Oral Presentation 9 - Title: Non-Invasive Monitoring of Burn Wound Healing Dynamics Using DISC Technology in a Porcine Model

Author(s): Shi Fu, Huiting Luo, Shiffoni Sukhlal, Divleen Singh, Ethan Lester

Faculty Mentor(s): Miriam Rafailovich, Marcia Simon, Sami Khan, Duc Bui, Alexander Dagum, Gurtej Singh

Background: Traditional wound evaluation methods, such as visual inspection and histology, are often limited by their invasiveness and high cost. This study explores the use of Digital Image Speckle Correlation (DISC) as a non-invasive technique for quantifying wound healing progress through spatially resolved imaging of mechanical properties. By detecting subtle mechanical changes in tissue, DISC allows for frequent, real-time assessments without requiring invasive biopsies. This capability has the potential to improve patient-specific wound management and advance telemedicine applications.

Methods/Research Design. The DISC approach applies controlled mechanical deformation using a modified tensiometer for direct imaging. Digital image correlation algorithms track natural surface features (e.g., pores, hair follicles) to measure displacement and strain, distinguishing intact, healing, and regenerated tissue. A deep partial-thickness burn model was created on Yorkshire pigs using a standardized vertical progression burn method. Wounds were treated with collagen-fibrin scaffolds, followed by autologous skin cell suspension (ASCS) from the RECELL Autologous Cell Harvesting Device (Figure 1). DISC imaging was conducted at multiple time points before biopsy collection (Days 14 and 28), providing real-time force propagation analysis. Heatmaps and displacement profiles were used to assess scaffold integration and mechanical changes in the wound bed, with control measurements taken from healthy skin. Histological cross-sections were obtained using a 3 mm biopsy punch at specific wound locations-10 mm from the corners at early time points and from the center at the final time point. Although the locations of histology samples and DISC force measurements were not identical, DISC imaging enabled a dynamic, quantitative assessment of healing before tissue extraction.

Results (or Preliminary Results, as applicable for a project in progress): DISC and histological analysis revealed distinct differences in force propagation and tissue remodeling:
Control Skin:
• Heatmaps showed uniform force propagation, indicating optimal mechanical stability.
• Histology displayed a well-organized epidermis, dense collagen, and stable vasculature, characteristic of mature tissue.
Wound (Day 14):
• Heatmaps showed disrupted force propagation, suggesting incomplete scaffold integration.
• Histology revealed partial epithelialization, disorganized collagen, and limited vascularization.
Wound (Day 28):
• Heatmaps indicated improved force uniformity, approaching control levels.
• Histology showed complete epithelialization, organized collagen, and increased vascularization, marking the final maturation phase (Figure 2).

Conclusion (or Preliminary Conclusion, as applicable for a project in progress): DISC presents a promising, non-invasive, and quantitative approach to wound assessment by detecting subtle mechanical changes in tissue. It enables timely interventions, reduces dependence on invasive biopsies, and enhances patient-specific wound management. Preliminary findings suggest that long-term DISC tracking could offer valuable insights into contracture-related biomechanical changes and hypertrophic scarring. Further studies beyond Day 28 are needed to optimize scaffold-based therapies for burn injuries.