RF CAPACITIVE HYPERTHERMIA SYSTEM: EXPERIMENTAL RESULTS AND THERMAL MODELING

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Introduction

Radiofrequency capacitive hyperthermia, at 13.56 MHz, can be used as an adjuvant treatment of the traditional radiotherapy and chemotherapy for advanced inoperable malignant brain tumours. In this work, the authors show results of an experimental study on a human skull filled with water bags and results of electro-thermal FEM simulations on a 2D model of a human head. Moreover, experimental set up and a numerical analysis have been performed in order to demonstrate the effect of RF energy deposition on resulting heating compared with the one due to thermal conduction.

Methods

In fig.1a the experimental set-up for the RF capacitive hyperthermia application on a skull is shown. The experiments have been carried out with the Synchrotherm RF system in Verona hospital. In Fig.1b the 2D geometric model for FEM analysis is shown where the position of the four temperature probes are underlined.

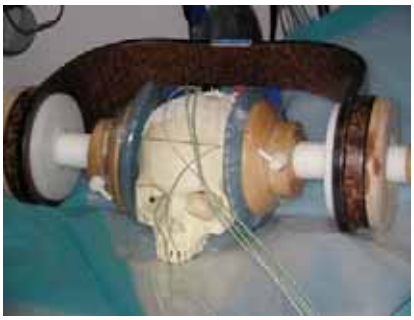

Fig.1a Experimental set-up

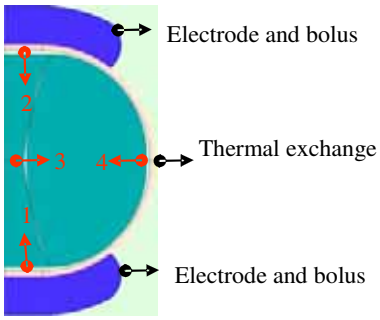

Fig.1b 2D geometric model for FEM analysis

In a second part of the work, developed in Electroheat laboratory of Padova University, only the effect of thermal conduction during the treatment has been considered: an experiment and a numerical model have been performed imposing the temperature of the electrodes surfaces at the constant temperature of 39°C.

Results

In Tab.1 thermal results obtained from experimental measurements and results of numerical calculation after 10 and 25 minutes of RF application are compared on correspondent points. The initial temperature in the FEM simulation is set equal to ambient temperature at 25°C.

	measured				calculated			
	1	2	3	4	1	2	3	4
15 min	38 °C	25°C	28°C	28°C	24°C	13°C	31°C	29°C
25 min	37°C	24°C	30°C	31°C	27°C	14°C	38°C	35°C

Tab.1 thermal results measured and calculated after 10 and 25 minutes of RF application.

In Fig.2 temperature evolution obtained from experimental and numerical analysis, with the only effect of thermal conduction considered, are compared. In this case, the initial temperature is set to 20°C.

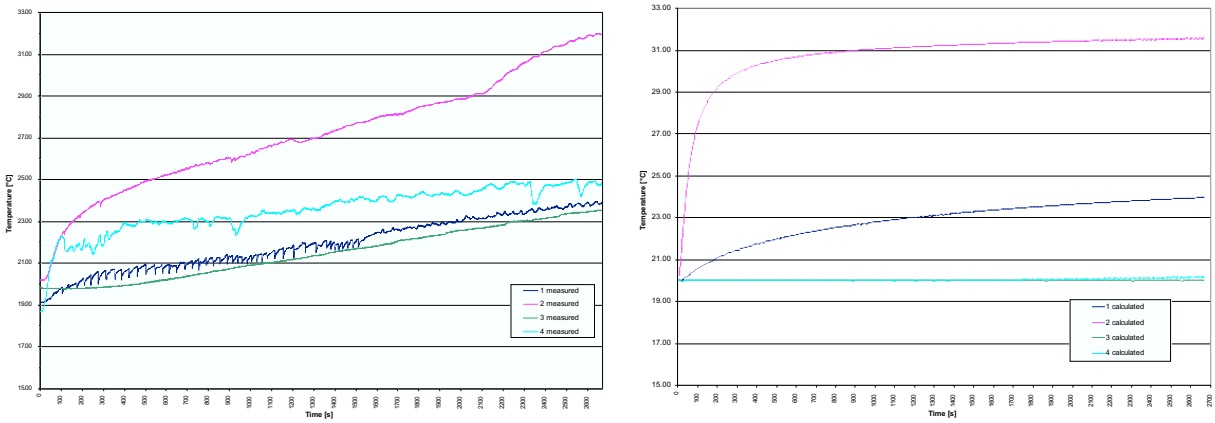

Fig.2 Temperature evolution

Conclusion

Thermal results measured and calculated (Tab.1) are very different due to difficulties encountered during experimental RF application on temperature acquisition. Fig.2 shows that time constant related to thermal conduction phenomena are so high that temperature raise up to therapeutic values, during RF application, can be reasonably attributed to RF energy deposition.

References

[1] Numerical Model for RF Capacitive Hyperthermia for Brain Tumours, V. D'Ambrosio, F. Dughiero, M. Giri, S. Maluta, ESHO 2006.