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WORKSHOP PRESENTATION Open Access

Initial experience with isotropic 3D cardiac T_2 mapping for the monitoring of cardiac allograft rejection

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Background

Cardiac T_2 mapping has been suggested for monitoring of acute allograft rejection, since the T_2 relaxation time increases with myocardial edema [1]. Besides its non-invasive nature, the main advantage of T_2 mapping over the reference standard endomyocardial biopsy (EMB) is that it results in a higher spatial coverage of the myocardium. Currently established 2D techniques are used to acquire several slices in short- and long-axis orientation, which should suffice for the detection of moderate to severe rejection (ISHLT degree 2R-3R [2]), since the manifestation of edema is global. However, in the case of the more common mild rejection, the manifestation of edema is localized and patchy, and might thus be missed by a selective 2D visualization. We therefore investigated the performance of a novel 3D cardiac T_2 mapping technique [3] for the detection of acute allograft rejection versus 2D T_2 mapping and EMB.

Methods

28 Patients (age 54 ± 12 y, 24 males) underwent routine EMB as well as 2D and 3D cardiac T_2 mapping at 3T. Navigator-gated 2D T_2 maps [4] (voxel size 1.2 × 1.2 × 5 mm^3) in 3 short-axis slices and a prototype self-navigated 3D radial whole-heart isotropic T_2 map [3] (voxel size 1.7 mm^3) were acquired with 3 T_2-preparation durations and free breathing. After reformatting of the 3D T_2 maps and matching for slice thickness, the 2D and 3D T_2 maps at the same location were segmented according to AHA guidelines [5]. The highest segmental 2D and 3D T_2 values of each patient were compared statistically, and then divided into groups according to their EMB rejection degree. These groups were then tested for differences in T_2 value. The 3D T_2 maps were furthermore directly rendered in 3D, after which they were inspected for foci of T_2 elevation.

Results

EMB analysis indicated allograft rejection in 3 out of 28 cases (i.e. 25 × 0R, 2 × 1R and 1 × 2R). The highest 2D segmental T_2 values of the groups were 49.9 ± 4.0 ms (0R), 48.9 ± 0.8 ms (1R), and 65.0 ms (2R). The reformatted 3D T_2 values agreed very well with the 2D T_2 values for all patients (p = 0.84, Figure 1). While neither of the 1R cases demonstrated significantly elevated segmental T_2 in the 2D or 3D T_2 maps, foci of elevated T_2=58.2 ± 3.6 ms that were not visible on the 2D T_2 maps could be clearly identified in both their rendered 3D T_2 maps (Figure 1B, black arrow).

Conclusions

The investigated 3D cardiac T_2 mapping agreed with the established 2D technique, and enables the identification of foci of elevated T_2 in regions of the myocardium that are not covered by the 2D technique. The 3D cardiac T_2 mapping technique thus appears to be well-suited for the investigation of mild allograft rejection (degree 1R), but this remains to be confirmed in a larger patient cohort.

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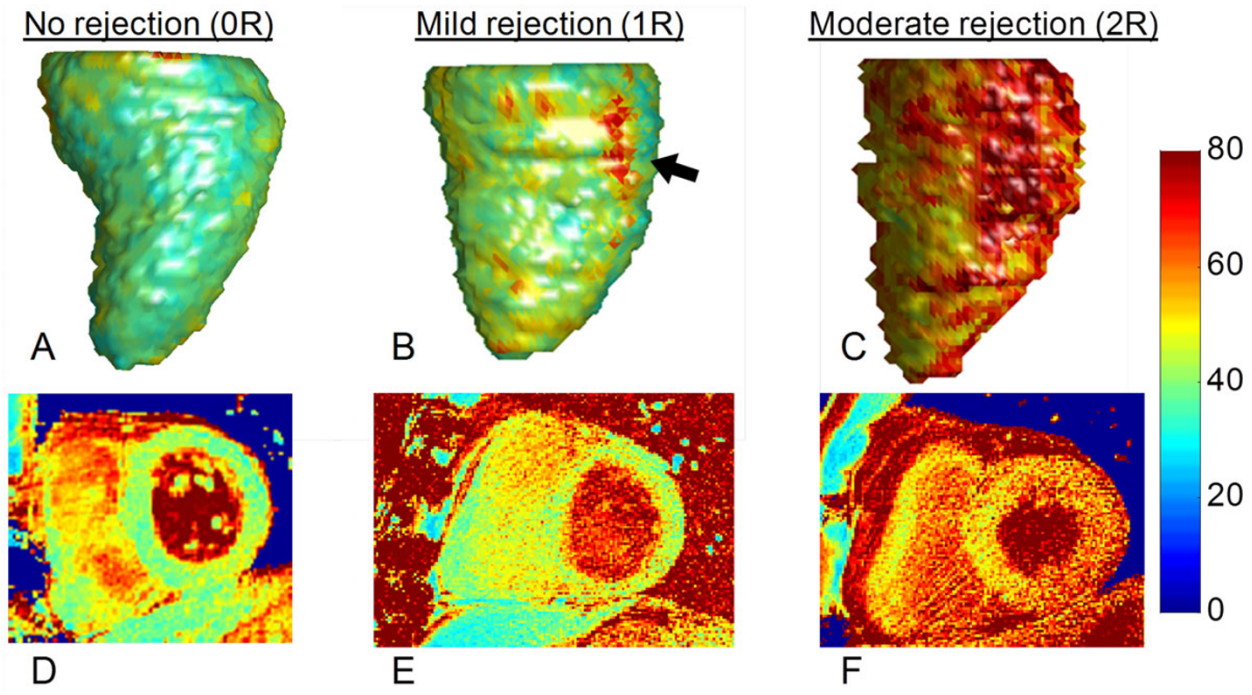

Figure 1 3D & 2D T_2 maps of cardiac allograft rejection. **A-C)** Examples of rendered 3D T_2 maps that were segmented along the center of the endocardium. **D-F)** Corresponding basal 2D T_2 maps. While the segmental T_2 values in 2D T_2 maps of the patients with mild rejection as determined through EMB were not elevated, the corresponding 3D T_2 maps contained myocardial regions with significantly elevated T_2 values (black arrow). The color bar indicates T_2 values in ms for all maps.

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