Abilities of Cardiac MSCT Imaging to Provide Useful Anatomical and Functional Information for Cardiac Resynchronization Therapy Optimization

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A main limit of biventricular Cardiac Resynchronization Therapy (CRT) is the high rate of non-responder (30%). Improvement in patient selection and device implantation strategy may reduce this rate. A challenging task to carry out remains both the identification of the most effective pacing sites and the left ventricular lead positioning (by a venous access). This paper aims to show how cardiac Multislice-CT (MSCT) imaging, from only one exam, can be helpful for the clinician to analyse venous system and cardiac function before the device implantation. 4D CT data have been analyzed in order to extract global and local left ventricle (LV) function and coronary vein anatomy. The proposed process is decomposed in four steps: (1) the 3D tracking of coronary veins based on minimum-cost path computation and on fast-marching technique; (2) the 3D extraction of the LV along the cardiac cycle by using a fuzzy connectedness algorithm, providing a surface mesh representation and volume variation along the cycle; (3) the cardiac LV motion estimation based on a multi-resolution surface matching method, giving access to functional parameters associated to anatomical segments (e.g. radial and longitudinal motion components); (4) the fusion of extracted data with adapted modes of visualization such as 3D dynamic and color-coded surfaces and synthetic bull-eye representations combining anatomical (LV endocardium and veins) and functional (endocardium motion) descriptions. Although the three first parts of this process have been presented in earlier works, the integration of the overall set of available information with adapted modes of visualization may represent an advance towards the optimal use of MSCT imaging in CRT planning. This approach has been tested on three patients. Results show that combined anatomical and functional information, concerning in particular the characterization of the venous network and the LV most delayed region, are of high interest for CRT optimization.