Free-breathing Semi-automated Quantitation of Area-at-risk Size in Patients with Acute Myocardial Infarction

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Objective

Non-viable myocardium can be detected using the late enhancement magnetic resonance imaging (MRI) technique [1]. Recently, T_2-weighted MRI scans of myocardial edema representing the area at risk in acute myocardial infarction has been introduced [2]. To improve visualization of edematous or hyperenhanced myocardium, blood is often nulled employing black-blood techniques such as a dual-inversion recovery prepulse. However, areas of slow blood-flow in the left ventricular cavity due to reduced left ventricular function will often display enhancement due to insufficient suppression of the blood. Balanced Steady State Free Precession (B-SSFP) is often employed in cardiac examinations due to the excellent contrast between blood and myocardium caused by a combination of T_1 and T_2 relaxation effects. We sought to investigate the use of B-SSFP scans to segment the myocardium accurately to improve depiction of the area at risk in acute myocardial infarction.

Methods

Twelve patients were scanned within a week following a myocardial infarction. For optimal visualization of the myocardium, a free-breathing navigator B-SSFP sequence was used employing 30 dummy shots to achieve steady-state prior to imaging with a resolution of 0.68x0.68x8 mm^3, 12 slices, TR of 4.0 ms, TE of 2.0 ms, and 1 average (Figure 1). A T_2-weighted fast spin-echo scan was used to visualize areas-at-risk with parameters as follows: 12 slices, 0.68x0.68x8 mm^3 voxels, 100 ms echo time (TE), 1558.4 ms repetition time (TR), echo train length of 20, and 2 averages (Figure 2). A short TI inversion recovery (STIR) sequence was used for fat suppression, and a navigator was used to allow free-breathing during acquisition. To ensure acquisition of images at end-diastole, the trigger delays of both scans were identical.

Using B-SSFP scans, the myocardium was segmented semi-automatically using Segment v1.8 (http://segment.heiberg.se) [3] by two independent reviewers. Segmentations were copied into the T_2 STIR images (Figure 3). A region judged to be normal in appearance in the basal slice was used to calculate average image intensity and standard deviations (SD). Areas displaying enhancement of mean + 2 SD and size of 0.1 ml or above were marked in blue, and their cumulative size calculated by both reviewers.

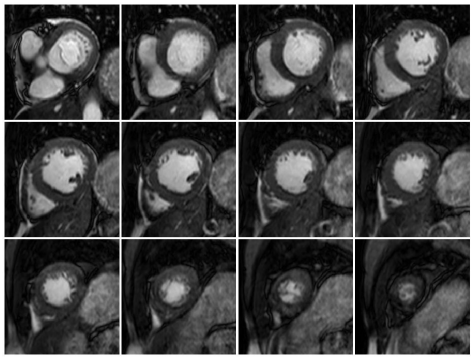

Figure 1: B-SSFP images used to segment the left ventricle. Note the excellent contrast between myocardium and blood typical of this sequence.

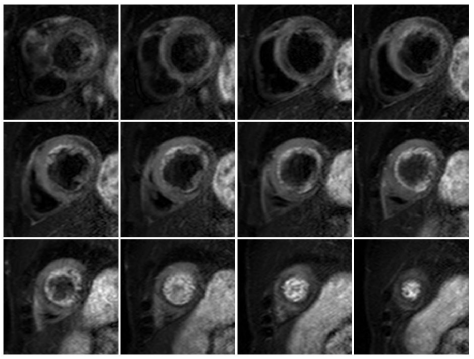

Figure 2: T_2 STIR sequence used to depict areas of edema corresponding to areas at risk.

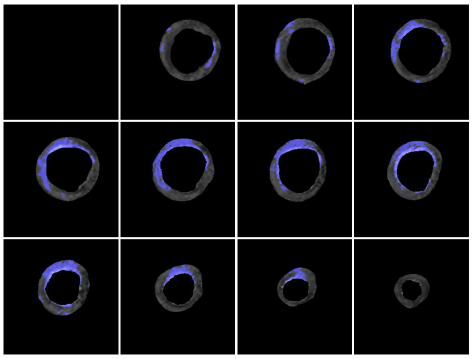

Figure 3: The segmented T_2 STIR images with areas of hyperenhanced myocardium marked in blue.

Results

The mean difference between to reviewers regarding the size of area at risk (defined as tissue exhibiting a signal intensity of above mean + two standard deviations) was 9.37 ml ± 8.54 ml with an average area at risk size of 56.52 ml.

Conclusion

Free-breathing semi automated quantitation of area at risk in patients with acute myocardial infarction was facilitated by the combination of navigator technique and the utilization a B-SSFP sequence to segment the myocardium. This approach may improve diagnostic accuracy and facilitate quantitative measurements of the size of non-viable myocardium and areas-at-risk. Inter-observer variation may be reduced with automated methods of defining a reference area of normal tissue.

References

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