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An Analysis of Temperature Distribution and Ablated Volume in the 3-D FEM Tissue Model with Blood Vessel During Radio-Frequency Ablation

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Abstract. The current treatment for brain tumor has many methods such as surgery or chemotherapy but often the treatments may affect the patient or treatment is still limited in some aspects. A promising technique for brain tumor treatment is radio-frequency ablation. Radio-frequency ablation utilizes alternating current (AC), typically at about 500 kHz, to destroy unwanted tissues by heating to temperatures exceed 45 °C to 50 °C. The objective of this research is to study the treatment of brain tumor during radio-frequency ablation with computer simulation through finite element method (FEM) for solving problem. A three-dimensional FEM model of a brain tissue with brain tumor and blood vessel is considered. Three types of blood vessels i.e. aorta, main veins and terminal veins are studied. The electric current equation and time-dependent bioheat transfer equation coupled with time-dependent convective blood vessel heat transfer equation is solved to predict temperature distribution and ablated volume within brain tissue model. The simulation results are compared with the simulation results from previous work to verify the accuracy of the presented model. The effects of blood vessel is included and not included in the brain tissue model, types of blood vessel and treatment time during radio-frequency ablation on the temperature distribution and ablated volume are investigated. The outcomes indicated that size of blood vessel results in heat sink effects which increase with velocity of blood flow. The aorta causes more heat sink effects than main veins and terminal veins, respectively; thereby the ablated area and ablated volume in case of aorta is higher than one in case of main veins and terminal veins, respectively. In addition, the temperature value increases with greater treatment time. The results from this study provide the basis for planning the radio-frequency ablation of brain tumor and leads to approaches of medical practice process improvement.