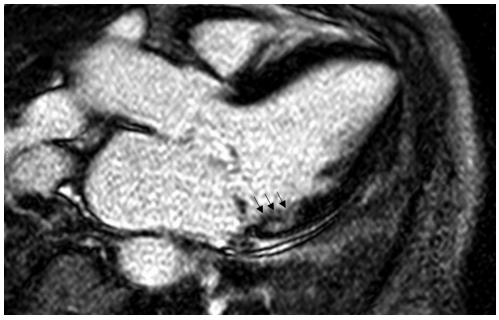
changes within the RV that are associated with adverse surgical outcomes and poorer prognosis following mitral valve surgery. Future studies are needed to confirm whether LGE is a new imaging biomarker that can be used to risk stratify severe asymptomatic MR patients for surgery.

Abstract 110 Table 1 Features of patients with and without gadolinium enhancement

Late gadolinium enhancement	Number of patients	MR fraction (%)	Systolic RV volume (ml/m^2)	RV ejection fraction (%)	Peak VO_2(ml/kg/min)	VE/VCO_2
None	43	32±12	28.5±7.7	61±8	24.6±6.9	31.1 ±5.0
RV insertion gadolinium	8	46±17*	31.4±7.6*	55±6*	23.1±8.7	33.2 ±3.2*
LV myocardial gadolinium	10	42±19*	35.1±11.1*	55±8*	23.0±5.9	36.7 ±6.9*

*denotes statistical significance of P0.05 compared to non-gadolinium cohort on Independent samples 2 tailed T-Test



Abstract 110 Figure 1 Late gadolinium enhancement of the basal inferolateral LV

111 NEW NORMAL RANGES AND SUPERIOR REPRODUCIBILITY OF 3D MYOCARDIAL STRAIN ON CARDIOVASCULAR MAGNETIC RESONANCE-FEATURE TRACKING

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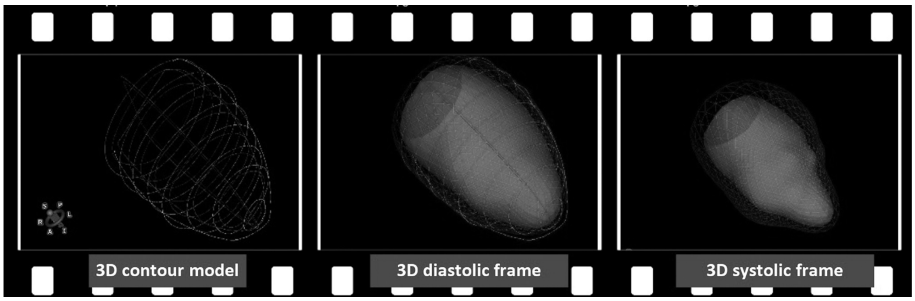
Background Myocardial deformation can be key to clinical decision. 2D feature-tracking of cardiovascular magnetic resonance (CMR-FT) imaging is user-friendly but has poor reproducibility, particularly for radial strain. 3D CMR-FT may improve repeatability by reducing through-plane artefact. The aim of this study was to provide normal ranges for 3D CMR-FT and compare its reproducibility to older generation 2D CMR-FT.

Method 56 asymptomatic, healthy subjects (43.7±12.9 year, 52% male) undertook CMR (1.5 Tesla scanner Magnetom Avanto, Siemens, Erlangen, Germany). 3D FT-CMT was generated using the SSFP HLA, VLA and short axis cine images (Figure 1). A single observer (BL) analysed the CMR studies using 2D and 3D CMR-FT (Circle cvi$^{42®}$ version 5.3) and after 4 weeks, re-analysed blinded scans for intra-observer variability. Inter-observer variability was generated by separate tracking by a second blinded observer (AS) in a randomly generated subset of 15 subjects. Agreement was tested by calculating mean bias and 95% limits of agreement (confidence intervals) from Bland–Altman analyses, coefficient of variation, and inter-class correlation coefficient (ICC).

Results There is modest agreement between all measures of 2D and 3D peak strain analysis (ICC=0.44 to 0.58). Mean global circumferential strain (GCS) on 3D analysis is −16.8 ±2.5, compared to 2D GCS of −20.2±3.31 and −20.6 ±3.4 at the base and mid-ventricular level respectively. Mean

Abstract 111 Table 1 Intra- and inter-observer reproducibility for 2D and 3D CMR-FT

Variability	Mean 3D bias±SD	Mean 2D bias±SD	T-Test on 2D vs 3D bias	3D intraclass correlation coefficient (95% CI)	2D intraclass correlation coefficient (95% CI)
GLS Intra-observer	1.73±1.43	1.85±1.52	p=0.70	0.64 (0.38 to 0.79)	0.67 (0.50 to 0.79)
GLS Inter-observer	1.11±1.48	1.58±1.91	**p=0.25**	0.53 (0.04 to 0.82)	0.62 (0.19 to 0.85)
GCS Intra-observer	1.10±1.10	1.87±1.74	**p<0.01**	0.81 (0.67 to 0.89)	0.75 (0.61 to 0.85)
GCS Inter-observer	1.02±1.22	2.08±2.28	**p=0.03**	0.79 (0.79 to 0.88)	0.56 (0.04 to 0.83)
GRS Intra-observer	6.66±8.06	8.90±9.71	**p=0.10**	0.63 (0.44 to 0.77)	0.61 (0.42 to 0.75)
GRS Inter-observer	6.13±7.48	10.78±12.67	**p=0.04**	0.67 (0.27 to 0.87)	0.35 (-0.09 to 0.71)



Abstract 111 Figure 1 Generation of 3D CMR-FT model through HLA, VLA and short axis contours

global longitudinal strain (GLS) is −13.7±2.3 on 3D CMT-FT and −19.3±2.7 on 2D CMR-FT. Global radial strain (GRS) is 45.5±10.9 for 3D, compared to 55.1±14.4 and 48.0±13.4 at the base and mid-ventricular level respectively.

Table 1 displays the inter- and intra-observer variability of each technique. Intra-observer variability was significantly improved by 3D CMT-FT for GCS, whilst inter-observer variability was significantly improved for GCS, GRS and strain rates. No reproducibility differences were identified for GLS.

Discussion Peak strains using 3D FT-CMR is different to 2D normal range values. 3D CMR-FT has superior intra- and inter-observer reproducibility compared with 2D CMR-FT, particularly for GCS and GRS strain, the latter being the principal systolic strain and should improve detection of sub-clinical ventricular dysfunction.

112 EVALUATION OF PATIENTS WITH LEFT VENTRICULAR THROMBUS USING INTRA-CARDIAC BLOOD VISUALISATION WITH 4D FLOW

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Introduction Ventricular thrombus is a serious complication in a subgroup of left ventricular dysfunction (LVD) patients because of the risk of embolisation. Thrombus occurs as a consequence of stasis, hypercoagulability and endothelial injury. There are no reliable predictors for which patients will develop thrombus. 4D flow CMR may allow insights into thrombus formation by intra-cardiac blood flow visualisation. We hypothesise that in patients with LV dysfunction and thrombus, compared to those without thrombus, the residual volume would constitute a similar proportion of the LV end diastolic volume (EDV) but possess less kinetic energy, thereby predisposing the blood to stasis and therefore thrombus formation.

Methods 100 participants (47 LV dysfunction but no thrombus (LVD) patients, 17 LV dysfunction and thrombus patients and 36 controls underwent CMR (Table 1)). LV flow was analysed as 4 components; direct flow, retained inflow, delayed ejection flow and residual volume. Each components volume was calculated in proportion to the EDV. The kinetic energy of the blood per millilitre was summed throughout the cardiac cycle and divided by the cycle length to calculate the average kinetic power. 25 controls, 14 LVD and 14 thrombus patients returned for an interval scan to assess the stability of flow parameters.

Results Both patient groups had significantly increased residual volume (LVD 50±10%, thrombus 51±12% vs 30±4% controls, p 0.001) and decreased direct flow (LVD 11±7%, thrombus 16±10% vs 38±4% controls, p 0.001). There was no difference between the 2 patient groups (Fig 1A). The average kinetic power of the residual volume was significantly higher in the LVD group (0.55±0.30 microJ/ml) compared to the thrombus group (0.38±0.16 microJ/ml, p 0.02) (Fig 1B). No difference between patient groups was seen for the direct flow average kinetic power (Fig 1C). 4D flow parameters were similar between visits with no significant change on paired t-tests (Table 2). The average kinetic power of the residual volume was higher in the LV dysfunction than thrombus group at visit 1 and 2, but failed to reach statistical significance with the smaller cohorts.

Discussion The residual volume blood of thrombus patients possessed less kinetic power than that of LV dysfunction patients with a well matched LV size, impairment and

Abstract 112 Table 1 Clinical characteristics of controls, LV dysfunction and thrombus patients.

	Controls (n=36)	LV dysfunction (n=47)	Thrombus (n=17)	P value (between all groups)
Demographics				
Age (yrs)	57 ± 12	59 ± 13	62 ± 14	0.399
Male, n (%)	25 (70)	37 (79)	13 (76)	0.62
IHD, n (%)	-	17 (36)	13 (76)	0.0007
Body mass index (kg/m^2)	25 ± 4	28 ± 4	29 ± 4	0.006
Systolic BP (mmHg)	134± 20	125± 18	122± 17	0.04
Diastolic BP (mmHg)	78 ± 10	71 ± 11	70 ± 10	0.004
Heart rate (bpm)	64 ± 14	64 ± 13	68 ± 15	0.542
Prognostic markers				
BNP (pmol/L)	7 ± 5	44 ± 64	115± 166	<0.0001
6 minute walk test (m)	624± 77	490± 91	476± 99	<0.0001
Minnesota Heart Failure Questionnaire	-	21 ± 21	15 ± 16	0.294
CMR results				
LV EF (%)	67 ± 4	37 ± 10	38 ± 15	<0.0001
LV EDV (ml)	159± 31	257± 101	239 ± 95	<0.0001
Left atrial EF (%)	56 ± 6	40 ± 11	36 ± 17	<0.0001
LV sphericity index	1.7 ± 0.2	1.4 ± 0.2	1.5 ± 0.2	<0.0001
Mid LV short axis peak systolic circumferential strain (%)	-19 ± 3	-10 ± 4	-13 ± 4	<0.0001
Mid LV short axis peak diastolic circumferential strain rate (s^{-1})	83 ± 19	49 ± 20	54 ± 19	<0.0001