Effect of Blood Flow for Combination of Hyperthermia with Radiation Therapy for Treatment in Breast Tumors

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Abstract

Hyperthermia[1] combined with radiation therapy[2] has proven to be effective for tumor treatment. By increasing the temperature, tumors become radiosensitive, allowing for reduction in radiation dose. Blood being a temperature regulator makes it difficult to increase the temperature by an external means. Therefore, we plan to observe the blood flow[3] effect via mathematical calculations, computer simulation, and dynamic phantom[4].

Keywords: hyperthermia[1], radiation therapy[2], blood flow[3], dynamic phantom[4]

1. Introduction

Combination of hyperthermia and radiation therapy for treatment of tumors has been investigated by many researchers. Blood makes it difficult to maintain higher temperatures for a long period of time due to tumor's inability to maintain the temperature due to blood flow. The purpose of this research is to investigate the blood flow effect by means of microbiological investigations, as well as technical experiments and simulations.

2. Methods

2-1. Mathematical Calculations

Studies show that tumor vasculature has high vascular density, so the blood flow in the tumor is random and not uniform as compared to normal tissue. By referring to Poiseuille's law equation for blood flow, we are able to calculate theoretical values for capillaries inside of a breast and tumor. For example, in breast tissue, capillary blood flow can be approximately 2.06×10^{-7} mL/min, whereas in a tumor it can reach as high as 2.14×10^{-5} mL/min.

2-2. Computer Simulation

By utilizing CST software for simulation, we are able to visualize the loss of heat from blood flow.

2-3. Dynamic Phantom Experiment

The dynamic phantom is designed in such a way that will allow for the reproduction of blood flow within the breast. These results will allow for us to quantify the change in velocity, as well as the difference between the change within the breast and the change within the tumor.

Fig. 1 Dynamic phantom

3. Summary

Blood flow differs between normal tissues and tumor tissue as per calculations above. Due to this difference, is a discrepancy in temperature when heat is applied to a breast tumor. Therefore, these reactions and effects are to be investigated for the purpose of finding the optimal combination treatment method for breast cancer tumors.

References

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[2] Mankoff, D A, et al. "Blood Flow and Metabolism in Locally Advanced Breast Cancer: Relationship to Response to Therapy." *Advances in Pediatrics.*, U.S. National Library of Medicine, Apr. 2002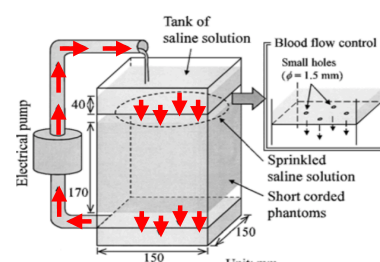, www.ncbi.nlm.nih.gov/pubmed/11937594.