Sensitivity Analysis of Temperature Field in the Heated Soft Tissues with Respect to the Time Delays

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Heat conduction in the heated soft tissues can be described using the different mathematical models. The Pennes model (1948) which is based on the Fourier law is widely known. To take into account the specific heterogeneous structure of biological tissues, currently other models based on extended Fourier law are being developed. In these models the heat flux delay relative to the temperature gradient (Cattaneo-Vernotte equation) and the delay of the temperature gradient relative to the heat flux (dual-phase lag equation) are introduced. The delay times are called the relaxation time and thermalization time, respectively. Experimental studies show that delay times vary widely and are different for different types of biological tissues. To estimate the temperature changes in heated tissues due to the perturbations of time delays the methods of sensitivity analysis are used [1, 2]. In this approach, the basic problem described by the dual-phase lag equation and appropriate boundary-initial conditions is differentiated with respect to the parameter under consideration (a direct approach). Next, these both problems are solved using (in the case considered) the numerical methods. Finally, based on the solutions obtained, the impact of changes in individual parameters on the tissue temperature distribution is assessed. In this way one can analyse the influence of the parameters appearing in mathematical model on the final form of the problem solution, in other words, which of these parameters are more or less important.


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