

Early Peak Filling Rate Predicts Cardiovascular Death in Patients with Preserved Ejection Fraction

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Background

Cardiac magnetic resonance (CMR) is an accurate method for assessing cardiac structure and systolic function, but evidence lacks surrounding CMR-based diastolic function indices for prognostication. This study evaluates CMR derived diastolic parameters for predicting adverse cardiovascular events in patients with preserved left ventricular ejection fraction (LVEF).

Method

- From a registry of 773 subjects who underwent CMR, 547 patients were identified to have preserved LVEF (defined as LVEF \geq 50%). Clinical characteristics are shown in Table 1.
- The atria and ventricles were segmented (Figure 1) using SuiteHeart (Neosoft).
- Left atrial volume (LAV) and left ventricular mass (LVM) were measured and indexed to body surface area.
- Left ventricular time-volume curves in diastole were used to calculate early peak filling rate (E-PFR), time to E-PFR, and time to fill 80% of left ventricle (T80) as seen in Figure 2.
- Left ventricular filling pressure (LVFP) was estimated with a validated model¹: $LVFP = 6.1352 + (0.07204 * LAV) + (0.02256 * LVM)$.
- Primary outcomes included cardiovascular (CV) death and major adverse cardiovascular events (MACE).

Table 1. Clinical Characteristics

Characteristics	Overall (n = 773)	LVEF < 50% (n = 226)	LVEF \geq 50% (n = 547)
Age	54 \pm 16	56 \pm 17	53 \pm 16
Male	378 (49)	146 (19)	232 (42)
BMI	28.3 \pm 6.6	28.9 \pm 6.5	28.1 \pm 6.6
CAD	288 (37)	94 (12)	194 (35)
HTN	437 (57)	149 (19)	288 (53)
Diabetes	202 (26)	78 (10)	124 (23)
Cardiovascular Death	61 (8)	26 (3)	35 (6)
MACE	195 (25)	111 (14)	84 (15)

Values as shown as mean \pm standard deviation or number [percent]

Figure 1. Example Atrial and Ventricular Segmentation

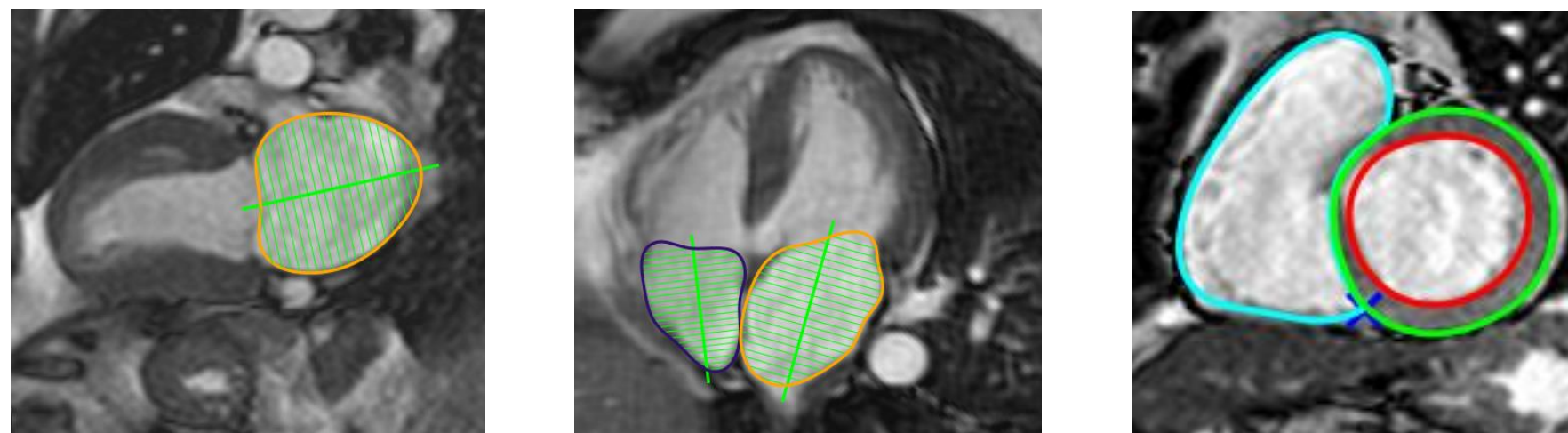


Figure 2. Example Diastolic Left Ventricular Time-Volume Curve and Filling Rate Curve

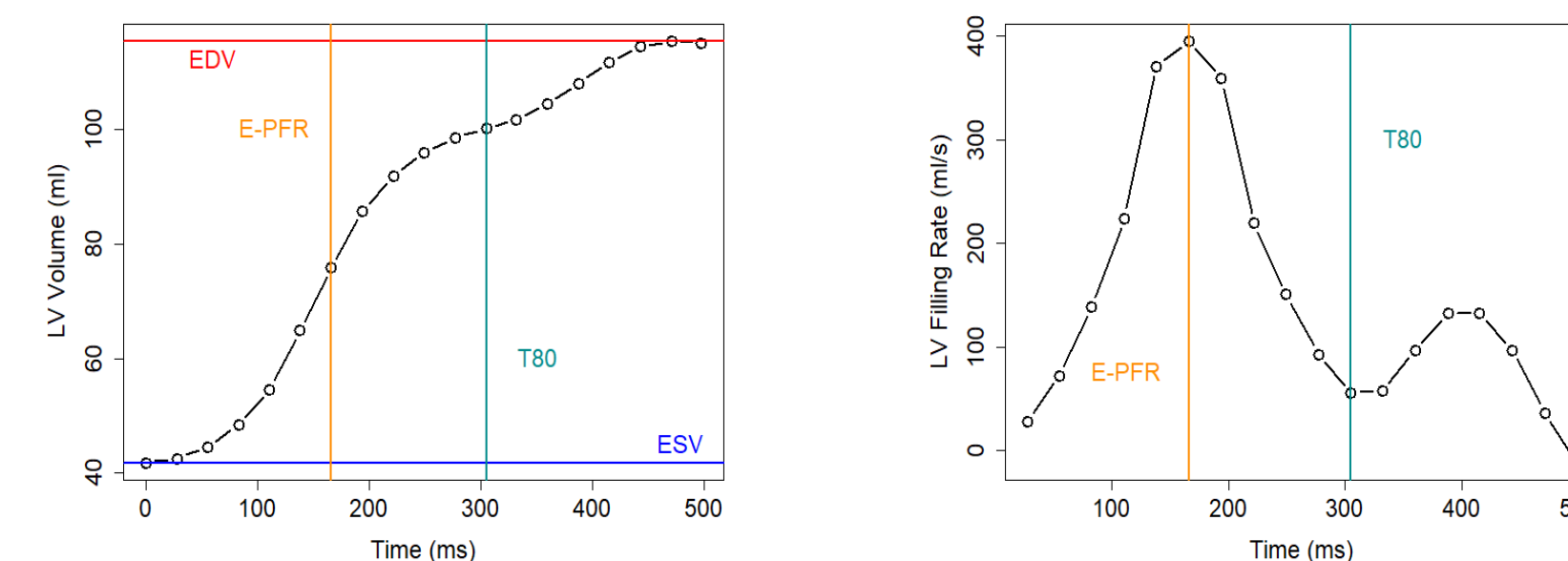


Table 2. Diastolic Parameters by CV Outcome in in LVEF \geq 50%

	MACE+ (n = 84)	MACE- (n = 463)	CV Death+ (n = 35)	CV Death- (n = 512)
LVM (g)	119	107	107	109
LVMI (g/m ²)	62	56	56	57
LAV (mL) *	76	67	76	68
LAVI (mL/m ²) *	40	35	40	36
LVFP (mmHg) *	14.3	13.4	14.1	13.5
E-PFR (ml/s) *†	372	410	335	409
Time to E-PFR (ms)	170	165	164	166
Time to 80%LV (ms)	0.76	0.75	0.80	0.75

*Significant difference in MACE based on p < 0.05
† Significant difference in CV death based on p < 0.05

Figure 3. ROC Curves Comparing Diastolic Parameters and MACE in LVEF \geq 50%

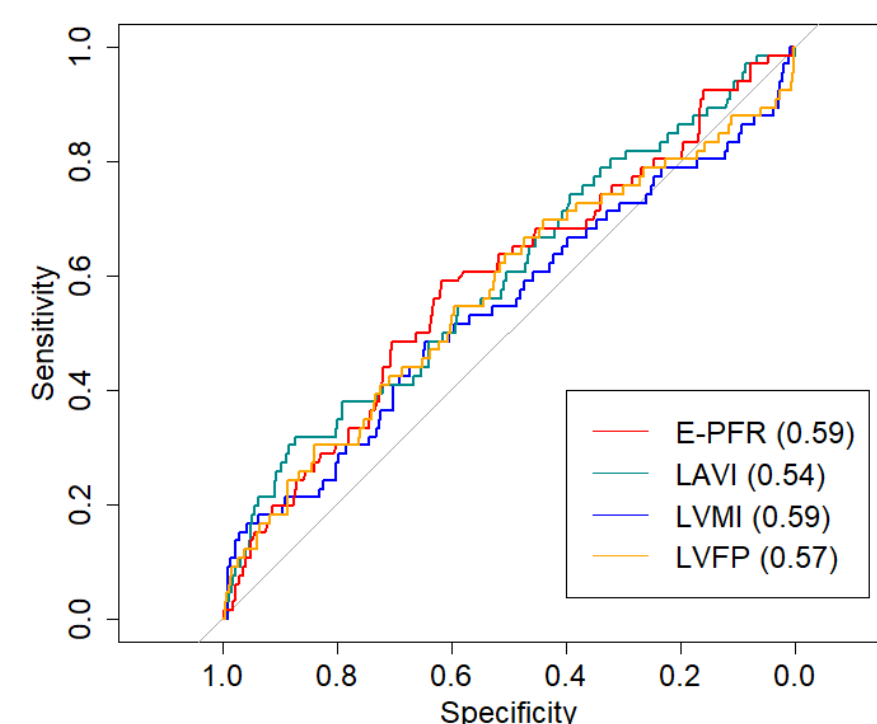
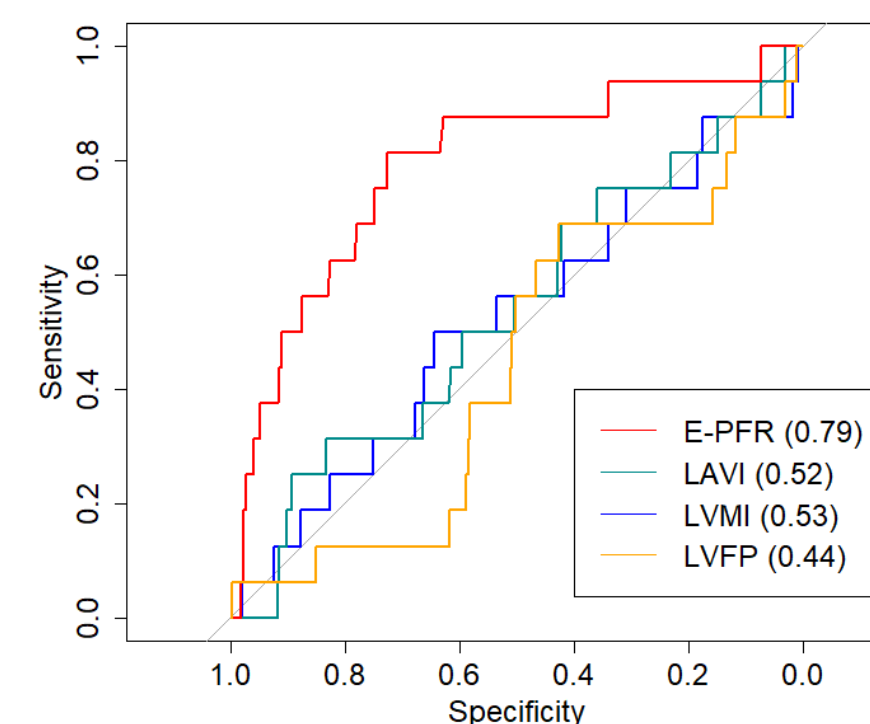


Figure 4. ROC Curves Comparing Diastolic Parameters and CV Death in LVEF \geq 50%



Results

- The median follow-up duration was 5.3 years, and average LVEF was 61%, with a total of 35 CV deaths (6%) and 84 MACE (15%). CMR parameters are shown in Table 2.
- Patients with MACE had significantly different LAV, LAVI, LVFP, and E-PFR measurements.
- For CV death, only E-PFR was significantly different.
- There was no difference in c-statistics (Figure 3) between E-PFR, LAVI, LVMI, and LVFP for MACE.
- E-PFR had a c-statistic 0.79 for CV death, which was significant higher than LAVI (0.52, p < 0.001), LVMI (0.53, p < 0.001), and LVFP (0.44, p = 0.004).
- Optimal E-PFR cut-off for CV death by Youden's index was 307 ml/s, with a sensitivity of 81% and specificity of 73%.

Discussion

- CMR derived left ventricular time-volume curves can be used to characterize diastolic function.
- In patients with normal LVEF, CMR diastolic parameters provide modest prognostic information for MACE.
- However, lower E-PFR was a better predictor of CV death than LVFP, LAVI, and LVMI.

Conclusion

In patients with normal LVEF on CMR, a lower E-PFR based on left ventricular time-volume curves suggests an increased risk of CV death.

References

¹Garg P et al. Cardiac magnetic resonance identifies raised left ventricular filling pressure: prognostic implications. Eur Heart J. 2022 Jul 7;43(26):2511-2522.

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