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Post-extrasystolic Potentiation Recruits Incremental Contractile Reserve of Dyssynergic Myocardium During Dobutamine Stress Testing: Evidence by Pulsed Wave Tissue Doppler Imaging

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Dobutamine stress echocardiography is an established diagnostic method for the detection of myocardial viability in patients with severe left ventricular dysfunction[1]. The presence of viable myocardium identifies patients who will benefit from coronary revascularization, by improving both functional capacity and long-term survival. Occasionally, dobutamine infusion has been combined with other stressors, such as post-extrasystolic potentiation, in order to improve accuracy. The contractile reserve after combined dobutamine infusion and post-extrasystolic potentiation can be quantified by pulsed wave tissue Doppler imaging. We describe a patient with severe left ventricular dysfunction, in which pulsed wave tissue Doppler imaging allowed to demonstrate that post-extrasystolic potentiation superimposed on dobutamine infusion is able to further recruit contractile reserve, as compared to dobutamine infusion alone. A nuclear scan assessing glucose utilization was used as a reference.

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Key Words: myocardial viability; dobutamine stress echocardiography; post-extrasystolic potentiation; pulsed wave tissue Doppler imaging.

Introduction

Dobutamine stress echocardiography is widely used to identify myocardial viability. Dobutamine activates adrenergic beta-receptors, which stimulate actin–myosin interaction, resulting in an increased myocardial thickening during systole. Detection of a substantial amount of viable myocardium identifies patients with left ventricular dysfunction who will benefit from coronary revascularization procedures. Occasionally, dobutamine infusion has been combined with post-extrasystolic potentiation. This technique exploits extrasystolic beats, whose post-extrasystolic pause prolongs ventricular filling period, thus activating the Frank–Starling mechanism. According to this mechanism, there is a relationship between ventricular end-diastolic volume and ventricular performance, resulting in contractile recruitment of viable myocardium.

We describe a patient with severe left ventricular dysfunction, studied by dobutamine stress echocardiography and post-extrasystolic potentiation. Pulsed wave tissue Doppler imaging allowed the quantification of the contractile response to both stressors. A single photon emission computed tomography scan assessing the F18-fluorodeoxyglucose uptake was used as a reference.

Case

A 67-year-old male with severe ischaemic left ventricular dysfunction (ejection fraction 33%, measured by radionuclide ventriculography) was referred for the evaluation of myocardial viability. Dobutamine stress echocardiography was performed as previously

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Table 1. Systolic velocities (cm/s) of normal and post-extrasystolic beats during the main steps of dobutamine stress echocardiography.

cm/2	PS		L		I		A		P		AS	
	NB	PESP	NB	PESP	NB	PESP	NB	PESP	NB	PESP	NB	PESP
(1) Rest DSE	6	9	5	8	5	8	5	8	6	7	5	8
(2) Low DSE	8	11	7	9	8	10	7	9	8	9	7	9
(3) Peak DSE	9	12	8	9	10	12	9	10	9	10	9	11

A=anterior wall, AS=anterior septum, DSE=dobutamine stress echocardiography three main steps (rest, low: 10 μg/kg^{-1}/min^{-1}, peak), I=inferior wall, L=lateral wall, NB=normal beat, P=posterior wall, PESP=post-extrasystolic potentiation, PS=posterior septum.

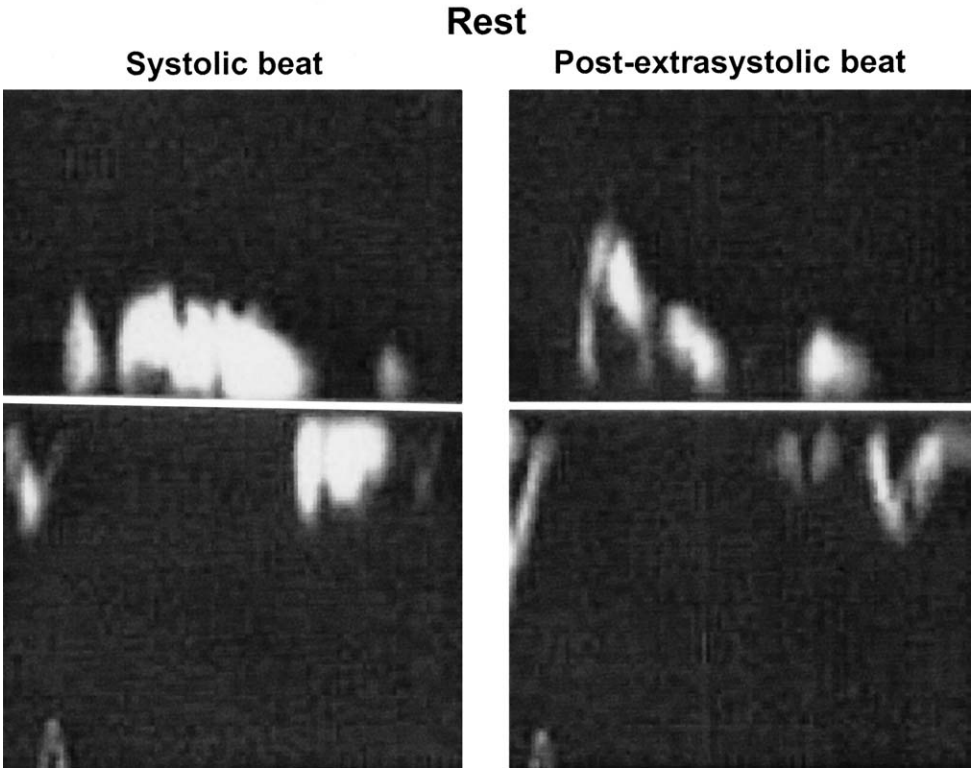

Figure 1. 'Post-extrasystolic potentiation recruits incremental contractile reserve of dyssynergic myocardium during dobutamine stress testing: evidence by pulsed wave tissue Doppler imaging'. Riccardo Rambaldi, MD. Ph.D.

described and scored by visual wall motion assessment and pulsed wave tissue Doppler imaging[2]. Severe dyssynergy (severe hypokinesis, akinesis or dyskinesis) was present in inferior and posterior walls. Extrasystolic beats, with a reproducible coupling time interval, were present at rest and during each stage of dobutamine stress echocardiography. The six-segment model (posterior, anterior septum, lateral, inferior, anterior, posterior walls) of longitudinal shortening was selected as the optimal approach of pulsed wave tissue Doppler imaging during the technical demanding setting of stress echocardiography. The mitral anulus served as anatomical reference point in order to reproduce consistent sampling sites. A Toshiba Powervision echocardiographic imaging system was used, with a 3·7 MHz probe, with a pulse repetition frequency of 4·5–6.0 KHz. A temporal resolution of 6–8 ms was achieved at rest and during stress echocardiography. Systolic velocities by pulsed wave tissue Doppler imaging of normal and post-extrasystolic beats were recorded on tape at rest, low dose (10 μg/kg^{-1}/min^{-1}) and peak dose dobutamine infusion and measured off-line. At F18-fluorodeoxyglycose-single photon emission computed tomography the left ventricle was divided into six segments (posterior, anterior septum, lateral, inferior, anterior, posterior), corresponding to the echocardiographic segments. F18-fluorodeoxyglycose-single photon emission computed tomography detected viability in the inferior wall. Systolic velocities (cm/s) of normal and post-extrasystolic beats during dobutamine

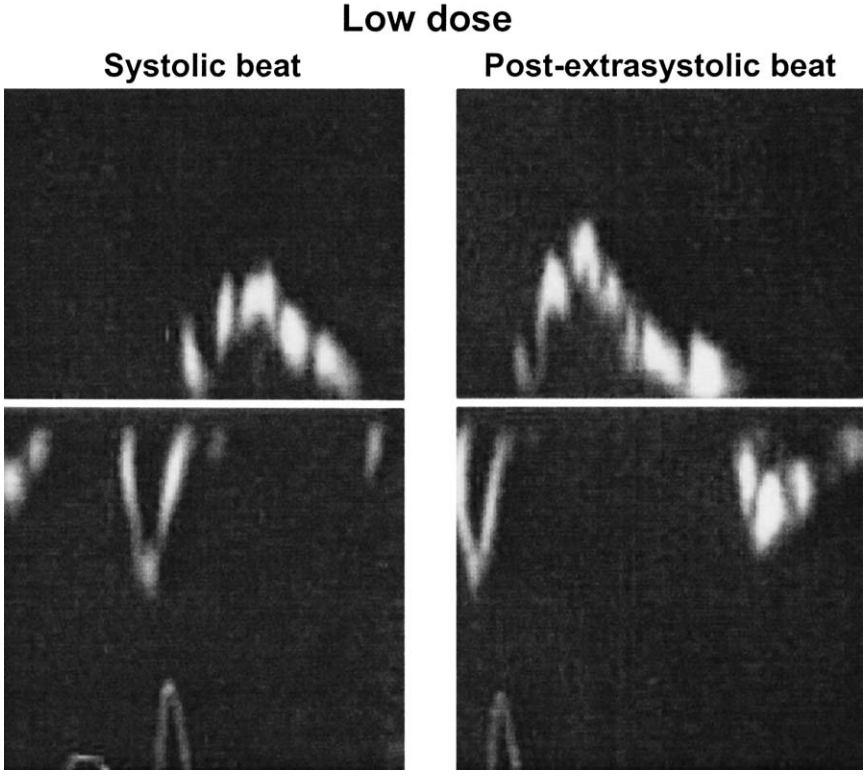

Figure 2. 'Post-extrasystolic potentiation recruits incremental contractile reserve of dyssynergic myocardium during dobutamine stress testing: evidence by pulsed wave tissue Doppler imaging'. Riccardo Rambaldi, MD, Ph.D.

stress echocardiography are shown in Table 1. The average exceeding of systolic velocity of post-extrasystolic vs normal beats was >60% at rest, >30% at low dose and >15% at peak stress (Figs 1 and 2). This finding predicted myocardial viability in the inferior wall as detected by F18-fluorodeoxyglycose-single photon emission computed tomography, and segmental contractile improvement after revascularization of the stenotic left circumflex coronary artery.

Discussion

The identification of myocardial viability is important to select patients with severe left ventricular dysfunction who may benefit from coronary revascularization. Dobutamine infusion is used to activate adrenergic beta-receptors, which in turn activate myocardial contractility. Less used is post-extrasystolic potentiation, a technique based on the contractile recruitment of myocardium occurring after a premature extrasystolic beat. The Frank–Starling mechanism is involved in this case; a longer ventricular filling period following post-extrasystolic pause occurs and the subsequent ventricular contraction is potentiated. The study of Scognamiglio *et al.*[3] assessed the value of the combination of dobutamine and post-extrasystolic potentiation for the evaluation of myocardial viability in 45 patients. The authors found no incremental value of the combined use of dobutamine and post-extrasystolic potentiation for the prediction of myocardial viability. However, the authors used the subjective standard wall motion scores, while we used quantitative pulsed wave tissue Doppler imaging. In our case we were able to measure an incremental contractile response of dyssynergic segments during simultaneous stimulation by dobutamine and post-extrasystolic potentiation. Our findings suggest that the contractile response to dobutamine infusion does not exhaust all the available contractile reserve. These findings might be tested in a wider patient population.

Contractile reserve potentiation after post-extrasystolic potentiation was most pronounced at rest and became less obvious during increasing dobutamine doses. This finding might be related to the shortened diastolic filling period during dobutamine-induced tachycardia, which resulted in reduced end-diastolic fibre stretch, thus opposing the Frank–Starling mechanism.

References

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