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Temperature Calculations in Body during Thermal Treatment by Capacitive Heating Device

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1. Introduction

In recent years, various types of medical applications of electromagnetic techniques have been investigated. Especially, thermal effect of the electromagnetic field to human body can be used for treatment of cancer. Today, large number of capacitive heating devices, which utilize electric current of 8 MHz, are employed in Japan. Figure 1 (a) illustrates main unit of the device. The main part of this device consists of two electrodes with water boluses, oscillation unit, and controller. The maximum output power is 1.5 kW [1]. Electric current of 8 MHz is applied to a patient via pair of electrodes. Temperature of target tumor(s) inside the patient and their periphery increased by Joule heating of the current. The temperature in and around the target can be measured by some thermocouples equipped with the device. However, the temperatures are not measured in many cases because of invasiveness. Moreover, few studies have reported the temperature distribution inside patient body during the treatment. So, in this study, the temperatures inside the body were calculated under practical situation.

2. Calculation Model and Results

In this study, realistic high resolution whole body voxel model [2] is employed as a patient under the thermal treatment. The patient is placed two electrodes, whose diameter is 250 mm, with water boluses. In the calculation, first, specific absorption rate (SAR) is calculated by use of finite difference time domain (FDTD) method. Then, the bioheat transfer equation is numerically solved based on the resultant SAR values with several practical parameters. Figure 1 (b) indicates an example of calculated temperature distribution inside the patient body. Some high temperature regions are observed around the surface of the patient body and around spine. On the other hand, the temperature of deep region of the body such as liver is not increased compared with the surface.

3. Summary

In this study, temperature distributions inside the patient body under the thermal treatment by the capacitive heating device were calculated. As a result, high temperature regions were observed around the surface of the patient body and borders of different organs inside its. As a further study, many treatment cases should be considered for understanding the characteristics of the capacitive heating scheme.

4. References

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2. T. Nagaoka, S. Watanabe, K. Sakurai, E. Kunieda, S. Watanabe, M. Taki, and Y. Yamanaka, "Development of realistic high-resolution whole-body voxel models of Japanese adult male and female of average height and weight, and application of models to radio-frequency electromagnetic-field dosimetry," Phys Med Boil, **49**, 1, January 2004, pp. 1-15.

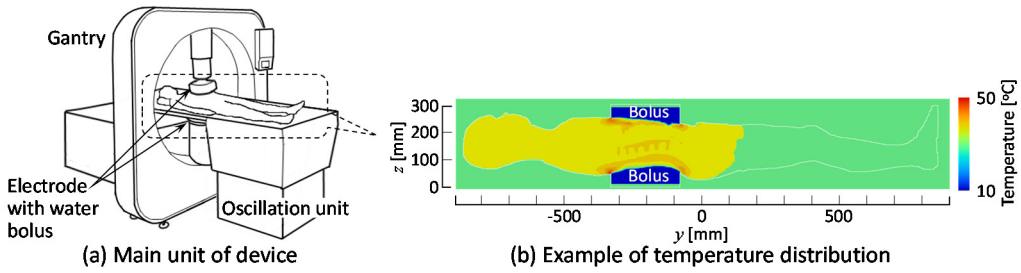

Figure 1. Conventional capacitive heating device and temperature distribution inside patient body during treatment (output power: 500W, heating time: 30 min.).