Design of Multiple Ground System for Maternal Defibrillation

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Abstract

Although cardiac arrest may be statistically insignificant event financial and more important emotional costs in such cases are quite devastating. To this purpose in our previous work we studied effect of defibrillator pads position on the current density in the body and consequently the power dissipated to the fetus (embryo). Complicating the matter is the fact that the lower abdominal part consists of multiple heterogeneous segments which significantly complicates the modelling process. To address this issue we replaced the intestinal part with the equivalent organ with slightly larger conductivity.

In this paper we study the effects of multiple grounding pads. Namely, we believe that by placing multiple pads in the lower abdominal part we would be able to decrease the current density and consequently power that would be dissipated to fetus and amniotic liquid. In Figure 1 we illustrate the geometry of the model used in this study. In Figures 2 and 3 we illustrate the power dissipation as a function of the azimuthal angle of the pads for three most important organs, amniotic liquid, fetus and heart of the mother. Namely as a consequence of placing additional pads there exist a risk of decreasing the power surge being delivered to the heart which may result in defibrillation failure. It is therefore extremely important to analyze possible positions so that the power delivered to the heart is maximized (or at least above the desired threshold needed to resuscitate the heart) and power delivered to the amniotic liquid is minimized.

As a preliminary result in this paper we utilize COMSOL Multiphysics® software with the AC/DC Module to develop the code that can be used as a subroutine in the optimization process which could result in the optimal number of pads as well as their positions. In order to address the issue of designing the maximum charge needed on the defibrillation pads we propose to invert the boundary problem in which we define power delivered to the heart (inside the model) as a boundary condition rather then current density on the torso surface. We demonstrate on a simplified 2D example applicability of this approach and outline procedure that can be implemented using COMSOL software.

Figures used in the abstract

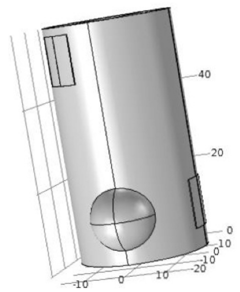

Figure 1: COMSOL Model of Two Ground system.

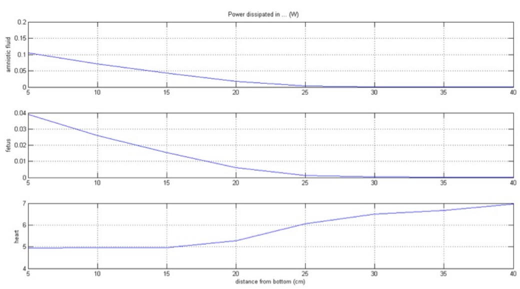

Figure 2: Power dissipation in two pads system.

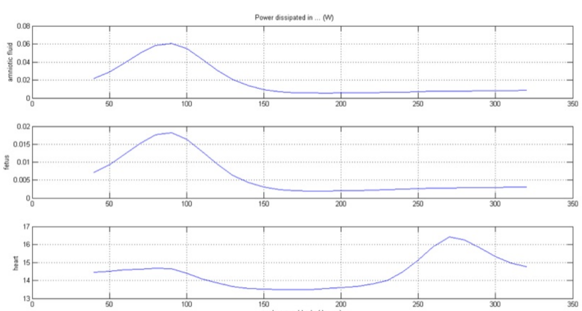

Figure 3: Power dissipation in three pads system.