High Temporal Resolution Breath-held 3D FIESTA CINE: Validation of Ventricular Function in Patients with Chronic Myocardial Infarction

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Introduction

The acquisition of MR data needed for an evaluation of global cardiac function consumes a significant portion of the allotted exam time. Cardiac function images are typically acquired using an ECG-gated, breath-held 2D CINE steady-state free precession (SSFP) acquisition. Complete heart coverage consumes 6-8 minutes as 8-12 slices are acquired with rest periods between breath-holds. A breath-held, retrospectively gated 3D CINE SSFP acquisition (3D FIESTA CINE) has been shown to provide similar image quality to the commonly used breath-held 2D CINE [1]. 3D FIESTA CINE uses a variable temporal sampling technique to reduce the scan time to a 29-heartbeat acquisition, acquiring the low spatial frequency data at a higher temporal resolution than the outer portion of k-space.

One limitation of the original 3D FIESTA CINE implementation was the poor acquired temporal resolution (96/192ms inner/outer k-space). In this study parallel imaging was added to 3D FIESTA CINE to improve the temporal resolution. We demonstrate the equivalency in global ventricular function measurements of the proposed 3D CINE technique against the conventional 2D approach in a patient population.

Methods

Parallel imaging (ASSET) was added to 3D FIESTA CINE to reduce the number of acquired phase-encode lines in k-space by a factor of 2. The efficiency achieved using ASSET then permitted the reduction of the views per segment (VPS) to 1 and 2 (from 2 and 4) for the inner and outer k-space regions respectively, thereby increasing the temporal resolution by a factor of 2.

Eight patients (5 male, 3 female; mean age: 54±14 years; mean weight: 80±17 kg) with chronic myocardial infarction were scanned under an IRB approved protocol. A double-oblique short axis volume was acquired using 3D FIESTA CINE with ASSET on a 1.5 T Signa CV/i scanner (GE Medical Systems, Waukesha, WI). The imaging parameters were as follows: TE/TR/flip 1.9/4.0/45^o;256x128 matrix;0.5 NEX;48x43.2 cm FOV;8-10mm slice thickness; ±125 kHz bandwidth; central/outer k-space temporal resolution 48/96 ms. For comparison, double-oblique short axis 2D FIESTA CINE images were acquired with typical parameters of: TE/TR/flip 1.6/3.6/45^o;256x160 matrix;1 NEX;40x40 cm FOV;8 mm slice thickness;4 mm spacing; acquired temporal resolution 43 ms; average breath-hold time of 12 seconds.

Quantification was performed using a custom research application, CINE tool (GE Medical Systems, Waukesha, WI). LV volumes were analyzed with manual tracing of the endocardial borders.

Results

Images acquired with the 3D FIESTA CINE acquisition showed good contrast between the blood and myocardium with a total acquisition time of 28±*2* seconds (Figure 1). There was a good correlation of the end diastolic volume (EDV), end systolic volume (ESV) and ejection fraction (EF) between the 3D FIESTA CINE and 2D FIESTA CINE as seen in Table 1. There was no significant difference found in the EDV, ESV or EF between the two methods.

Conclusions

By adding parallel imaging to 3D FIESTA CINE we were able to increase the acquired temporal resolution and demonstrate the clinical effectiveness of the imaging method. Using a single breath-hold, whole heart coverage could be attained saving minutes off the standard cardiac MR examination. Moreover, only a single, albeit longer, breath-hold was required compared with the 8-12 breath-holds for the 2D studies.

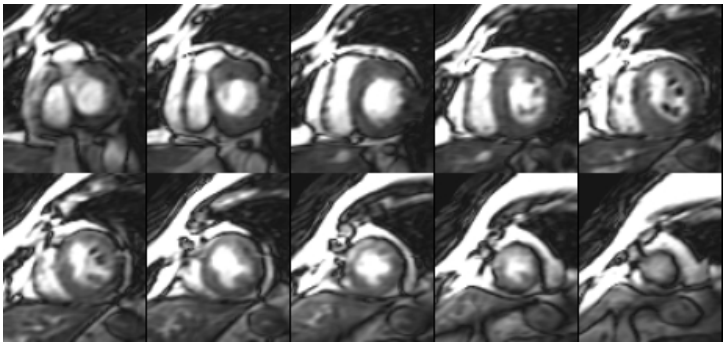

Figure 1. End-diastolic cardiac phase of 3D FIESTA CINE

References

1. Rettmann, D, Proc ISMRM 2002; 784.

Technique	EDV(cc)	ESV(cc)	EF(%)
3D	*168.08±72.56*	*80.66±62.10*	*55.29±13.68*
2D	*177.19±59.42*	*79.38±52.87*	*57.74±13.82*
Mean Difference	*-9.12±21.62*	*1.28±14.74*	*-2.46±4.19*
R^2	*0.93*	*0.96*	*0.91*
P	*0.27 (NS)*	*0.81 (NS)*	*0.14 (NS)*

Table 1. Results of quantification of 3D vs. 2D FIESTA CINE.