Detection of Circulating Tumor Cells in Uveal Melanoma by the Photoacoustic Method

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ABSTRACT #5983

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Circulating tumor cells (CTCs) have been shown to be a prognostic marker in breast cancer. We hypothesized that circulating melanoma cells (CUMCs) detection could be utilized in the management of uveal melanoma, in calculating survival. Prior methodologies for the circulating uveal melanoma cells (CUMs) detection have been fraught with poor sensitivity, limiting their clinical utility. Development of an improved method is necessary to establish the clinical utility of CUMC monitoring. Photoacoustics, also referred to as laser-induced ultrasound, is a novel platform for the detection and quantification of CMCs. Photoacoustics uses short duration pulsed light to create ultrasonic acoustic waves in an optically absorbing medium, in this case melanoma within melanoma. As light is absorbed by melanin within melanoma, the optical energy gets converted into thermal energy trapped within the material and subsequent thermal expansion waves. Transient thermal expansion of the absorbent cell results in the propagation of acoustic pressure waves defined by the Gruneisen parameter of the cell, p = αρc(ΔV/V)

where (p) is pressure, (c) is the density, (α) is the optical absorption coefficient of the cell, (ρ) is the Gruneisen coefficient, which describes fraction of optical energy converted to acoustic energy. The resultant acoustic wave is transduced to a voltage signal indicating the presence or absence of an absorbent cell. CTCs can be quantified and subsequently identified by a two-phase analysis of two properties of the absorbent cell. Classical absorbance and yield for the cell would be two (ΔV). CTCs were isolated and incubated with SAH2 and antibody 1-WB (Figs. 1 & 2).

RESULTS

CTCs of circulating melanoma cell line UM002B, established at Thomas Jefferson, were titrated to various cell concentrations and analyzed in a 48-well plate using the photoacoustic method. Uveal melanoma cells of differing concentrations were spiked into healthy donor peripheral blood mononuclear cells (PBMCs) and healthy whole blood samples. PBMC isolates were analyzed for CUMCs.

Recovery rates for CUMCs in whole blood averaged 10% of expected cell yield (23/216 noise adjusted cells). Detection limit 125 cell/mL. Detection limit 125 cell/mL. Uveal Melanoma Cell Line Sensitivity

Methods:

Cats from uveal melanoma cell line UM002B, established at Thomas Jefferson, were titrated to various cell concentrations and analyzed in a 48-well plate using the photoacoustic method. Uveal melanoma cells of differing concentrations were spiked into healthy donor peripheral blood mononuclear cells (PBMCs) and healthy whole blood samples. PBMC isolates were analyzed for CUMCs.

Results:

CUMCs were successfully quantified by the photoacoustic method including single cell detection. Recovery rates of cultured cells in a neutral density solution approached 25%. Recovery rates for CUMCs in whole blood averaged 10% of expected cell yield (23/216 noise adjusted cells) with a higher detection rate at lower cell concentrations. Photoacoustics offers a reliable method for the detection of CUMCs with an accuracy that meets or exceeds previously reported CUMC yields. Studies analyzing CUMCs from patients with metastatic disease are ongoing.

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References