Journal of Cardiovascular Magnetic Resonance

Poster presentation

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Validation of a fast method for quantifying left ventricular torsion

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from 13th Annual SCMR Scientific Sessions
Phoenix, AZ, USA. 21-24 January 2010

Published: 21 January 2010

Journal of Cardiovascular Magnetic Resonance 2010, **12**(Suppl 1):P252 doi:10.1186/1532-429X-12-S1-P252

This abstract is available from: http://jcmr-online.com/content/12/S1/P252

Purpose

To develop and validate a quantitative method, requiring limited user interaction, for the fast calculation of left ventricular (LV) torsion.

Introduction

LV torsion is an important measure of LV performance [1,2]. Torsion is the difference in the angle of rotation between apical and basal slices. Rotations in image space directly correspond to rotations in Fourier space; therefore it is possible to exploit this property and measure LV torsion in *k*-space.

Methods

Short-axis tagged images were acquired at 1.5 T in six beagle dogs using the 3D fast gradient echo pulse sequence with the following parameters: 180 × 180 × 128-160 mm field of view (FOV), 384 × 128 × 32 acquisition matrix, 12° imaging flip angle, ± 62.5 kHz receiver bandwidth, TE/TR = 3.4/8.0 ms, and five pixel tag spacing. Tissue tags in two short axis slices were tracked semi-automatically using the FindTags [3] software to define "gold standard" results.

Tissue Tag Tracking

Estimates of LV rotation at each slice level in each time frame were obtained from the rotation of horizontal and vertical tag intersections about the LV centroid determined using FindTags.

k-space Cross Correlation

The only user interaction needed for processing is contouring of the LV epicardium in the first time frame. After masking, the LV epicardial edge was smoothed to reduce ringing in *k*-space before Fourier transformation. The *k*-space magnitude data for each frame was 2D cross-correlated with a rotated version (-1° to 1° with step-size of 0.25°) of the frame immediately after it within the same slice. The maximum of the cross-correlation from all

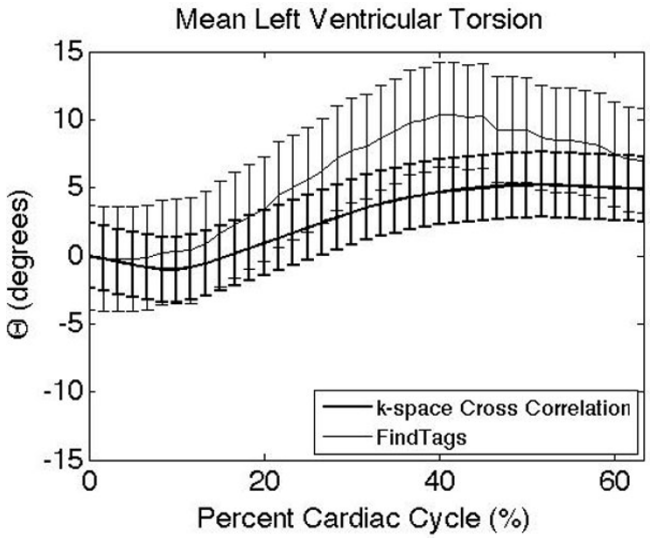

Figure 1

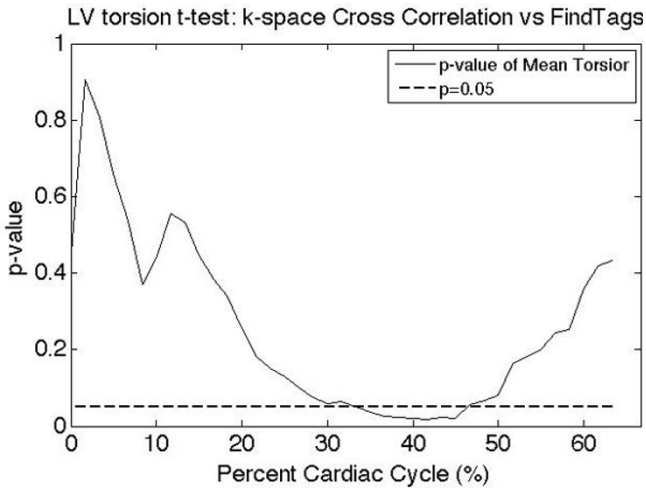

Figure 2

tested rotations defined the angle of rotation between the first frame and each subsequent frame.

Results

Figure 1 compares FindTags and *k*-space cross-correlation (mean ± SD for each method). In Figure 2, p-values from a t-test demonstrate significant differences between the two groups only during 35% to 45% (late systole) of the cardiac cycle. Figure 3, shows a Bland-Altman analysis; it is clear that there is good agreement between the two techniques for calculating mean torsion with a bias (XCorr-FindTags) of -3.1° and 95% confidence intervals of (-12.9, 6.7).

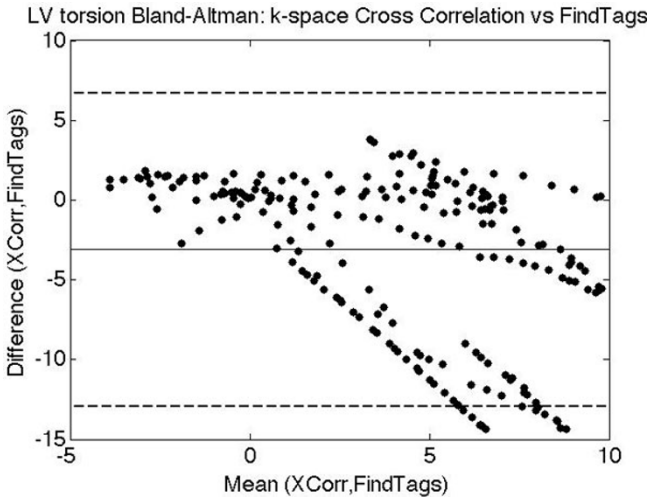

Figure 3

Conclusion

We have developed a fast, user friendly, and accurate algorithm for computing global LV torsion. Refinements in image acquisition and k-space processing should improve the overall accuracy.

References

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