CASE REPORT

Myocardial infarction during adenosine stress test

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A 65 year old woman with history of ischaemic heart disease underwent standard adenosine stress test for myocardial perfusion imaging. She sustained inferior myocardial infarction during the final stages of the stress test. She was admitted to the coronary care unit and received thrombolytic treatment. The patient made an uneventful recovery. Adenosine is widely used for myocardial stress imaging tests and has a good safety profile. So far there has been only one other reported myocardial infarction during adenosine stress test, which was under special circumstances because three days before the test the patient had undergone percutaneous transluminal coronary angioplasty when a severe circumferential dissection was noted. The present patient's case highlights the need to be aware of rare but potentially serious complications of adenosine, even though it generally has an excellent safety record for use in myocardial stress testing.

A 65 year old woman attended our nuclear medicine department for pharmacological stress myocardial perfusion imaging in July 2000.

Her cardiac history included hypertension and mild aortic valve disease. She had her first proven myocardial infarction in 1996 but subsequent myocardial perfusion imaging in 1998 had shown no significant reversible ischaemia. In early 2000 she was routinely reviewed as a cardiology outpatient, where concern over ongoing anginal symptoms prompted a request for repeat myocardial perfusion imaging. Shortly after this review she had a further proven myocardial infarction and was given thrombolytic treatment with tissue plasminogen activator. She was discharged on aspirin, ramipril, and isosorbide mononitrate. Approximately four weeks later she was again admitted to hospital where unstable angina was diagnosed. She settled with conservative management and was discharged with the addition of diltiazem to her medication.

Pretest 12 lead ECG showed longstanding T wave inversion in chest leads V4, V5, and V6 (fig 1). The patient was asymptomatic before the start of the stress test, with a resting heart of rate 84 beats/min and blood pressure 170/80 mm Hg. In keeping with the departmental protocol all antianginal medication—that is, isosorbide mononitrate and diltiazem—had been discontinued 24 hours before the stress, with avoidance of all products containing caffeine. As on her previous study, a standard six minute adenosine stress protocol was followed: 140 μg/kg/min, with continuous 12 lead ECG monitoring and regular blood pressure measurements. Five minutes into the study, the patient developed severe central chest pain with radiation to her left shoulder, profuse sweating, nausea, and vomiting. Her heart rate and blood pressure remained stable throughout the stress test. The infusion was stopped and sublingual nitrates and oxygen were administered, with no improvement of her pain. This eventually subsided with the administration of intravenous diamorphine (5 mg). ECG at this stage showed ST elevations of 2.5 mm in lead III and 1.0 mm in aVF, and ST depression in leads I, aVL, and V2–V6 (fig 2). A working diagnosis of acute inferior myocardial infarction was made and the patient was fast tracked to the coronary care unit, where she received reteplase. The documented ECG changes persisted for 30 minutes from the onset of her chest pain. Cardiac troponin I tested 24 hours from the onset of chest pain was 7.92 μg/l reflecting significant myocardial damage (the range in our centre for troponin I is from normal at < 0.15 μg/l to minor myocardial damage at 0.15–1.5 μg/l and major damage at > 1.5 μg/l in the last seven days). The patient made an uncomplicated recovery and was discharged from hospital on the sixth day following admission, with a final diagnosis of acute inferior wall myocardial infarction. At her six months' follow up, she was asymptomatic with medication unchanged and resting ECG showing inferior lead Q waves in addition to the previously recorded lateral T wave inversion.

DISCUSSION

Adenosine has been used for many years in pharmacological myocardial stress tests and has a well established safety record.[1 2] It has a number of well documented predictable side effects reflecting its mode of activity, with arrhythmias (most

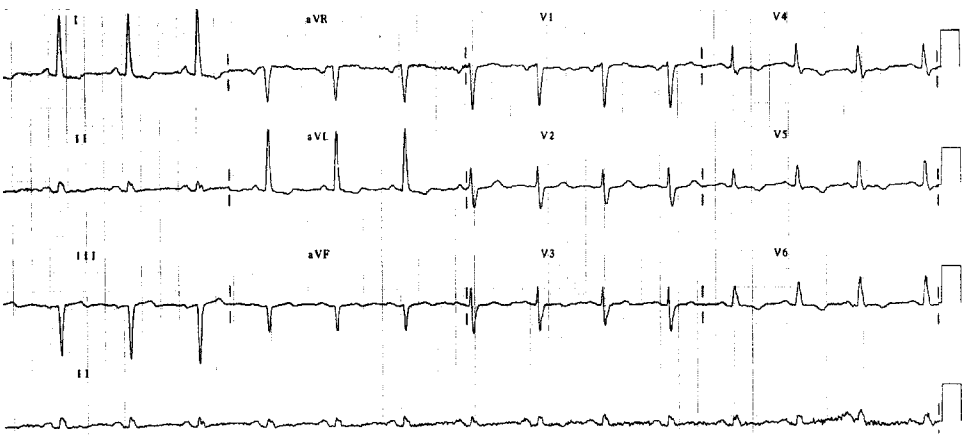

Figure 1 Resting ECG.

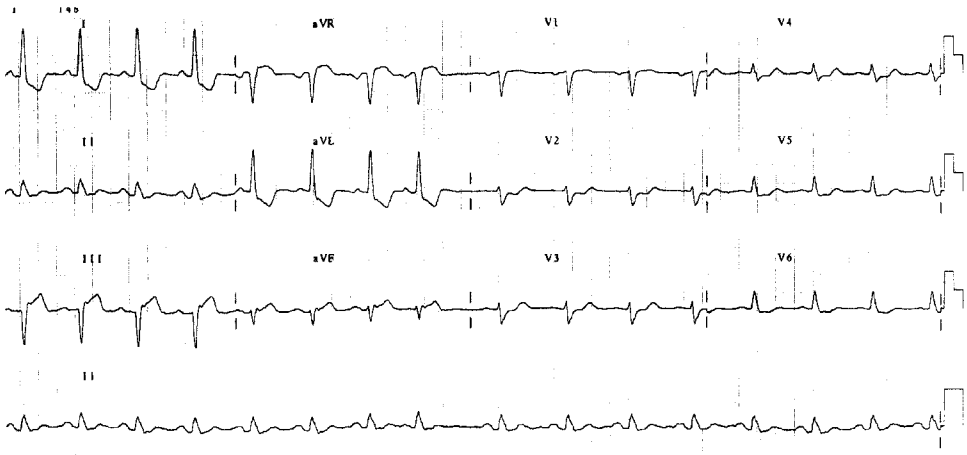

Figure 2 ECG after five minutes of adenosine infusion.

commonly ventricular extrasystoles), transient atrioventricular nodal block of differing degrees, and hypotension frequently recorded.[1]

Adenosine acts on the cardiovascular system to alter the electrophysiological activity of the heart and to promote vasodilatation. These effects are mediated through two different cellular receptors, A1 and A2.

Adenosine exerts its electrophysiological effects on the heart by binding to the A1 receptor, slowing atrioventricular conduction with potential progression to heart block. Although pre-existing first degree heart block is not a contraindication to adenosine, it is contraindicated in higher degrees of heart block without a pacemaker.[3] Most cases of induced heart block resolve with discontinuation of the adenosine infusion but patients with sinoatrial disease are at risk, with progression of sinus bradycardia to sinus arrest reported.[4]

Adenosine acts on the A2 cell membrane receptor to increase the potent vasodilator cAMP; its action on this receptor is inhibited by both caffeine and theophylline. In healthy coronary arteries, the vasodilator response to the rise in cAMP brought about by a standard protocol adenosine infusion results in a four- to fivefold increase in coronary blood flow.[5] The typical haemodynamic response is a mild increase in heart rate in response to induced peripheral vasodilatation and a slight fall in both systolic and diastolic blood pressures.

Diseased arteries have reduced coronary flow reserve with limited ability to vasodilate and accordingly exhibit a reduced response to adenosine relative to healthy vessels. Most of the total increased blood to the myocardium arises from an increase in blood flow through healthy vessels.[6] As tracer uptake is proportional to blood flow, this results in a relative hypoperfusion to territories supplied by diseased vasculature and the subsequent heterogeneous perfusion pattern on the stress images. Although ischaemia is inferred from this appearance, the incidence of true ischaemia is low.[7]

The vascular supply to the myocardium is such that the subendocardium is most at risk of ischaemic insult. In the presence of coronary artery disease, there are several predisposing factors to the development of regional ischaemia from adenosine infusion: (1) 'transmural steal' or diversion of blood from the subendocardium to the subepicardium in territory supplied by a stenosed vessel[7 8]; (2) reduction of distal perfusion pressure arising from increased flow across a stenosis; and (3) a generalised fall in perfusion pressure secondary to adenosine induced vasodilatation with a reduction in flow through high resistance collateral vessels supplying "at risk" territory.

It is proposed that in this patient the effect of factors (1) and (2) above was sufficient to induce inferior myocardial infarction, with increasing hypoxia and accumulation of end products of metabolism such as lactate in the territory supplied by a critically narrowed artery.[7] As her blood pressure and heart rate remained stable throughout the stress, neither factor (3) nor increased oxygen demand is considered likely to have played a significant part.

Conclusion

Adenosine is widely used for pharmacological stress in myocardial perfusion imaging and has a well established safety record. Its minimal effect on heart rate and blood pressure with little change on the double (rate–pressure) product results in little increased oxygen requirement and rarely true ischaemia. Only one other myocardial infarction during adenosine stress test has been reported.[1] This records the test having been performed under exceptional circumstances with the patient having undergone percutaneous transluminal coronary angioplasty three days earlier, during which a severe circumferential dissection was noted.

While the vast majority of documented side effects reflect the action of adenosine on nodal activity, this case report does show that significant ischaemia, although rare, can be induced as a result of the multifactorial action of adenosine on coronary blood flow. The importance of continuous patient monitoring and careful assessment of all clinical symptoms and signs during the stress test is underlined.

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