

The Efficacy of Hyperbaric Oxygen Therapy Versus Low Level Laser Therapy on Transcutaneous Oxygen Saturation for Venous Leg Ulcer

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Abstract

Background and Purpose: Venous ulcers are most common kind of chronic leg ulcers represents about 60 to 80% and considered the main cause of morbidity. Hyperbaric Oxygen therapy recorded significant improvement of wound healing and tissue repair at all stages.

Wound healing was one of the first areas in which the effect of Low Level Laser Therapy was investigated; laser irradiation is releasing of vascular endothelial growth factor (VEGF) which stimulates not only angiogenesis but also endothelial cell growth.

This study investigated the effect of HBOT versus LLLT on transcutaneous oxygen saturation (TcPO₂) at the margin of chronic leg ulcers.

Patients and Methods: Forty patients with chronic venous ulcers suffering for more than 6 weeks without improvement, their ages ranged from 20 - 60 were included in the present study. Those patients were classified randomly into 2 groups of equal number, 20 patients for each group. The first group was treated with Low Level Laser Therapy by Scanner Infrared diode laser with wavelengths 880 and 950 nm - Energy density 5 J/cm² - time of session depended on ulcer parameters (once daily for repeated 10 days) and the second group was treated with Hyperbaric Oxygen Therapy by Hyperbaric oxygen chamber at pressure 1.5 Bar, time of session 90 minutes with 60 minutes breathing 100% pure oxygen through the individual mask (once daily for repeated 10 sessions).

Results: Hyperbaric oxygen therapy got the higher mean value recorded 1.884 ± 0.506. While the mean value of low level laser therapy recorded 0.265 ± 0.529.

Conclusion: Improving the microcirculation and increasing transcutaneous oxygen saturation to the ulcer region with hyperbaric oxygen therapy was more than low level diode laser.

Keywords: Transcutaneous; Oxygen Saturation; Hyperbaric; Oxygen Therapy; Low Level Laser; Diode Laser

Introduction

Many types of chronic leg ulcers exist, the majority of the patients from about 60 to 80% had venous leg ulcers [1]. This is the main reason of morbidity affecting the social and economical states of any country [2].

Transcutaneous oxygen saturation (TcPO₂) at ulcer margins is one of the widespread methods used to measure partial pressure at the oxygen dissolved in liquid after penetrating skin levels [3].

In literature, TcPO₂ reflects the underlying microvascular circulation, used to determine peripheral vascular diseases, wound healing assessments, Hyperbaric oxygen therapy indications and improvements [4].

Statement of the Problem

The delayed ulceration healing and its effects on rate of recovery and period of hospitalization are serious and functional problem, therefore, the selection of the appropriate treatment modalities is one of big challenges to deal with these patients.

Design of the Study

This study conducted at Kobri El Kobe Medical Collection, Hyperbaric Oxygen therapy and Foot Care Rehabilitation Center in the period from March 2019 to June 2019. Patients accepted the experimental study and signed acceptance approval before the beginning of the study.

Purpose of the Study

This study was designed to evaluate the effect of HBO versus LLLT on transcutaneous oxygen saturation for chronic venous leg ulcers which assessed by one method of evaluative approaches.

Subjects

Forty patients with long lasting chronic venous ulcers suffering from more than 6 weeks without improvement classified randomly into two groups:

- **Group A:** 20 patients treated with low level diode laser therapy.
- **Group B:** 20 patients treated with hyperbaric oxygen therapy.

Inclusive criteria:

- Patients ages ranged from 20 - 65.
- All patients are diabetic controlled.
- Patient's cardiac ejection fraction must be ≥ 45 was evaluated pre sessions for one time and blood pressure must be $\leq 150/90$ mm/Hg measured pre each session.
- All patients are free from chronic obstructive pulmonary disease, lung fibrosis, pleural effusion and pneumonia.
- All patients' ears are clinically evaluated to be fit for hyperbaric chamber

Equipments

The equipment in the present study was delimited into two main equipments.

Therapeutic equipment:

1. Hyperbaric oxygen chamber at pressure 1.5 Bar, time of session 90 minutes with 60 minutes breathing 100% pure oxygen through the individual mask.
2. Scanner Infrared diode laser (wavelengths 880 and 950 nm- Energy density 5 J/cm² - time of session depended on ulcer parameters) used to focus on the site of venous ulcer with a distance not less than 60 cm.

The sessions repeated once daily for 10 days.

Measurement equipment

Transcutaneous hemoglobin saturation with oxygen:

- Superficial electrode with an individual membrane inserted adhesive to the ulcer margin. The steps for TcPO₂ measuring were recorded at the main chamber monitor (Model Module Box 84TE-serial number: 0216 - 1021-0211).
- The measurements were done pre treatment and after 10 days through the study. Time for each evaluation was pre the treatment procedures.

Result

Transcutaneous oxygen saturation for both groups.

The mean value of the differences of ulcer %TcO₂ between the pre treatment ulcer %TcO₂ and after 10 days of treatment by low level laser in relation to the pre treatment %TcO₂ of Group A was 0.265 ± 0.529 .

The mean value of the difference of ulcer %TcO₂ between the pre treatment ulcer % TcO₂ and after 10 days of treatment by hyperbaric oxygen in relation to the pre treatment %TcO₂ of Group B was 1.884 ± 0.506 .

The difference between the mean values of increasing transcutaneous oxygen saturation between both groups are more in Group B than Group A.

Discussion

Positive synergistic effects on tissue hyper oxygenation gained from combining hyperbaric oxygen therapy at 1.4 bar partial pressure and infrared therapy [5].

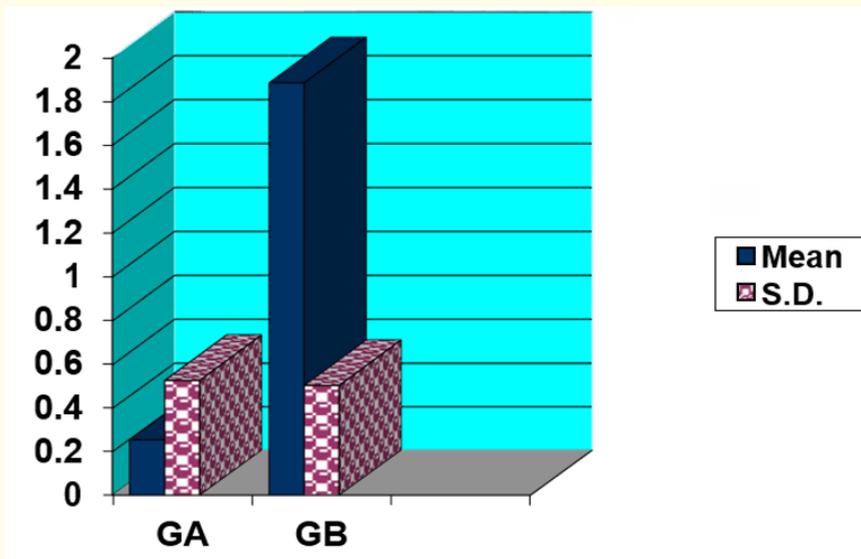


Figure 1: Shows the difference between the mean values and standard deviations of ulcer %TcO₂ between the pre treatment ulcer % TcO₂ and after ten sessions of treatment in relation to the pre treatment ulcer %TcO₂ of both groups.

Statistical Group	Group A	Group B
Patients number	20 patients	20 patients
Ulcers number	26 ulcers	27 ulcers
Mean	0.256	1.884
S.D. ±	0.529	0.506
Standard error	0.104	0.097

Table 1: Shows the difference between the mean values and standard deviations of ulcer %TcO₂ between the pre treatment ulcer %TcO₂ and after ten days of treatment in relation to the pre treatment ulcer %TcO₂ of both groups.

Hyperbaric oxygen therapy leads to increase partial pressure of arterial oxygen estimated by Henry's law [6], that explained the important role of HBO in tissue repair of the ischemic ulcers through improving energy metabolism and swelling reduction [7].

Building of new capillary network at the site of chronic ulcers requires adequate amount of oxygen concentration for the tissues to create a powerful angiogenesis' stimulus combined with fibroblastic proliferation leading to revascularization [8].

Low level laser therapy had serious effects on wound healing on a morphometric study for rats depending on cytokine level indicated that LLLT enhanced the initial level of the inflammatory stage as an important healing factor in chronic ulcer healing also depending on count of collagen fiber indicated that LLLT extended its effect to the remodeling stage of wound healing [9].

Another experimental study investigated the effects of low level laser therapy with wavelength 660 nm, 2 Jouls/ulcer site on 45 old rats, and recorded high significant positive effects of LLLT on enhancement inflammatory agents and improvement of collagen production through the stages of ulcer healing [10].

Both HBOT and LLLT had positive effects on improving healing and tissue repair established by many studies either for animals or humans. Because tissue oxygenation concerned an important factor for all stages of wound healing and angiogenesis for ischemic t issues, this study concerned to record the level of transcutaneous oxygen saturation pre and post 10 sessions of treatments with both HBOT and LLLT.

Hyperbaric oxygen therapy get the higher mean value recorded 1.884 while the mean value of low level laser therapy recorded 0.256.

This result reflected the main effect of HBOT on tissue repair depending on increasing oxygen saturation but the main effect of LLLT needs more investigation.

Further studies are recommended to investigate the effects of LLLT on oxygen saturation and the effects of combined therapy between HBOT and LLLT on rapid healing action for chronic ischemic ulcers.

Conclusion

Improving the microcirculation and increasing transcutaneous oxygen saturation to the ulcer region with hyperbaric oxygen therapy were more than low level laser therapy.

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