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INTER-STUDY REPRODUCIBILITY OF STRAIN MEASURMENTS BY CARDIAC MRI: A COMPARISON OF FEATURE TRACKING, SINGLE BREATH-HOLD TAGGING AND MULTI BREATH-HOLD TAGGING

A Singh,[1] C D Steadman,[2] J N Khan,[1] S A Nazir,[1] G P McCann[1] [1]*Glenfield Hospital;* [2]*University Hospital of North Staffordshire*

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Introduction Strain and strain rate are important indices of LV function and are of prognostic value in many cardiac conditions. The current gold standard for its measurement is myocardial tissue tagging using cardiac MRI (CMR) that requires acquisition of additional sequences and semi-automatic post-processing. Feature tracking (FT), a technique that relies on automatic tracking of voxels of tissue at the cavity-tissue interface throughout the cardiac cycle, has recently been introduced and shown to have reasonable inter-study reproducibility (Cofficient of variation (CoV) ~20%) in healthy volunteers. The inter-study reproducibility of FT has not been reported in any patient groups nor compared to MRI tagging. We sought to compare circumferential strain and strain rate values using Tagging and FT, and determine their inter-study reproducibility in patients with severe Aortic Stenosis (AS).

Methods CMR was performed twice on eight patients with isolated severe AS without obstructive coronary disease, on a 1.5 T (Siemens Avanto) scanner (median interval 12 days). Complementary tagged (CSPAMM) images were acquired with both single breath-hold (SBH: temporal resolution 42 ms) and multiple breath-hold (MBH: high temporal resolution 17 ms) sequences. InTag post-processing toolbox (Creatis, Lyon, France) in OsiriX (Geneva, Switzerland) was used to calculate the Circumferential Peak Systolic Strain (PSS), Peak Systolic Strain Rate (PSSR) and Peak Early Diastolic Strain Rate (PEDSR).

Table 1 Mean values

Measurement	Region	SBH (Mean ±SD)	MBH (Mean ±SD)	FT (Mean ±SD)
PSS	Global	−17.02±3.42*,**	−19.12±3.54*	−28.68±3.39
	Mid-ventricular	−18.13±3.39	−19.64±3.51	−19.20±3.47
	Base/mid average	−17.97±3.43	−19.28±3.17	−18.84±2.27
PSSR	Global	−0.80±0.07*,**	−0.93±0.11*	−1.85±0.39
	Mid-ventricular	−0.88±0.09*	−0.95±0.11*	−1.24±0.35
	Base/mid average	−0.85±0.08*	−0.92±0.08*	−1.14±0.22
PEDSR	Global	1.01±0.31*,**	1.21±0.36*	1.78±0.54
	Mid-ventricular	0.98±0.32	1.14±0.37	1.14±0.38
	Base/mid average	0.95±0.28	1.17±0.35	1.09±0.25

Table 2 Inter-study reproducibility

Technique	Region	Mean difference (±SD)	CoV (%)
SBH (PSS; PSSR; PEDSR)	Global	−0.33 (2.06); −0.01 (0.07); 0.02 (0.18)	12.19; 9.36; 17.53
	Basal/mid average	−0.59 (1.64); −0.03 (0.07); 0.04 (0.11)	9.27; 8.87; 11.74
MBH (PSS; PSSR; PEDSR)	Global	−0.73 (1.45); −0.02 (0.06); 0.05 (0.18)	7.71; 6.85; 15.08
	Basal/mid average	−0.19 (1.07); −0.02 (0.09); 0.08 (0.16)	5.59; 10.14; 14.43
FT (PSS; PSSR; PEDSR)	Global	−0.14 (1.81); 0.00 (0.16); 0.11 (0.16)	8.65; 11.80; 13.07
	Basal/mid average	−0.44 (1.70); −0.05 (0.07); 0.10 (0.12)	9.13; 6.31; 11.10

*Statistically significant difference compared to FT ($p<0.05$)
**Statistically significant difference compared to MBH ($p<0.05$)

Diogenes CMR FT software (TomTec Imaging Systems, Munich, Germany) was used to calculate the same parameters on the short-axis stack of SSFP cine images at basal, mid and apical levels, using an average of epicaridal and endocardial contours.

Results PSS, PSSR and PEDSR were calculated globally (average of base, mid, apex) as well as individually for each slice. FT revealed overall higher values for global measurements than with both tagging techniques ($p<0.05$ for SBH/MBH values vs FT) (table 1). However, excluding the apical slice, there was no difference between the PSS and PEDSR between the Tagging techniques and FT. The inter-study reproducibility results are shown in Table 2. Results were comparable between Tagging and FT. The apical slice was found to be the least reproducible (CoV 20.38%, 19.69%, 16.77% for SBH, MBH and FT respectively). Excluding the apical slice improves the reproducibility of both tagging and FT.

Conclusions This study has demonstrated that Global PSS, PSSR and PEDSR values are considerably higher with FT than Tagging in patients with severe AS unless the apical slice is excluded. The reproducibility of strain and strain rate measurements with FT are comparable to that of tagging in severe AS patients. Given that FT does not require additional image acquisitions to standard cine images this technique is likely to become the preferred method for strain and strain rate quantification with MRI.

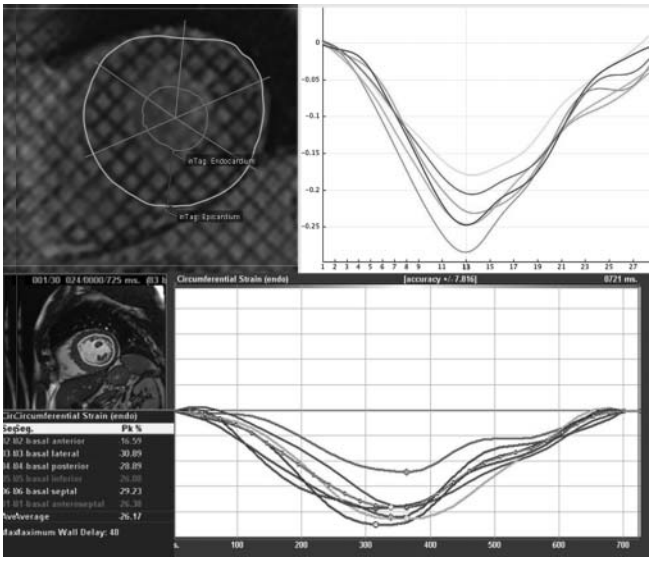

Figure 1 Tagging and feature tracking techniques.