STRAIN-ENCODED MAGNETIC RESONANCE IMAGING PROVIDES REPRODUCIBLE ASSESSMENT OF RIGHT VENTRICULAR REGIONAL FUNCTION

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BACKGROUND

Regional right ventricular function assessment is important in patients with heart failure and arrhythmogenic right ventricular dysplasia. Currently, there is no easily reproducible method for accurate assessment of regional right ventricular (RV) function. To date, the application of MRI with tissue tagging provides the most comprehensive method for assessment of left ventricular and right ventricular regional function. However, regional RV function assessment is often compromised due to incomplete tags resulting from the thin walled RV.

HYPOTHESIS

We hypothesize that the use of through-plane tags in strain encoding (SENC) MRI would permit an easy and reproducible method for assessment of regional RV function; in SENC, signal intensity is directly dependent on the degree of tissue contraction allowing direct quantification of strain.

AIM We aim to test the reproducibility of SENC MRI for assessment of regional RV function in normal human subjects.

METHODS

Normal human volunteers (n=16) were imaged on Philips Achieva 3 Tesla XMR scanner (Philips Medical Systems, Best, The Netherlands) with a 6-element cardiac phased array coil. After initial scouting and obtaining gradient echo cine images in four chamber view, four-chamber SENC images were acquired during a single breath hold throughout 13 heart beats using prospective ECG gating. SENC MRI is based on the acquisition of two images with different phase-encodings, or tunings, in the slice-selection direction. We call these images the low-tuning (LT) and high-tuning (HT) images. Bright regions in the LT and HT images represent static and contracting tissues, respectively. The two images are then combined as described in (1) to result in a strain image, where signal intensity is proportional to the strain value. Strain measurements calculated from SENC images have recently been validated against standard Spatial Modulation of Magnetization (SPAMM) tagging images (2). Figure 1 shows a diagram of the SENC pulse sequence. Imaging parameters are: TR = 14.4 ms; TE = 0.8 ms; flip angle = 40˚; and slice thickness = 8 mm).

DATA ANALYSIS

Images were analyzed using the SENC software package (Diagnosoft Inc., Palo Alto, California). Circumferential systolic strain of the RV was calculated from the SENC MRI four-chamber view. Circumferential myocardial strain was measured during systole at six equidistant points along the RV free wall, starting from base to apex (Fig.2). In order to detect the timing of end-systole from the cine SENC images in the absence of corresponding ECG, peak contraction of the RV free wall was defined as the maximum value of the averaged circumferential strain from the six points. Regional function was defined as the strain value of each point at the time of peak contraction. Intra-observer and inter-observer variability were calculated by using the intra-class correlation coefficient (R).

RESULTS

The SENC MRI measured myocardial strains for the basal, mid and apical regions of the RV free wall were (mean ± standard deviation): -20.4 ± 2.9, -18.8 ± 3.9 and -16.5 ± 5.7, respectively. Regional myocardial strain measurements demonstrated low intra- and inter-observer variability (r = 0.85 / 0.85, 0.79 / 0.78 and 0.93 / 0.84 for the basal, mid and apical regions, respectively). The overall intra- and inter-observer variability were r = 0.85 and 0.82, respectively.

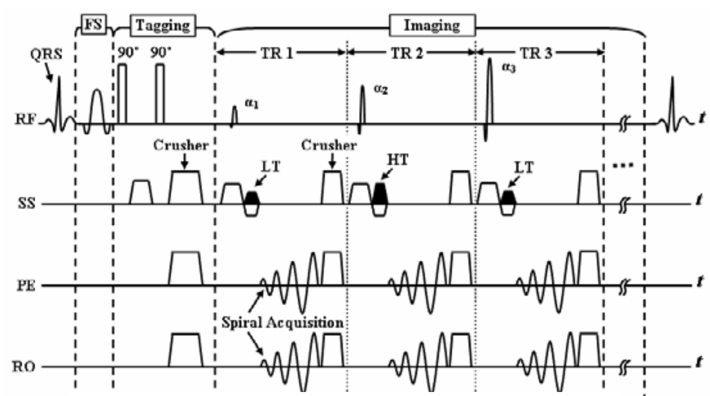

Figure 1. The pulse sequence diagram

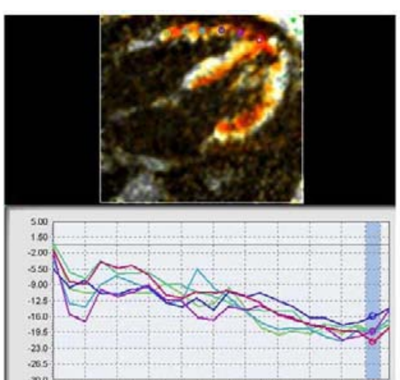

Figure 2: Four-chamber SENC MRI view at the end-systolic frame showing the position of the six points along the RV free wall and the corresponding strain curves. Y axis shows the strain values and the X axis shows the time frames.

CONCLUSIONS

SENC MRI allows rapid and reproducible quantification of regional RV function in healthy volunteers and has the potential for objective assessment of regional strain in patients with RV dysfunction.

REFERENCES

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