When time does not heal wounds: optical imaging of diabetic wounds

Shima Mehrvar¹, Kevin Rymut², Janis Eells³, Sandeep Gopalakrishnan³, Mahsa Ranji¹,*
¹ Biophotonics Lab, Department of Electrical Engineering, ² College of Nursing, ³ Department of Biomedical Sciences, UWM.

Introduction

Motivation

Chronic wounds

• Nonhealing wounds
• 6.7 million people in the US [1]

Diabetic wounds

• Diabetic foot ulcers
• 15% of diabetic patients [2]

Hard to be cured

• Diagnostic tools
• Wound care therapies

Goal

Optical metabolic imaging to quantitatively assess diabetic wound healing.

Background

• Mitochondrion produces ATP[3]
• Main coenzymes are NADH and FAD that are autofluorescent!
• Redox Ratio = \( \frac{NADH}{FAD} \)
• RR is related to the metabolic state and oxidative stress of tissues

References


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Contact

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

Methods

In vivo fluorescence imager

Mercury arc lamp
Filter wheel
CCD camera

Day0
Day1
Day2
Day3
Day4

Healing
• Noninvasive system
• Portable device
• Real-time information

3D fluorescence cryoimager

• Snapshot of metabolic state
• 3D volumetric information [4,5]

3D fluorescence cryoimager

• In vivo fluorescence imager

• Optical imaging systems successfully revealed the diabetic-induced mitochondrial dysfunction and higher oxidative stress [6].
• This information would be beneficial to find adequate and effective mitochondrial-targeted interventions to treat wounds in diabetes.

Conclusions

Real-time metabolic images

Day0
Day1
Day2
Day3
Day4

Healing
• Lower redox ratio (blue color) in diabetic wounds associates to higher oxidative stress

Not Healing

Diabetic
Control

Volumetric metabolic images

• Optical biopsies of wounds at day 4
• 61% drop in the metabolic state of diabetic wound due to higher oxidative stress

Future Directions

• Studying the effect of different diabetic types in wound healing progress
• Studying different treatment options such as photobiomodulation

References