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Left ventricular function monitoring in heart failure

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Imaging modalities are used for screening, risk stratification and monitoring of heart failure (HF). In particular, echocardiography represents the cornerstone in the assessment of left ventricular (LV) dysfunction. Despite the well-known limitations of LV ejection fraction, this parameter, repeated assessment of LV function is recommended for the diagnosis and care of patients with HF and provides prognostic information. Left ventricular ejection fraction (LVEF) has an essential role in phenotyping and appropriate guiding of the therapy of patients with chronic HF. This document reflects the key points concerning monitoring LV function discussed at a consensus meeting on physiological monitoring in the complex multi-morbid HF patient under the auspices of the Heart Failure Association of the ESC.

Introduction

Serial imaging evaluation of heart failure (HF) patients is an established part of routine clinical practice. Multiple imaging modalities are used in the screening, risk stratification, and monitoring of HF patients, although echo cardiography remains the mainstay of imaging in these settings.[1-3] In particular, left ventricular ejection fraction (LVEF), is the most common parameter used in patient classification and to guide management, and to assess patient prognosis.[4,5] Heart failure patients stratified according to different categories of LVEF ((i.e. <40%, 40−50% and >50%) represent diverse phenotypes of demography, clinical presentation, aetiology and outcomes at 1 year. Furthermore, echocardiography follow-up is crucial because a substantial proportion of HF patients may show dynamic changes in LVEF over time, especially those with an ischaemic aetiology, and patients may transition from one category to another. However, LVEF presents considerable limitations, such as variability between different imaging techniques, poor reproducibility, and moderate correlation with functional capacity.[4,6]

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Guidelines-based indications for left ventricular ejection fraction monitoring

Repeated assessment of cardiac morphometry, function, and myocardial status helps in risk stratification and therapeutic decision-making, in particular, when assessing changes in a patient's clinical condition.[7-9] Routine echocardiography in the absence of any clinical status change is rarely recommended in the management of a HF patient, particularly with a frequency or more than once per year. In the long-term follow-up of a patient with HF or significantly reduced LVEF, many experts feel an annual or biannual assessment by echocardiography is reasonable but more frequently than that cannot be justified. There are certain circumstances where repeat echocardiography can be supported. *Table 1* summarizes the clinical situations in which regular imaging evaluation is advised.

For example, according to the ESC STEMI guidelines, patients with LVEF <40% on discharge should undergo repeat echocardiography within 6–12 weeks of optimal medical treatment in order to evaluate the need for implantable cardioverter-defibrillator implantation (Class IC recommendation).[10,11] In situations where echocardiographic images are difficult or inadequate, alternative

Table 1 Clinical situations when repeat imaging evaluation is useful

Clinical deterioration without a clear precipitating change in medication or diet
To determine candidacy for device therapy
LVEF 3 months after MI on optimal medical therapy
LVEF after revascularization
For scar tissue in CRT lead placement area
With implanted CRT and ICD devices
For CRT programming optimization
No improvement in symptoms/functional capacity
Changes in arrhythmia status and ICD discharges
To detect device complication
Ischaemia/viability for revascularization decision
Monitoring of cardiomyopathies during pregnancy
Monitoring of reversible cardiomyopathies
Peripartum cardiomyopathy
Takotsubo cardiomyopathy
Tachycardia-induced cardiomyopathy
Monitoring of cancer treatment-related cardiac dysfunction
Response to therapy in infiltrative myocardial diseases
Routine (≥2 years) surveillance of known HF or cardiomyopathies in stable settings
Left ventricular assist device decisions
To determine candidacy
For optimization of device settings
To detect device-related complications
For weaning decision
Monitoring of rejection in cardiac transplantation

imaging modalities, preferably cardiac magnetic resonance, can be used.[12–14]

However, the optimal timing of repeat echocardiography to detect treatment-induced changes in LV structure or function remains uncertain, given variability in the extent and timing of the full effects of pharmacological or device treatments on LV function.[15–19] The anti-remodelling effect of mineralo-corticoid receptor antagonists, for example, in terms of patients crossing the threshold of 35% in LVEF was observed after 6–9 months of medication use[20–22] though investigators of a study with eplerenone concluded that even 9 months may be too short a period to detect the full extent of changes in LV volumes and LVEF in stable well-treated HF patients. Meanwhile, the effect of revascularization on the LV remodelling has been demonstrated within 9–12 months.[23,24]

In an attempt to reduce variability in repeat evaluation of LVEF, three-dimensional echocardiography has been recommended as preferred over classical two-dimensional imaging.[25] Cardiac magnetic resonance also serves as an alternative technique of high precision and excellent reproducibility for longitudinal assessment of ventricular volumes and function, it being limited mainly by cost and relatively less frequent availability for routine clinical purposes.

In good responders to treatment on stable optimally titrated medications and no changes in clinical status, reassessment of cardiac structure and function more frequently than every 1–2 years is unlikely to yield any additional value. Regular surveillance should include not only systolic but also evaluate diastolic functional parameters according to a proposed algorithm,[26] which has validated against invasively measured LV filling pressures.[27] Serial echocardiographic measurement of E/e' in the HOMEOSTASIS study was shown to reliably detect raised left atrial pressure in stable outpatients with HF.[28] The value of average E/e' $\geq$15 accurately detected a left atrial pressure elevated $\geq$20 mmHg, suggesting pre-emptive treatment adjustment, while an E/e' lower than 12 essentially excluded an elevated filling pressure.[29,30] Quantitative measures of right ventricular function and biventricular deformation indices hold promise to reflect the dynamics of myocardial performance across the spectrum of HF phenotypes.[31,32]

Conclusions

Despite the well-known technical and clinical limitations of LVEF, this parameter remains a cornerstone for the classification, stratification, management, and monitoring of HF.[4]

However, quality-improvement strategies are needed to optimize the value of routine monitoring in this population.

Finally, telemedicine for LV monitoring and implantable LV assist systems have been shown to be capable of facilitating improved outcomes in HF.[33,34] Despite this, devices for remote monitoring are still under-utilized in clinical practice and further studies are needed to ascertain whether they may represent a new standard of care in HF. A new diagnostic algorithm for HFpEF may help advance diagnosis and monitoring of this condition.[35]

Conflict of interest: none declared.

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