

Defibrillation Electrical Current Pathways in the Heart and Chest of a Pig

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Although electrical defibrillation of the heart has been in clinical practice for about 50 years, the pathways of electrical current through the chest and heart remain poorly understood. A better understanding of these pathways will provide a means for defibrillation system designers to improve the overall efficacy of these systems. Current pathways are investigated in the heart and chest of a post-mortem pig using a technique called Current Density Imaging (CDI).

CDI maps the magnetic fields, produced by an externally applied current source, onto the phase images of a Magnetic Resonance Imaging (MRI) volume data set. Volume current density distributions are obtained by taking the curl of these magnetic field maps. Two post-mortem pigs were imaged using the CDI technique. Square current pulses of 12 ms duration and 150 to 200 mA amplitude were applied to the pigs through flexible copper defibrillation electrodes. Vector plotting and streamline techniques were employed to visualize the 3 dimensional (3D) current pathways through the tissues of the heart and chest. From this visual analysis, the major current entry and exit regions of the heart are identified and the flow of current within the heart is described. Figure 1 (A) shows an iso-surface of MRI pig data with a cut plane that corresponds to the 3D stream tube plot of current density vectors in Figure 1 (B).

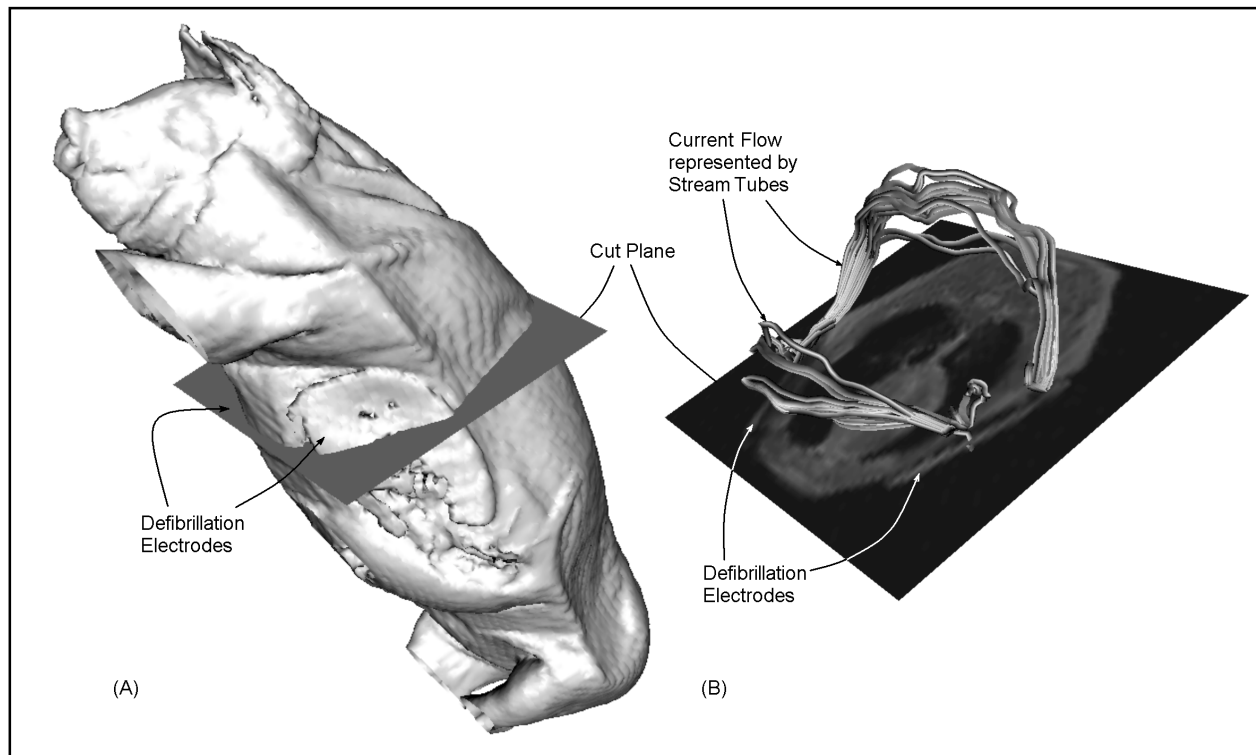


Figure 1: (A) Iso-surface of MRI pig data showing location of defibrillation electrodes and a cut plane. (B) Same cut-plane as in (A) with stream tubes representing some of the current density vector data acquired using CDI. Stream tubes indicate major current pathways through the chest and back of the pig.

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