

Prognostic importance of right ventricular dysfunction

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Although left ventricular ejection fraction is a powerful predictor of mortality following a myocardial infarction, in certain situations right ventricular ejection fraction may provide additional prognostic information

DETERMINANTS OF RVEF IN PATIENTS WITH CHF

RVEF is determined by intrinsic right ventricular contractile function, and by right ventricular preload and afterload. Because DCM generally affects both ventricles, RVEF tends to be lower for any given LVEF in patients with DCM versus those with IHD.⁹ It is important to note that the function of the left ventricle can influence that of the right ventricle in two important ways. Firstly, the interventricular septum is shared by both ventricles, and contributes substantially to right ventricular contractile function.¹⁰ Secondly, RVEF is influenced by the afterload against which it has to eject (total pulmonary resistance), which is also greatly affected by left ventricular end diastolic pressure (LVEDP) as well as by pulmonary vascular resistance.¹¹ Therefore RVEF was negatively associated with raised mean pulmonary artery pressure and with raised right ventricular end diastolic pressure (RVEDP), with the combination being additive in predicting RVEF.¹¹

For these reasons, in patients with acute anterior myocardial infarction, in whom the infarct is limited to the anterior wall of the left ventricle and the upper septum, right ventricular ejection fraction is depressed at day 2, but recovers by day 10 despite persistent impairment of LVEF.¹²

WHY DOES RVEF DETERMINE OUTCOME?

The answer to this is unknown. It is certainly possible that the presence of additional right ventricular involvement may increase the substrate for malignant ventricular arrhythmias. However, the link between RVEF and mortality appears also to affect deaths caused by intractable CHF.⁷ This is therefore unlikely to be the sole explanation.

It was noted earlier that the combination of increased RVEDP and increased mean pulmonary artery pressure potentially predict reduced RVEF. Such patients are almost certain to exhibit pronounced diastolic ventricular interaction (DVI).¹³ In the presence of an enlarged heart, particularly when associated with right ventricular systolic hypertension, the pericardium and other surrounding structures (including the lungs) become stretched, and pericardial pressure (normally close to zero) becomes greatly elevated. Because the right ventricle is relatively thin

When considering the entire range of left ventricular ejection fractions (LVEF) after a myocardial infarction, this parameter is a powerful predictor of mortality.¹ However extended follow up studies have shown that prolonged survival occurs in some patients with congestive heart failure (CHF) who have adverse conventional prognostic markers, including very low LVEF.² In patients with LVEF < 20%, the absolute value has little prognostic significance but peak oxygen consumption (peak $\dot{V}O_2$) is predictive. There is increasing evidence that right ventricular ejection fraction (RVEF) is also a powerful predictor of mortality in this subgroup of patients—perhaps the most powerful predictor.

In patients with CHF caused by dilated cardiomyopathy (DCM), reduced RVEF assessed using gated heart pool scanning (< 38%) has been shown to be associated with increased mortality in patients with LVEF < 30% but not in those patients with higher LVEFs.¹ Similarly, in patients with ischaemic heart disease (IHD), RVEF is prognostically important in those patients with LVEF < 40%.³ In a study undertaken in a cardiac transplant waiting list population (of mixed aetiology), patients were stratified according to RVEF greater or less than 24%. RVEF was shown to be an independent predictor of survival in a multivariate model that included LVEF. One year survival in the two groups was 44% and 93%, respectively.⁴ Juilliere and colleagues confirmed that LVEF and RVEF were both independent predictors of survival in a multivariate model.⁵ In another study of patients with mean (SD) LVEF 22 (7)%, resting RVEF (> 35%) was shown to be the most powerful independent predictor of survival in a multivariate model which included the other conventional prognostic markers (LVEF, peak $\dot{V}O_2$, peak percentage age and sex adjusted $\dot{V}O_2$, left ventricular end diastolic volume index, left ventricular end systolic volume index, and cardiac index).⁶

The presence of right ventricular involvement also has a major effect on short term outcome in patients with acute inferior myocardial infarction (odds ratio for in hospital mortality 3.2).⁷ Successful primary angioplasty promptly normalises RVEF in this setting and is associated with improved in-hospital mortality compared with patients in whom primary angioplasty is unsuccessful (2% v 58%).⁸

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Abbreviations: CHF, congestive heart failure; DCM, dilated cardiomyopathy; DVI, diastolic ventricular interaction; IHD, ischaemic heart disease; LVEDP, left ventricular end diastolic pressure; LVEF, left ventricular ejection fraction; RVEDP, right ventricular end diastolic pressure; RVEF, right ventricular ejection fraction; $\dot{V}O_2$, oxygen consumption

walled, and unable to maintain a significant transmural pressure gradient, RVEDP usually provides a very close estimate of pericardial pressure. In such patients, external constraint from the pericardium and right ventricle (via the shared septum) restrains the filling of the left ventricle. Increases in LVEDP such as during exercise fail to cause the expected increase in left ventricular end diastolic volume and therefore (via the Starling mechanism) stroke volume, resulting in a greatly reduced ability to increase cardiac output on exercise.¹⁴ Consistent with this, RVEF is much more powerful than LVEF as a predictor of exercise capacity in CHF.¹⁵ CHF patients with DVI may be recognised non-invasively by the presence of a restrictive transmitral Doppler flow profile,¹⁶ itself a powerful adverse prognostic marker.¹⁷ The presence of DVI appears also to be associated with baroreflex abnormalities¹⁸ and with greater adverse neurohumoral activation.¹⁹ This is likely to be caused by the specific impact of DVI on stretch sensitive receptors in the left ventricle as well as by reduced cardiac output. Baroreflex dysfunction and neurohumoral activation are causally associated with both sudden death and disease progression.^{20, 21} Thus, while speculative, DVI may provide a plausible explanation for the effects of RVEF on both exercise capacity and survival in patients with CHF.

ASSESSMENT OF RIGHT VENTRICULAR FUNCTION

The assessment of RV function has historically been very difficult. Standard transthoracic echocardiography has been of limited use and so the majority of the literature is based on radionuclide ventriculography. Recent developments in echocardiographic technology, in particular the development of tissue Doppler imaging, have changed this situation. Long axis velocities of the right ventricle (free wall and tricuspid annulus) have been shown to be accurate and reproducible measures of right ventricular systolic function.^{22, 23} Patients with LVEF < 30% on stable maximal medical treatment might therefore appropriately undergo evaluation of right ventricular systolic function using this technique or using radionuclide ventriculography.

CONCLUSION

RVEF provides powerful prognostic information in patients with CHF, particularly in those with very low LVEF. Reduced RVEF may be a consequence of both intrinsic right ventricular disease and of increased right ventricular afterload. The mechanisms likely to be responsible for the prognostic impact of reduced RVEF are uncertain, but have been discussed.

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