ESTIMATING ENDOCARDIAL (HEART SURFACE) POTENTIALS FROM A NONCONTACT PROBE

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In recent years there have been a growing number of attempts at estimating electrical potentials on the heart surface from remotely measured signals. Because of the properties of the tissues and the time scales involved, the governing equation for potentials within the torso (except within the myocardium itself) is Laplace's equation (electrostatics). This makes the "forward problem" of calculating torso potentials from known heart surface potentials well-posed and stable. The inverse problem is far more difficult, since no electrical data is available on the heart surface, and we must estimate this data based on measurements at other locations.

The estimation of endocardial (interior heart surface) potentials from a probe placed in the heart chamber is one of the most promising applications of minimally invasive inverse techniques. The system developed by Endocardial Solutions, Inc (Minneapolis, MN) has two key advantages over body surface approaches: by working from the inside of the heart the conductivity of the intervening medium (blood) is uniform, and the distance from the measurements to the estimation sites is substantially smaller. Hence, the inverse solutions are inherently more accurate.

We compare three inverse algorithms– zero-order Tikhonov, first-order Tikhonov, and first-order Generalized Eigensystem regularization– for their ability to estimate the endocardial potentials from measured probe potentials and known geometric data. For each method, the Composite Residual Error and Smoothing Operator (CRESO) technique was used to estimate the regularization parameter. For the preliminary data examined here, higher-order regularization produced higher correlation coefficients between the estimated and measured endocardial electrograms than zero-order Tikhonov regularization.

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