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## **Efficacy of Hyperpolarized Light on Lower Limb Cellulitis with Lymphatic Disorders**

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**Abstract**---Purpose: The purpose of this study is to investigate the effectiveness of Hyperpolarized Light on lower limb cellulitis with lymphatic disorders. Methods: Thirty patients with lower limb cellulitis with lymphatic disorders participated in the study and were divided randomly into two equal groups. Group (A) received Hyperpolarized Light and Traditional Skin Care; Group (B) received Traditional skin care only. Both groups were assessed before and after treatment by using ALT 70 diagnostic model. Results: Statistical tests for normality revealed that most of variables were non-normally distributed. So, nonparametric tests were used for within group differences (Wilcoxon Signed Rank Test) and between groups differences (Mann-Whitney U Test). Statistical test used revealed that there was statistically significant difference between groups with significant reduction in ALT posttest in favor of study group A or study group ( $P$ -value $<0.001$ ). Statistical tests used revealed that there were no statistically significant differences between two groups (Study and control) in any variable of demographic and clinical data patients ( $P$ -value  $>0.05$ ). So, patients participated in the two groups were homogenous.

**Keywords**---cellulitis, hyperpolarized light, lower limb, lymphatic disorders, patients.

## Introduction

Cellulitis is an inflammatory pores and skin condition with an infectious foundation that influences the deep epidermis and subcutaneous tissue. Clinically cellulitis is characterized by painful, erythematous, and heat swelling of the affected region, often with a poorly-defined border setting apart them from the surrounding wholesome, non-affected pores and skin as adverse to erysipelas where in the borders of the lesions are well-defined (Steven, 2009). Erysipelas classically alludes to a shallower cellulitis of the confront or limits with lymphatic association, classically due to streptococcal contamination (Sullivan & Barra, 2018).

The classic introduction of redness, dolor torment, tumor swelling, warm are the trademarks of cellulitis. The range of seriousness ranges from localized erythema in a systemically well persistent to the quickly spreading erythema and fulminant sepsis seen with necrotizing fasciitis. Torment out of extent to the clinical signs, in specific, if went with by a history of fast movement ought to incite thought of a necrotizing fasciitis (Borschitz et al., 2015).

Hyperpolarized light has a low energy density (fluency) of an average of  $2.4 \text{ J/cm}^2$ . Hyperpolarized light reaches the area to be treated with a constant, steady intensity; this energy density has bio-stimulative effects. With Hyperpolarized 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 Hyperpolarized light is approximately  $40 \text{ mW/cm}^2$  at a treatment distance of 10 cm. This is equivalent to an energy density (fluency) of an average of  $2.4 \text{ J/cm}^2$  per minute. These properties of Hyperpolarized light allow it to penetrate the surface of the skin with minimum heating effect, no damage to skin and no known side-effects (Simic et al., 2006). The present study was designed to detect the effect of hyperpolarized light on cellulitis that following lower limb lymphedema.

## Methods

### Design

The current study was a prospective randomized control study with 30 male and female participants with lower extremity cellulitis that following lymphedema, randomly assigned to one of two treatment groups: The patients in the experimental group were treated using traditional skin care including antibiotics and hyperpolarized light therapy. The traditional skin care including antibiotics was used in the control group.

### Subjects

The study was carried out on 30 patients with cellulitis that following lower limb lymphedema were treated in surgery physical therapy clinic. Thirty male and female patients undergoing physical therapy treatments were participated in the

study. There were free from some pathological conditions like local or proximate malignancy, and anti-coagulated patients. Their mean age was 52.8 years. Patients with psychological disorders were excluded from the study. The thirty patients were randomly divided into two equal groups in number: Group (A): (the study group) (Hyperpolarized light therapy group). They received hyperpolarized light therapy and the traditional skin care. Group (B): (the control group): They received only the traditional skin care.

## **Material**

### **Evaluation**

ALT- 70 is a productive model to diagnose cellulitis and provide guidance about when a dermatology consultation is needed. Variables are: Asymmetry (3 points), Leukocytosis of 10000 mcl/or more (2 points), Tachycardia above 90 beats per minutes (1 point) and Age 70 (1 point). Scores 5-7 indicate likely cellulitis (>82.2% likelihood), and patients should receive appropriate therapy. This may vary based on comorbidities or underlying diseases.

Scores 3-4 indicate uncertainty, and consultation may be appropriate. Dermatology consultation may assist in the evaluation and can help identify alternative etiologies or explanations. Scores 0-2 suggest patients are unlikely to have true cellulitis (likelihood of pseudo-cellulitis >83.3%) and should be reassessed to have the differential diagnosis reconsidered (Adam et al., 2017).

### **Hyperpolarized light**

Hyperpolarized light therapy framework emanates light characterized by polarization, polychromic, incoherency and low energy; polarized light, its waves move (waver) on parallel planes. Direct polarization by reflection (the multi-layer reflect framework, Brewster reflect), is exceptionally effective and achieves a polarization degree of 95%. Hyperpolarized light treatment framework envelops the wavelength run from 480 nm to 3400 nm, this range contains the obvious light extend and an extent of infrared radiation (the electromagnetic range of hyperpolarized light does not contain bright radiation) (Monstrey et al., 2004).

#### **Procedures**

Group (A) (n=15) received Hyperpolarized Light and Traditional skin Care in the following steps:

- Patients were asked to be in comfortable position during limb preparation and not in dependent position.
- The therapist applied the Hyperpolarized light around the affected limb (Fluren) 10 min, 5 cm distance apart.
- Followed by Blue lens for another 10 min.
- Patients were asked to be relaxed for 5 minutes.
- Use Saline Solution for skin care and Fucidin 20 mg/g cream as a topical antibiotic.

Group (B) (n=15) received Traditional Skin Care in the following steps:

- Patients were asked to be in comfortable position during limb preparation and not in dependent position.
- Use Saline Solution for skin care and Fucidin 20 mg/g cream as a topical antibiotic.

### **Cellulitis assessment**

Assessment of Cellulitis was applied by using ALT 70 Diagnostic Model which assessed limb asymmetry (3 points), Leukocytosis of 10000 mcl/or more (2 points), Tachycardia above 90 beats per minutes (1 point) and Age 70 (1 point). Measurements are applied 2 times before treatment, after 6 sessions of treatment (2 weeks after initial evaluation).

### **Data analysis**

- Statistical analyses were performed using SPSS 24.0
- Simple statistics for Patients Characteristics.
- Non-parametric tests were used for within group differences (Wilcoxon Signed Rank Test) and between groups differences (Mann-Whitney U Test).
- Chi-square test was used for testing between group differences in gender distribution.

### **Results**

Thirty patients with lower limb cellulitis following lymphedema were participated in the study. These patients were divided into two equal groups. Each patient in the two groups (study and control) was evaluated before and after treatment program by using ALT 70 model. Group (A) received Hyperpolarized light + Skin care (including antibiotics) and Group (B) received only Skin care (including antibiotics).

Statistical tests for normality revealed that most of variables were non-normally distributed. So, nonparametric tests were used for within group differences (Wilcoxon Signed Rank Test) and between groups differences (Mann-Whitney U Test). Data were presented as median and interquartile range (IQR). Chi-square test was used for testing between group differences in gender distribution.

Descriptive Statistics of baseline characteristics of both groups:

- Study group: included 15 patients (9 males and 6 females) with median (IQR) of age and ALT were 60 (15) and 6(0), respectively, as shown in Table (1) and Figure (1).
- Control group: include 15 patients (7 males and 8 females) with median (IQR) of age and ALT were 48 (26) and 6(1), respectively, as shown in Table (1) and Figure (1).

Table 1  
The Descriptive Statistics of demographic and clinical data within both groups

Demographic and clinical data	Study Group	Control Group
Age (years) <sup>^</sup>	60 (15)	48 (26)
Gender (male/female) (count)	9/6	7/8
ALT pre <sup>^</sup>	6(0)	6(1)

(<sup>^</sup>): median (IQR)

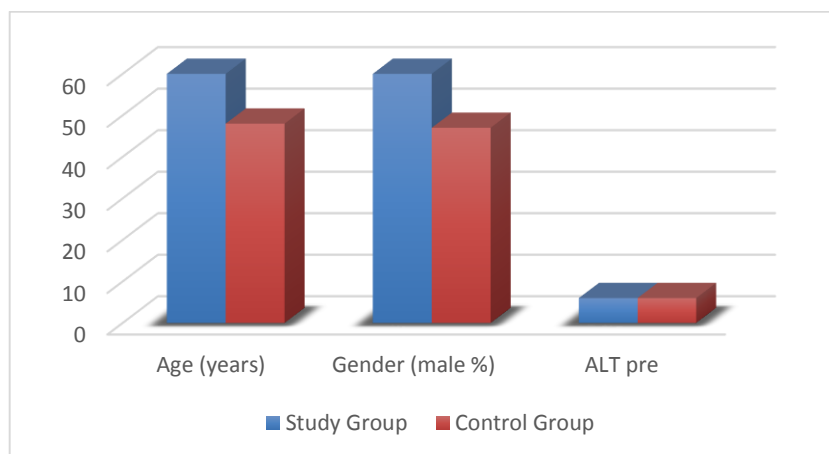


Figure 1. Chart showing age (years), gender distribution (male percentage), and ALT pre within both groups

### Results of statistical analysis of general characteristics between both groups

Statistical tests used revealed that there were no statistically significant differences between two groups (Study and control) in any variable of demographic and clinical data patients (P- value >0.05). So, patients participated in the two groups were homogenous. As shown in table (2).

Table 2  
Differences in demographic and clinical data between both groups

Demographic data and clinical	Test statistic value	p-value
Age (years)	83	0.233
Gender distribution	0.54	0.464
ALT 70 pre	85	0.27

Results of statistical analysis of differences within and between both groups in ALT:

- Within group differences:
  - Study group: median (IQR) of ALT pretest and posttest were 6 (0) and 3 (1), respectively as shown in Table (3). Statistical test used revealed that

there was statistically significant difference within study group with significant reduction in ALT posttreatment (P-value=0.001).

- Control group: median (IQR) of ALT pretest and post-test were 6(1) and 5(1), respectively as shown in Table (3) and Figure (2). Statistical test used revealed that there was statistically significant difference within control group with significant reduction in in ALT posttreatment (P-value<0.001).

Table 3  
Within groups differences in ALT 70 diagnostic model

ALT (PRE-POST)	Pre Median (IQR)	Post Median (IQR)	Test statistic	P-value
Study Group	6 (0)	3 (1)	-3.5	0.001*
Control group	6 (1)	5(1)	-3.9	0.000*

(\*): Significant at P-value<0.05

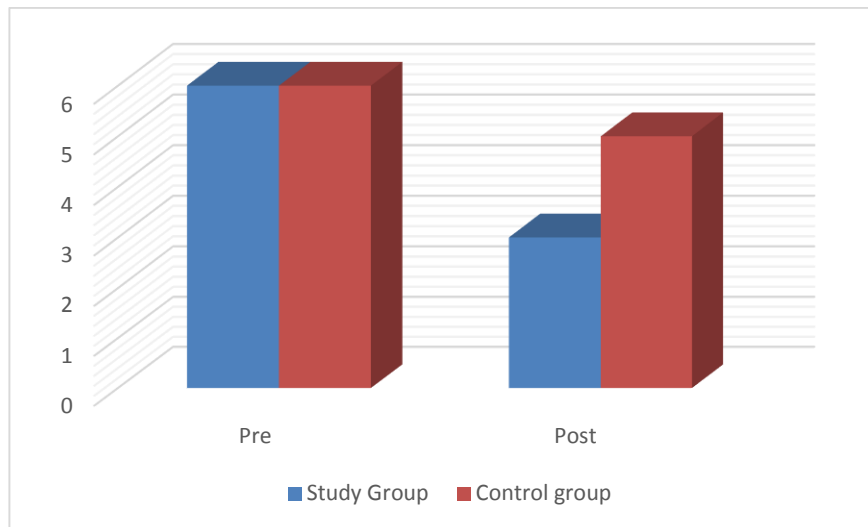


Figure 2. Chart showing medians of ALT 70 pre and posttest scores in both groups

- Between group differences  
Statistical test used revealed that there was statistically significant difference between groups with significant reduction in ALT posttest in favor of study group A or study group (P-value<0.001). As shown in table (4) , Figure (3) .

Table 4  
Between groups differences in ALT -70 d

Between group differences (study vs. control)	Test statistic	P-value
ALT post	208	0.000*

(\*): Significant at P-value<0.05



Affected limb before treatment      Affected limb After 2 weeks of treatment  
Figure 3. shows affected lower limb with cellulitis before and after treatment.

## Discussion

Polarization from low-power lasers and non-laser devices has been used as a non-invasive treatment in the treatment of various musculoskeletal disorders, promotion of wound healing, and treatment of skin ulcers, while polarization is a large number of light. The exact mechanism of action, known to have bio-stimulatory effects, such as cell proliferation, increased collagen synthesis, changes in the circulatory system, and anti-inflammatory effects, remains unknown (Iordanou et al 2007). The available non-laser optical device is the Biopton product, which emits a wide beam of polarized, non-coherent, multicolored, low energy light including wavelengths of visible spectrum (480-700 nm) and infrared (700-3400 nm). This series provides optimal penetration and tissue stimulation (Depuydt et al., 2009).

In 2014 Bahey El-Deen et al., compared hyperpolarized light with light-emitting diode therapy which can be considered a valuable therapy for the treatment of various wounds and wound healing disorders. They can promote and speed up wound healing through the stimulation and modulation of regenerative processes, anti-inflammatory effects and enhancing processes of the human defense system. However, polarized light therapy seems to be more effective in accelerating the healing rate and shortening hospitalization time than LED therapy.

The present study was conducted to detect the effect of hyperpolarized light on cellulitis that following lower limb lymphedema. Thirty male and female participants with lower extremity cellulitis that following lymphedema, randomly divided into two equal groups in number: Group (A): (the study group) (Hyperpolarized light therapy group). They received hyperpolarized light therapy and the traditional skin care. Group (B): (the control group): They received only the traditional skin care. The treatment was applied 3 sessions per week for 2 consecutive weeks. In the current study the researchers compared the two measured scores of ALT- 70 diagnostic model in two groups and proved that there was statistical difference between two groups and there was a strong positive effect in the study group which include hyperpolarized light and traditional skin

care on cellulitis with lymphedema. The study also revealed that there were no statistically significant differences between two groups (Study and control) in any variable of demographic and clinical data patients.

## Conclusion

The study concluded that combination between Hyperpolarized Light therapy and skin care has a positive effect in treatment of lower limb cellulitis that following lymphedema and better effect than traditional skin care only.

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