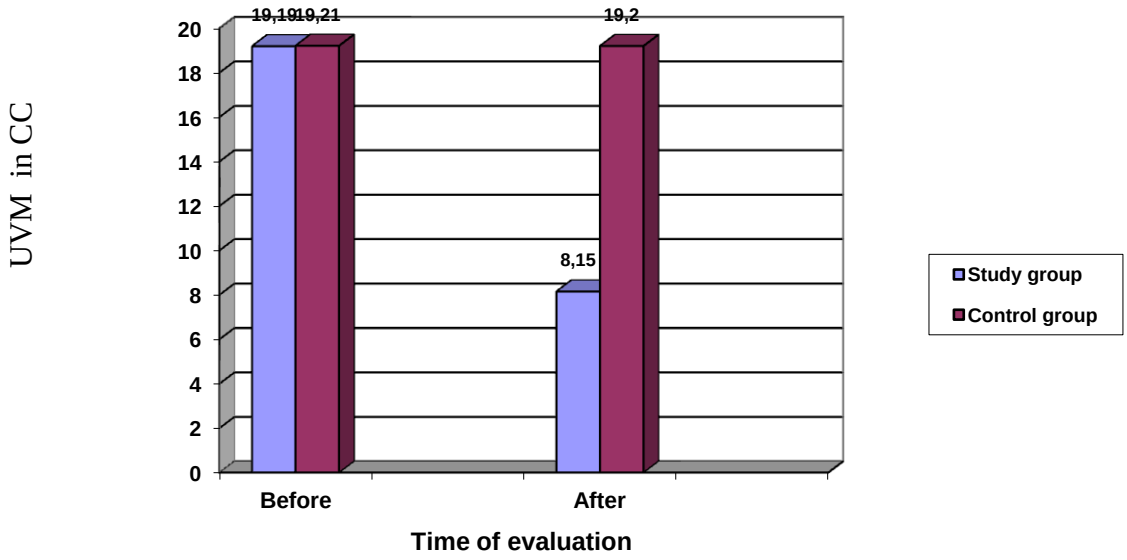

Fig (2): Mean values of the UVM before and after treatment in both groups.

Discussion

Pressure ulcer constitutes one of the major problems confronting the Healthcare professionals who are called upon to supervise the care of the severely disabled or debilitated patient. Every care provider is well aware of the complications manifested by the occurrence of ulceration in the chair or bed-ridden patient. Pressure ulcer prolongs patient morbidity and interferes with rehabilitation and medical maintenance. It may also frequently be implicated as a major contributing factor leading to the patient demise. Ulceration of the skin, especially over bony prominences, has undoubtedly plagued the disabled and debilitated patient since the beginning.

Before the advent of antibiotic therapy, secondary infection of the ulcerations led to an early death, whereas today the patients usually survive for prolonged period [1, 3,4.]

Improved the life span with the result that more people than ever before are living to a relatively old age. This results in a greater number of patients being cared in hospitals and nursing homes. Vastly improved emergency medical care with highly skilled paramedics, improved means of patient transport, more efficient receiving areas and comprehensive team-concept trauma care have effectively improved the salvage rate of the increasing number of people suffering from major trauma. The professional health care is being required, with increasing frequency to maintain and rehabilitate the elderly and severely disabled. Bedsores, more properly known as pressure ulcers or decubitus, are lesions caused by unrelieved pressure to any part of the body, especially portions over bony or cartilaginous areas. Although completely treatable if found early, without medical attention, bedsores can become life-threatening [6, 8, 9.]

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 [10, 13, 18,19.]

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 [20, 21,22,23, 24.]

The findings of the present study showed non-significant differences in the pre-treatment records of the USA between the mean values of the study and the control groups. As well as in the pre –treatment records of the UVM, between the mean values of both groups.

Results of the study group revealed a highly significant decrease in the mean values of USA and UVM, after application of the polarized light therapy, when compared against the pre-application results.

Also results of the study group revealed a highly significant decrease in the mean values of USA and UVM, after application of the polarized light therapy, when compared with the control group results after application of the regular ulcer care.

Significant differences showed in the study and control groups were consistent with those observed and recorded by Altland et al., 2004; Ballyzek et al., 2005; Bolton and Young, 2008; Coce et al., 2003; Depuydt et al., 2009; Hoeksema et al., 2002; Iordanou et al., 2007; Kubasova et al., 2005, 2006 and 2008; Medenica and Lens, 2003; Medenica and Lens, 2004; Monstrey et al., 2002, 2003 and 2004 as wellas Simic et al., 2006.

Results of this study support the expectation that application of the polarized light therapy had valuable effects in enhancing healing of pressure ulcers in patients with complete or incomplete spinal cord injury, as manifested by the highly decreases USA and UVM.

Conclusion

Polarized light therapy was effective in enhancing healing the pressure ulcers in patients with complete or incomplete spinal cord injury as manifested by the highly decreases in ulcer surface area and ulcer volume.

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فاعليـــــة الضـــــوء المستقطـــب في علاج قرح الفراش

أحمد ممدوح محمد عبدالقادر

المعهد القومي للاورام – جامعة القاهرة

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المستخلص

كان الهدف من البحث هو استكشاف تأثير العلاج بالضوء المستقطب مقابل فى تعجيل إلتئام قرح الفراش. اشترك في هذه الدراسة 30 مريضاً من مرضى اصابات النخاع الشوكى ولديهم قرح فراش, وكانت أعمارهم بين 30-50سنة وتم تقسيمهم إلى مجموعتين متساويتين فى العدد . المجموعة الأولى الضابطة تتلقى الرعاية الدورية للقرح ومجموعة علاجية تتلقى العلاج بالضوء المستقطب. ولقد أظهرت النتائج فروق ذات دلالة إحصائية عالية بين المجموعة العلاجية والمجموعة الضابطة فى نهاية مدة العلاج، وكان العلاج بالضوء المستقطب مثمر ومؤثرفي تحسين وتعجيل إلتئام قرح الفراش كما هو مثبت بتقليل كلا من مساحة وحجم القرح.