Cardiac Function by SSFP MRI: Accuracy of measurement of left ventricular Ejection Fraction per slice number and location.

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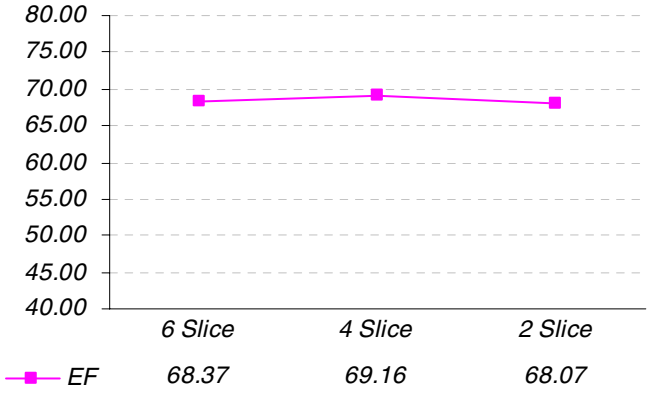
Background: Ejection fraction (EF) by cardiac MR cine is routinely determined by contouring the left ventricular (LV) endocardium at the end-diastolic (ED) and end-systolic (ES) phases on short-axis images. The measured ratio can be affected by excluding or including the papillary muscles or myocardial trabeculations[1]. These trabeculations increase towards the apex, making contouring difficult. Furthermore contouring the base at the level of, or even immediately below, the mitral valve is troublesome due to the valve moving in and out of plane. The labor to accurately contour and measure 6-8 slices can be very time consuming, and so we aimed to determine whether contouring fewer short-axis images, selected at the mid-ventricular level, would generate an EF that might closely approximate the value obtained by contouring all of the slices acquired from base to apex. We assume, for present purposes, that there are no marked regional variations in EF, which is frequently (but not always) the case in patient studies.

Method: 10 normal volunteers (aged 26.4 ± 6.7 years, 6 M), with no symptoms of cardiopulmonary impairment were scanned with a 32 channel coil, 1.5 Tesla MR scanner (Magnetom Avanto, Siemens Medical Solutions, Malvern PA). In all cases, the protocol involved multiplanar, breath-held SSFP (steady state free precession) cine imaging [2]. An average of 10 short-axis cine images were acquired perpendicular to the inter-ventricular septum, from the distal left atrium to the apex, with 30-50 phases per cardiac cycle. Image acquisition was gated to ECG signal. Acquisition time ranging from 5 to 7 seconds.Sequence parameters were: TR/TE = 2.9/1.2 (msec), FA°= 60, BW = 975(Hz/pixel), FOV= (223 -306) x (340 - 350)(mm), matrix of 134 x 350, slice thickness = 6 (mm), segments =12-14, temporal resolution =30-50 (msec). Parallel acquisition with an acceleration factor of 2 was employed routinely for enhanced speed. Post processing was performed on a dedicated workstation (Siemens Leonardo) using Argus software to quantify LV EF. Those slices which lay immediately distal to the base of LV were used to derive ED and ES volumes (6 slices). After analysis was completed for 6 slices, we excluded the most basal and most apical slices from this data set and then re-calculated EF based on the contours of the remaining 4 slices. We repeated this exclusion step once more so that only the 2 middle slices remained, and obtained the EF based on their contours. ANOVA was used to test for statistically significant differences between the 2-, 4- and 6-slice analyses.

Result:

Values for LV EF were found to be within the normal range for all subjects. ANOVA showed that there was no significant difference in the mean values obtained for EF by contouring 6, 4 or 2 slices (68.37 ± 6.38, 69.15 ± 8.62 and 68.07 ± 10.17 % respectively, P=0.958). The time taken for contouring ED and ES phases was 7.39 ± 1.56 minutes, on average, for each slice. This represents a time saving of approximately 30 minutes for the 2 slice over the 6 slice evaluation.



Conclusion:

It is feasible to quantify cardiac EF using as little as 2 representative slices. In patients without marked regional variations in EF, this approach may prove highly practical and time saving.

References:

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