Evaluation of the Cytotoxic Effects of Photodynamic Therapy in Two and Three Dimensions Cultures of Human Breast Cancer Cells

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Introduction: Breast cancer is a devastating disease with global impact on health, where metastasis remains the main cause of death. Photodynamic therapy (PDT) appears as a promising alternative for cancer treatment however, there is not yet enough knowledge about efficacy, costs and mechanisms involved. In this work we set out to evaluate the cytotoxic effects of PDT by using methylene blue (MB) as a photosensitizer in invasive human breast cancer cells growing in two (2D) and three (3D) dimensions allowing the cells to grow as spheroids.

Material and Methods: MDA-MB231 cells derived from a triple negative invasive human breast carcinoma, were plated onto uncoated or Matrigel™ coated 24-well plates (2D or 3D condition respectively). After 96h cells were incubated with vehicle or MB (20µM or 2µM) for 2h and irradiated or not (λ=650nm) at 5J/cm² dose rate. Cellular viability was evaluated by fluorescence microscopy analysis using Hoescht and Propidium Iodide staining.

Results and discussion: In 2D PDT treatment was able to significantly increase (p<0.05) cell death using MB (2µM-20µM) from 30min to 48h following cell irradiation (PDT: 98,7%±0,6% vs. control:5,2%±0,5%). In order to study the feasibility of PDT on three dimension cultures, we used the same protocol. We have also observed a significant increase in cell death (PDT: 86,7%±1,1% vs. control:10,7%±3,7%). Our results point at the efficacy of PDT using MB in both 2D and 3D cultures of MDA-MB231 cells. Conclusions: We showed for the first time, that MB and light were able to reach even the core of the spheroids and induce massive cell death. In sum we reveal the cytotoxicity of PDT in human breast cancer cells in a model that recapitulates the morphology of glandular epithelium. Finally, despite the need of further confirmatory studies, our observations contribute to indicate PDT as an alternative therapy for invasive breast tumors.

Keywords: Breast cancer; Photodynamic Therapy; Methylene blue
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