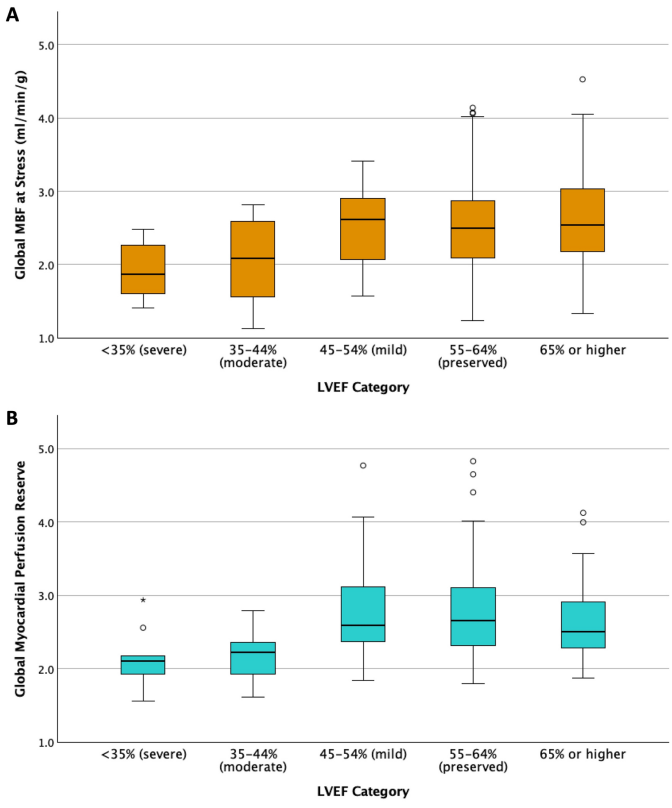

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Kiosk 9R-TA-01

Automated CMR Index of Left Ventricular Diastolic Function (e'): A Validation Study Against Echocardiography in the Large-scale beta3-lvh Trial

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Background: Diastolic function assessment is important in heart disease diagnosis and management, traditionally measured using echocardiography. CMR can also assess diastolic function using routine long-axis cine images, by tracking the mitral valve annular motion, to estimate the early diastolic velocity (e'). Pilot studies have demonstrated good accuracy of CMR e' compared with echocardiography e' [1, 2], but this requires manual annotation of the mitral annular points and is time-consuming. We have developed a deep learning approach to automatically track the mitral valve annular motion (MVnet) in four-chamber and two-chamber long-axis cines to derive e' [3]; however, large-scale validation is needed to systematically test its performance in routine clinical practice. This study aims to compare the accuracy of MVnet against echocardiography derived e', using the large dataset from the Beta3-LVH trial [4], for automatic measurement of diastolic function in CMR.

Methods: The Beta3-LVH trial was a multicentre study, with 296 patients diagnosed with hypertensive heart disease across 10 clinical sites in 8 European countries [4]. It incorporated up to three scans, including CMR and echocardiography, in different time points. A total of 715 paired CMR and echocardiograms were used. MVnet was automatically deployed in all CMR scans. Each paired long-axis cine was manually scored as either good, average, or low quality, based on the analysability of the mitral valve annular points, blinded to the model predictions. Transthoracic echocardiography scans provided averaged e' measures. Modality comparisons were assessed using Pearson correlation (r) and Bland-Altman analysis.

Results: From the 715 paired CMR and echocardiograms, the number of good, average, and low quality long-axis cines were 87, 401 and 227, respectively. Overall, CMR e' significantly correlated with echocardiography (Table 1, $p < 0.0001$) and all values were derived nearly instantaneously (<1 second per cine) without manual editing. In good quality cines, CMR e' had a strong Pearson correlation ($r = 0.648$) with low bias (-1.9 ± 1.6 cm/s) (Figure 1), consistent with previous pilot studies [1, 2]. In average quality cines, the Pearson correlation was moderate ($r = 0.519$) with low bias (-1.9 ± 1.9 cm/s). In low quality cines, the Pearson correlation was weaker ($r = 0.258$), with an increased bias (-3.0 ± 2.4 cm/s).

Conclusion: MVnet offers a viable and fast way (<1 second per cine) to automatically measure diastolic function on CMR using routine cine images. In this study, CMR slightly underestimated e' when compared to echocardiography. The results underline the importance of quality control in selecting long-axis cines for data reliability. CMR cines with higher temporal resolution may mitigate the underestimation of e'. Automated tools such as MVnet may enable CMR to routinely and reliably estimate diastolic function, expanding its clinical applications.

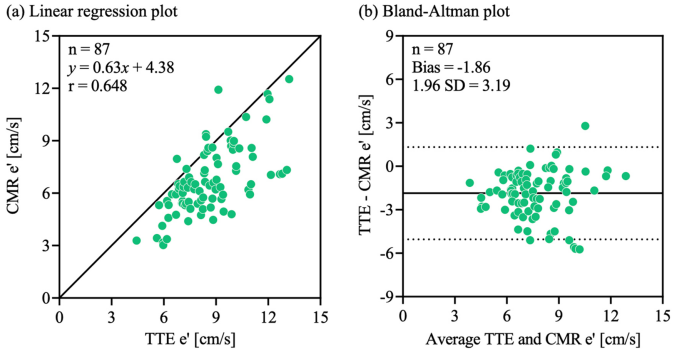

Table 1. Validation of early diastolic velocity (e', cm/s) by cardiovascular magnetic resonance (CMR) against transthoracic echocardiography (TTE) stratified according to good, average and low quality cines from the Beta3-LVH clinical trial. All Pearson correlations were significant ($p < 0.0001$).

Datasubset	TTE e'measures	CMR e'measures	Error measures	Pearson correlation
Good quality cines (n = 87)	8.6 ± 1.9	6.7 ± 2.0	-1.9 ± 1.6	0.648
Average quality cines (n = 401)	8.0 ± 1.9	6.1 ± 1.9	-1.9 ± 1.9	0.519
Low quality cines (n = 227)	7.9 ± 2.1	5.3 ± 1.9	-3.0 ± 2.4	0.258

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Kiosk 9R-TA-02

Gadolinium-FBee Virtual Native Enhancement for Chronic Myocardial Infarction Assessment: Independent Blinded Validation and Reproducibility Between Two Centres

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Background: CMR Virtual native enhancement (VNE) imaging is an emerging technique that can generate virtual LGE images without the need for contrast administration [1,2]. VNE uses deep learning to enhance native T1-mapping and cine imaging to detect myocardial scar. Following initial single-centre validation at the University of Oxford [2] multicentre validation is required prior to wider clinical adoption. For the first time we present prospective blinded assessment of VNE and LGE to assess VNE's ability to detect chronic myocardial infarction (MI) with an external, independent centre at the University of Leeds.

Methods: The Leeds team prospectively recruited and scanned 22 patients with either known or suspected chronic MI. In addition to their prescribed CMR scan (1.5T), 3 short-axis slices of T1-mapping (ShMOLLI) [3], pre-contrast SSFP cine and post-contrast MOCO LGE were acquired with matching slice positions. Only the T1-mapping and pre-contrast cine data were sent to the Oxford team to generate 3 matching slices of VNE images, blinded to LGE and all other clinical and CMR data. There was no additional training of the originally proposed VNE algorithm. VNE short-axis data were first assessed by a single CMR cardiologist (VMF), classifying patient cases and slices as having definite infarct, possible infarct, no infarct, or non-ischaemic pattern. After assessing the VNE image, the quality of T1-maps and cine images were assessed; poor quality cines or T1-maps deemed to affect VNE quality would lead to rejection of the slice. The Leeds team (PT, PS), blinded to VNE images, independently determined scar based upon the LGE scan and clinical information.

Results: Overall, 2/22 (9%) patients and 17/66 (26%) slices were unsuitable for VNE generation, due to artefacts in cine or T1-maps. Of the remaining 20 patients, 8 had MI on LGE. Based solely on the information provided in the 3 short-axis VNE slices, the blinded VNE observer identified all 8 MIs correctly (7 classified as definite and 1 as possible infarct). No patient without infarction on LGE was misclassified by blinded VNE analysis.

On a per slice analysis, 13/49 (27%) slices with infarction and 29/49 (59%) without infarction were classified correctly (86% agreements). 3 individual slices from 3 different patients with infarction on LGE were misclassified by VNE analysis as having no infarction (false negative; two VNE slices missed small subendocardial LGE signals, one picked up by VNE but hazy signals). There were no false positives.

Conclusion: This first, independent centre, blinded, prospective validation of VNE analysis supports its high propensity to detect LGE hyperintensities in patients with chronic myocardial infarction. These data confirm the potential of VNE as a contrast-free alternative for viability CMR, particularly for patients in whom gadolinium contrast is contraindicated. This finding paves the way to designing further trials to validate VNE in larger multi-centre studies for wider clinical applications.

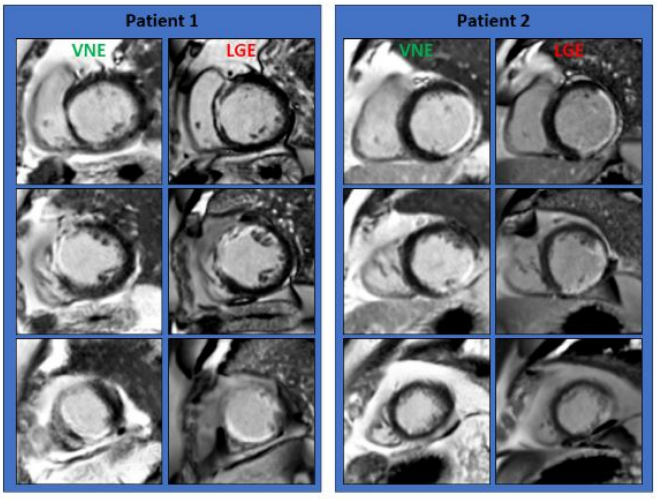

Table 1. Confusion matrix comparing infarction by LGE and VNE analysis.

	Per patient		
	VNE definite infarct	VNE possible infarct	VNE no infarct
LGE infarct	**7**	**1**	**0**
LGE no infarct	**0**	**0**	**12**
	Per slice		
	VNE definite infarct	VNE possible infarct	VNE no infarct
LGE infarct	**13**	**3**	**3**
LGE no infarct	**0**	**1**	**29**

Author Disclosure: P Swoboda: Nothing to disclose; **P Thompson**: N/A; **Q Zhang**: N/A; **M Shabi**: N/A; **S Neubauer**: N/A; **S Piechnik**: N/A; **V Ferreira**: N/A; **S Plein**: N/A

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