Biological Effect of Hyperthermia in Combination with Radiation in Breast Cancer Cells

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Abstract:
Combination of hyperthermia and radiation therapy for treating cancer cells has been a topic of research for decades. For radio-resistant cancer cells this combination can be promising. High temperature makes tumors sensitive to radiation dose, consequently the overall radiation dose can be reduced. The aim of this study is to design a non-invasive antenna to increase the temperature more than 42.5℃ on superficial breast tumors and then apply low dose radiation and to see the biological changes henceforth inside the cells. In this research, experiments were done in MCF-7 and MDA 231 breast cancer cells.

Keywords: Hyperthermia, micro-strip patch antenna, breast carcinoma cells, fractional radiation

1. Introduction

Breast cancer is the most common cancer and one of the leading cause of death in women. Ionizing radiation leads to double-strand DNA damage in cells, and DNA repair takes place after thereafter. With application of high temperature along with radiation can terminate or minimize the DNA repair process. In this research, a micro-strip patch antenna is designed which can be applied non-invasive way to the tumor and also to see the biological changes happen in different types of breast cancer cells.

2. Material and Methods

In previous experiments, different types of antenna were studied, which concludes that for heating superficial tumors, non-invasive antennas are more suitable [1]. In this research, non-invasive micro-strip patch antenna is designed and temperature calculation and SAR calculation were done on muscle tissue. The aim is to find optimal conditions for the combination treatment. On the MCF-7 and MDA 231 breast cancer cells fractional X-rays radiation of five times 3 Gy daily by RADSOURCE RS-2000 Biological System (160kV, 25 mA) was performed at the University of Macau. Before radiation treatment the cells were heated up to more than 42.5℃. Cell proliferation was observed over the course of one week (**Figure 1**). For the heating of superficial breast tumors, a patch antenna was designed using CST simulation software. The dimensions such as length, width, relative dielectric constant of substrate, substrate thickness and radiation parameters were optimized to find the best arrangement.

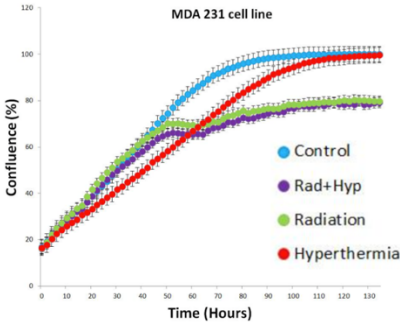

Figure 1 Effects on MDA 231 cell growth

3. Outlook

In order to observe the difference between radiation and radiation and hyperthermia, we plan to increase the temperature up to 45℃ and try several patterns of time profiles. Knowing more about the biological effects in specific cell lines will help to find better approach for customized breast cancer treatment. The patch antenna design is a small microwave systems operating at 2.45 GHz. This method requires controlling the spatial distribution in order to avoid injuring healthy tissue. For future work we aim to develope a more sophisticated heating device.

References

[1] Debnath, O. B, et al., *Thermal Medicine*, vol. 33, no. 2, 2017, pp. 53–62., doi:10.3191/thermalmed.33.53.