

Non-invasive pressure volume loops derived by cardiovascular magnetic resonance: association between area at risk or infarct size and cardiac hemodynamics at 2-6 days after myocardial infarction

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Abstract

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Background

A novel non-invasive method for generation of pressure volume loops (PV-loops) using brachial blood pressure and cardiovascular magnetic resonance (CMR) imaging has recently been presented and validated (1). The non-invasive nature of this method enables calculation of PV-loops in large patient cohorts previously not feasible due to the need of invasive measurements.

Purpose

The purpose of the present study was to investigate how cardiac hemodynamics assessed by PV-loop variables such as stroke work, potential energy, contractility and ventriculoarterial coupling is related to myocardium at risk and infarct size in a cohort of patients with acute myocardial infarction (MI).

Method

A total of 100 patients with ST-elevation MI (STEMI) were included from the SOCCER, MITOCARE and CHILL-MI trials (2-4). The CHILL-MI cohort (n = 11) was prone to a stricter selection criterion than the SOCCER cohort, including first-time myocardial infarction and no comorbidities. All patients underwent a CMR examination at 2-6 days after MI. Non-invasive PV-loops were generated by combining volumetric CMR data and brachial sphygmomanometric pressure measurements using a recently validated method (1). Maximal elastance (E_{max} , translated to contractility), stroke work, potential energy and ventriculoarterial coupling (E_a/E_{max}) were measured from the PV-loops. Myocardium at risk and infarct size were assessed using contrast-enhanced steady state free precession and late gadolinium enhancement images, respectively.

Results

Contractility, ventriculoarterial coupling, stroke work and potential energy all correlated to myocardium at risk (E_{max} : $r^2=0.25$, E_a/E_{max} : $r^2=0.36$, stroke work: $r^2=0.21$, potential energy: $r^2=0.10$) and infarct size (E_{max} : $r^2=0.29$, E_a/E_{max} : $r^2=0.41$, stroke work: $r^2=0.25$, potential energy: $r^2=0.15$) as shown in Figure 1. Furthermore, contractility showed a stronger correlation to myocardium at risk (E_{max} : $r^2=0.77$) than to infarct size (E_{max} : $r^2=0.37$) for the CHILL-MI patients as shown in Figure 2.

Conclusion

Non-invasive CMR derived PV-loop parameters can be used to assess cardiac hemodynamics early after STEMI showing that increased myocardium at risk and infarct size are both associated with an increased ventriculoarterial coupling and potential energy, and a decreased contractility and stroke work. To what extent these hemodynamic parameters provide incremental prognostic information compared to conventional parameters such as ejection fraction and left ventricular dimensions after STEMI remains to be determined.

