Using Holographic Microscopy to Identify Morphological Differences Between Melanocytes and Melanoma Cells

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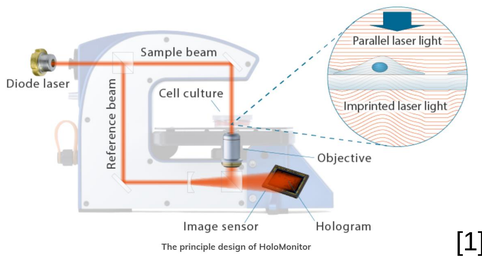
SURE EXP+ Undergraduate Research

ABSTRACT

Despite current skin cancer research, the mechanisms underlying the progression of melanoma are not fully elucidated. This study employs digital holographic microscopy to delineate the morphological and behavioral differences between melanocytes and SK-MEL-28 melanoma cells. SK-MEL-28 cells exhibited greater variability in size and movement, more regular polygonal shapes, and higher optical thicknesses. This study has important implications in determining potential biomarkers to identify different cancerous states, allowing for more precise diagnostic and therapeutic approaches to treatment.

INTRODUCTION

Melanoma is a highly aggressive skin cancer whose metastasis is not fully understood. It arises from the uncontrolled growth of melanocytes, which produce melanin for skin and hair pigmentation. The behavior and morphology of melanoma cells, such as the BRAF-mutant SK-MEL-28 cells, could be visualized via holographic microscopy (HoloMonitor M4). It enables detailed visualization of cellular structures by recording a hologram produced by the interference of a reference and sample beams.



The principle design of HoloMonitor

[1]

METHODS

The App Suite Cell Imaging software for the HoloMonitor M4 analyzed images taken at 15-minute intervals over 58 hours, conducting Guided End Point Assays (Cell Quality Control), Guided Kinetic Assays (Kinetic Proliferation and Motility Assays), and Cell Morphology Assays.

SKILL: CRITICAL THINKING

- Analyzed raw data from the HoloMonitor M4 to elucidate the structural differences between melanocytes and SK-MEL-28 cells
- Studied the significance behind dimensionality reduction techniques in understanding data and employed it in the context of cancer discrimination
- Interpreted morphological implications in the context of cell behavior

RESULTS

Figure 1. Holographic Microscopic Images and Single Cell Thickness Measurements Across Length and Width of Melanocytes (A) and SK-MEL-28 Cells (B)

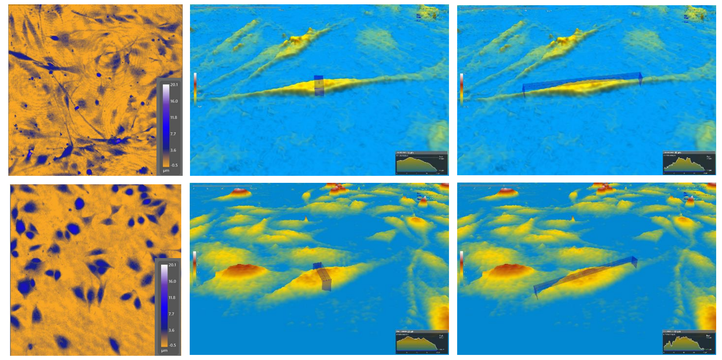


Figure 2. Cell Movement Plots for Melanocytes (A) and SK-MEL-28 (B)

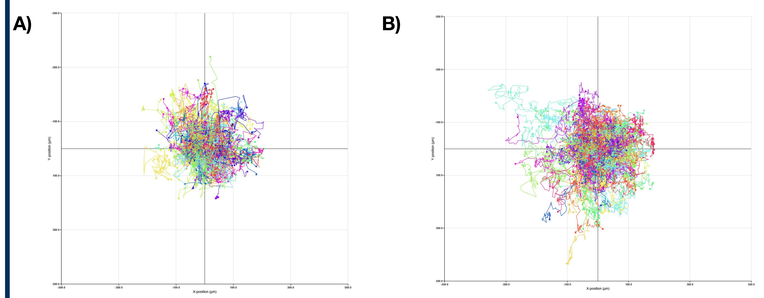


Figure 3. Principal Component Analysis (PCA) plot and t-Distributed Stochastic Neighbor Embedding (t-SNE) Analysis of the Morphological Features of Melanocytes and SK-MEL-28 Melanoma Cells

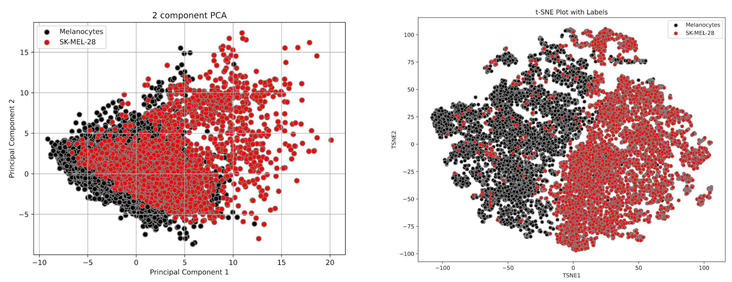
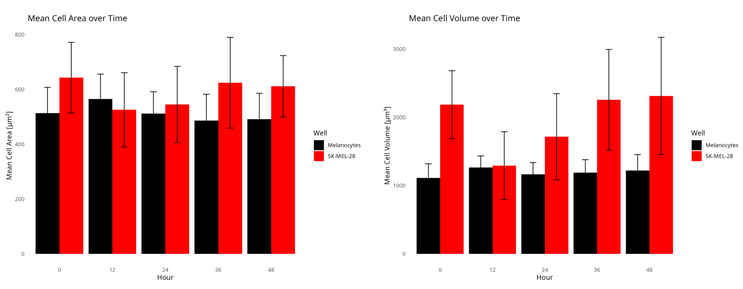
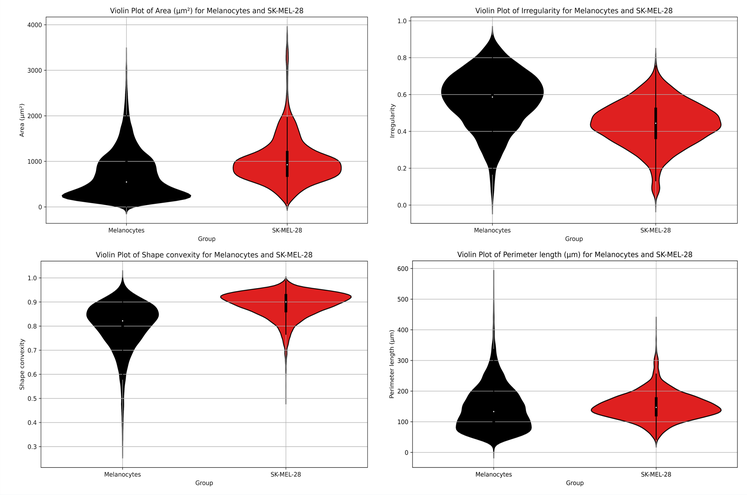


Figure 4. Bar Graphs of Mean Cell Area and Volume Over 48 Hours



RESULTS

Figure 5. Violin Plots for Morphological Features of Melanocytes vs. SK-MEL-28 Cells



DISCUSSION

- Distinct clustering in the PCA and t-SNE plots indicate significant differences in the morphological characteristics of melanocytes and SK-MEL-28 cells.
- Melanocytes exhibited elongated, irregular shapes with convex boundaries. SK-MEL-28 cells displayed more regular, circular boundaries, as well as a higher optical thickness.
- Previous research has identified that SK-MEL-28 cells exhibit polygonal morphology [2], as well as a mixture of triangular dendritic and elongated dendritic morphologies [3].
- SK-MEL-28 cells exhibited more varied movement patterns and consistently higher mean cell areas and volumes over time.
- Future research can be conducted to discern the differences between other mutated melanomas, such as NRAS-mutant vs. BRAF-mutant.

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