Effect of Far-red Photo-biomodulation on the Metabolic State of Diabetic Wounds

Soudeh Mostaghimi\textsuperscript{a}, Shima Mehrvar\textsuperscript{a}, Farnaz Foomani\textsuperscript{a}, Sandeep Gopalakrishnan\textsuperscript{b}, Mahsa Ranji\textsuperscript{a,*}

\textsuperscript{a}Biophotonics Lab, Department of Electrical Engineering, University of Wisconsin Milwaukee,
\textsuperscript{b}College of Nursing, University of Wisconsin Milwaukee

Introduction

\textbullet Objective
- Chronic lower-extremity ulcers are a common complication of diabetes.
- Approximately 15% to 25% of individuals diagnosed with diabetes will develop a lower extremity ulcer at some point in their lifetime [1].
- Photobiomodulation (PBM) using far-red (FR) light is a non-invasive, painless, and inexpensive therapeutic modality with high efficacy in preclinical and clinical studies [2].
- Our goal is to quantitatively assess the process of wound healing and the effect of FR on it in the early stages of wound healing by using a custom designed instrument, called in vivo fluorescence imager.

\textbullet Background
- Normal Wound healing process has four overlapping major phases (Figure 1): hemostasis, inflammation, proliferation and remodeling [3].

Methods

\textbullet In vivo Fluorescence imager
- Capture the metabolic indices (NADH and FAD) in-vivo (Figure 3)
- Non-invasive, non-contact, and portable

\textbullet 3D Fluorescence Cryo-imager
- Provides us with 3D volumetric Imaging and redox ratio (Figure 4)
- Preserves the metabolic state of the tissue

\textbullet Animal Groups
- Treated group (n=6): Far-red light treatment (60s/day) for 1 week
- Control group (n=5): received no treatment.

Experimental Protocol

- Fluorescence imager: Imaging the wounds on mice on day 0, day 3, day 6, and day 9 the experiment.
- Fluorescence 3D Cryo-imager: Flash-freeze wound biopsies from control and treated group on day 9 of the experiment for later cryo-imaging

Results

\textbullet In vivo Fluorescence imager
- Redox ratio (RR) is increasing in the treated group. Meaning the wound is healing
- Wound size decreases on treated group with a faster rate.

\textbullet 3D Fluorescence Cryo-imager
- RR in the treated group is significantly higher than the control group at day 9.
- The Cryo-imager results are in correspondence with those of fluorescence imager

Contact

*Corresponding author: Mahsa Ranji
Email: ranji@uwm.edu
Website: https://people.uwm.edu/biophotonics/

References


Conclusion

- On day 9, both instruments showed that the redox ratio was mitigated in far-red light treated wounds, resulted in a more reduced metabolic state in comparison with controls.
- The increase in the surface redox ratio and mean redox ratio in the treated group can be interpreted as a progress in wound healing.
- Mitochondrial redox state was successfully used to monitor the wound healing process.

Acknowledgments

We would like to acknowledge the support of UWM RGI 101x370