Registering SPECT and MR Images for Non-invasive Localization of Stem Cells Grafted in the Infarcted Rat Myocardium

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This abstract demonstrates the application of mutual information (MI) based registration of radionuclide and MR images in an effort to use multimodality imaging for non-invasive localization of stem cells grafted in the infarcted myocardium in rats. Radionuclide imaging such as SPECT inherently has high sensitivity and is suitable for tracking of labeled stem cells, while high resolution MRI is able to provide detailed anatomical and functional information of myocardium. Thus, co-registration of SPECT images with MRI will map the location and distribution of stem cells on detailed myocardium structures. For validation, SPECT data were simulated using a Monte Carlo based projector that modeled the pinhole-imaging physics assuming non-zero diameter and photon penetration at the edge. Translational and rotational errors of the registration were examined with respect to various SPECT activities, and they are averagely about 0.50mm and 0.82 degree, respectively. Only the rotational error is dependent on activity of SPECT data. Stem cells were labeled with ^{111}Indium oxyquinoline and grafted in the ischemic myocardium of a rat model. Dual tracer small animal SPECT images were acquired, which allowed simultaneous detection of ^{111}In-labeled stem cells and of [^{99m}Tc]sestamibi to assess myocardial perfusion deficit. The same animals were subjected to cardiac MR imaging. A MI-based registration method was then applied to SPECT and MR images. By co-registration, the ^{111}In signal from labeled cells was mapped into the akinetic region identified on cine MR images; the regional perfusion deficit on the SPECT images also coincided with the akinetic region on the MR image.