

# MRI to X-ray Fluoroscopy Overlay for Guidance of Cardiac Resynchronization Therapy Procedures

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Cardiac resynchronization therapy (CRT) can be an effective procedure for patients with heart failure but 30% of patients do not respond. This may be partially caused by the sub-optimal placement of the left ventricular lead.

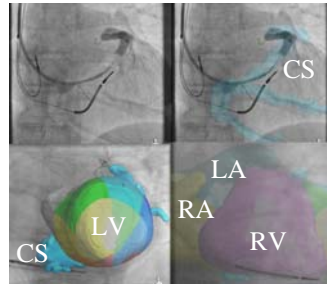
We demonstrate how pre-procedural cardiac MR images can be used to assist CRT by integration of anatomical and functional information with live X-ray images. We evaluated our approach in 7 patients. Each patient underwent pre-CRT MRI (Philips 1.5T Achieva ) using MultiHance contrast. This included whole heart imaging using a cardiac and respiratory gated bSSFP sequence; 3D tagged and cine imaging for function; and late enhancement imaging for scar.

The MRI data were processed to yield a detailed anatomical model. Whole heart segmentation was achieved automatically using the Philips EP Planner and the coronary venous anatomy was manually segmented by a clinical expert. Functional information was derived using the Tomtec 4D LV-Analysis. The left ventricle was segmented into the standard 16 segment AHA model and the functional information could be added to this. If scar was present, this was segmented by an expert and added to the model.

The implant was carried out using a Philips Allura X-ray system and the detailed cardiac model was registered to the X-ray fluoroscopy using multiple views of a catheter looped in the right atrium. There was complete freedom of movement of the X-ray system and respiratory motion compensation was achieved by tracking the diaphragm. The software framework was a specially modified version of the Philips EP Navigator.

We validated the registration using balloon occlusion coronary venograms. The mean 2D target registration error for 7 patients was  $1.3 \pm 0.68$ mm. Furthermore, left lead deployment was successful in all patients.

In conclusion, we demonstrate a complete software/workflow solution for guidance of CRT by using pre-procedural MRI data combined with live X-ray fluoroscopy.



(a) X-ray image. (b) Coronary venous overlay. (c) 16 segment AHA model. (d) Complete anatomical model.