FEASIBILITY OF ENTIRE CARDIAC MRI EXAMINATIONS DURING FREE BREATHING USING GRICS MOTION CORRECTION

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TARGET AUDIENCE

MR scientists and clinicians interested in motion correction and cardiac MRI.

PURPOSE

Cardiac MRI examinations are complex and conventionally rely on patient cooperation (breath-holding). Besides patient discomfort, the extensive use of breath-holding has several practical drawbacks: i) the scanner idle time is high due to the need for pauses between sequences for the patient to recover and for giving instructions to the patient, making the overall examination relatively inefficient; ii) the image quality is often sacrificed using acceleration methods (lowering SNR by at least $R^{1/2}$ with R the acceleration factor) especially for 3D post-contrast acquisition; iii) images from different slices/sequences are misregistered making the post-processing inefficient. In this work we evaluate the feasibility and potential benefit of a complete cardiac MRI examination during free-breathing using GRICS motion correction [1].

MATERIAL & METHODS

Complete free-breathing cardiac MRI examination was performed in 5 patients with Duchenne muscular dystrophy (age range: 8 to 20 years old) using a 1.5T Signa HDxt General Electric scanner. The protocol included: localizer scans and sensitivity map calibration; pre-contrast function assessment by 2D cine imaging (2D balanced SSFP, 224x224 matrix, 45° flip angle, 8 mm slice thickness, whole heart short-axis coverage); post-contrast 2D cine (2D balanced SSFP, same parameters except 60° flip angle, only 3 short-axis slices, one 2-chamber slice and one 4-chamber slice); fibrosis assessment by 3D late Gadolinium enhancement (“3DMDE”, 256x192 matrix, 8 mm slice thickness, TI=200ms, short-axis, 2-chamber and 4-chamber orientation). Physiological data, including ECG and 2 respiratory belts, were acquired and recorded using a custom real-time system [2]. For patients with highest heart rates (range was 100 to 125 bpm), our real-time system allowed late enhancement data to be acquired every two heart beats to reduce corruption of the image contrast due to RR variations.

For all cine and late enhancement datasets GRICS reconstruction was used to correct for non-rigid respiratory and cardiac motion (intra-cardiac window motion).

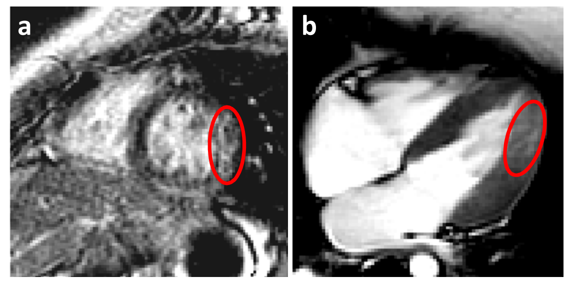

Fig.1 Example motion-corrected images obtained from the free-breathing protocol (patient 1): 3D late enhancement (a); post-contrast 2D cine (b). The presence of diffuse fibrosis in the lateral segments is indicated in red.

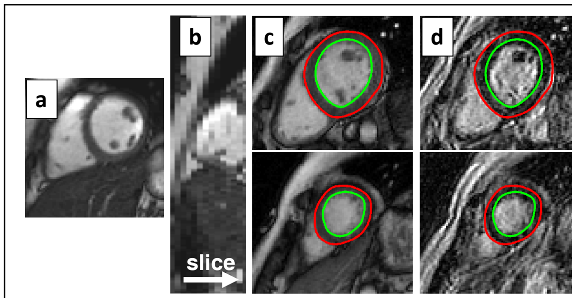

Fig.2 Illustration of the motion-consistency through the examination (patients 2 and 3): slice-to-slice consistency in 2D short-axis cine stacks (a) after reformatting to a long axis view (b); endocardium and epicardium ROIs segmented on two cine slices (c) and copy/pasted onto the 3D late enhancement images (d). Both examples show consistent alignment of the GRICS reconstructed data with no need for post-processing registration.

RESULTS

Data were successfully acquired and reconstructed with all 5 patients. Ejection fractions were measured to be 53% (+/- 8%). An experienced cardiologist identified the presence of fibrosis in 2 of the 5 patients (see example in Fig.1). With regard to motion, GRICS reconstructed data were highly consistent from one acquisition to another as was observed from 2D cine slice-to-slice alignment and from combined analysis of cine and 3DMDE volumes (see Fig.2).

CONCLUSION

These preliminary results in patients with breathing difficulties suggest that complete cardiac MRI examinations might be performed during free-breathing with GRICS motion correction.

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REFERENCES

[1] Odille *et al.*, MRM 2008, 60:146-157; [2] Odille et al., IEEE TBME 2007, 54:630-640