999. Patient-Specific Coronary Artery Territories

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Introduction: The American Heart Association proposed a 17-segment model for the segmentation of the left ventricle together with a mapping from each segment to a supplying coronary artery [1]. This proposal is based on population averages. Several studies have confirmed the inaccuracy of this mapping due to large anatomical variations of the coronary arteries among individuals. Several proposals have been made for a different mapping between the 17 segments and the coronary arteries [2, 3].

Purpose: Due to the large variation in coronary anatomy there is a need for a patient-specific assignment of ventricular segments to supplying coronary arteries. We propose to use a segmentation of the coronary arteries and the epicardium to compute this patient-specific mapping.

Methods: The three primary coronary arteries (LAD, LCX and RCA) and the left ventricle are segmented in a whole-heart MRI (SSFP) or CT scan of at least 150 slices. For the coronary arteries we employ a semi-automatic vessel tracking algorithm [4]. The left ventricle is segmented using a fully automatic approach [5]. The epicardial surface of the resulting segmentation is represented as a quadrilateral mesh. The centerlines of the coronary arteries are projected on the epicardial surface. A Voronoi diagram of the projected arteries is computed using a Euclidean geodesic distance metric. The patient-specific coronary territories are computed using a modified marching squares algorithm.

Both the coronary territories and the coronary arteries are projected onto a bull's eye plot using a parameterization of the left ventricle based on cylindrical coordinates, using the cardiac long axis as the primary axis of the cylinder (Figure 1a). The continuous nature of the epicardial surface is preserved in this projection. This means that the bull's eye plot does not consist of rings representing slices, but that the distance to the center is proportional to the distance to the apex. This bull's eye plot can for example be used as an overlay for the analysis of viability (Figure 1b).

Results: We have performed an in-house evaluation by applying our technique to five subjects. For each subject we produced both a 17-segment model and a projection of the patient-specific coronary territories from our approach. Both diagrams were annotated with a projection of the segmented coronary arteries. We then asked an experienced clinician to judge the correspondence between the coronary arteries and the suggested coronary territories for both diagrams. The results suggest our patient-specific coronary territories provide a better correlation. The clinician also

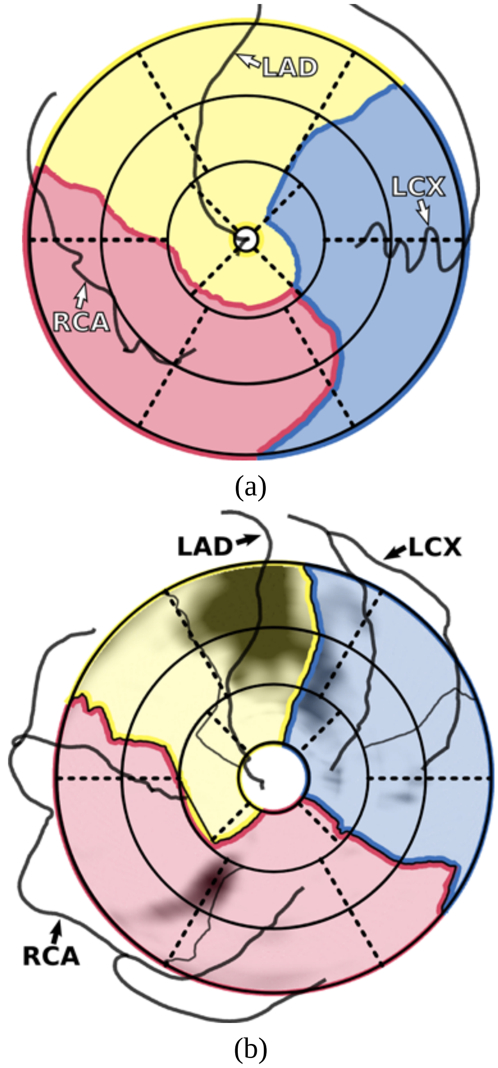

Figure 1. (a) Bull's eye plot showing patient-specific coronary territories. The dotted lines represent the 17-segment model. (b) Patient-specific coronary territories as an overlay on a bull's eye plot of a late enhancement scan.

expressed a preference to our method above the 17-segment model.

The continuous relation between the distance to the center of the bull's eye plot and the distance to the apex caused some confusion with our clinician. This approach may also be less preferable when used in combination with data consisting of only few slices. In the cases where we used MRI scans, the segmentation of the coronary arteries required significant manual adjustment in order to obtain acceptable results. For our CT cases this was not necessary, as there we were even able to segment several side branches. Our approach can optionally use these additional branches to generate more than three coronary territories.

Conclusion: Using our patient-specific approach to determine the coronary territories, detailed information on the coronary anatomy becomes available during analysis.

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