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Sudden Occlusion of a Saphenous Vein Bypass Graft Relieved by Direct Injection of Nitroglycerine

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An unusual case of sudden occlusion of a saphenous vein bypass graft to the right coronary artery, during a coronary angiographic study, is presented. Such occlusion was relieved by direct intragraft nitroglycerine injection, as typically happens in case of coronary arterial spasm. A possible pathogenetic mechanism, based on the present knowledge of platelet aggregation and the role of the powerful vasoactive agent Thromboxane A_2, is discussed.

Key words: coronary angiography, coronary artery spasm, aortocoronary bypass, nitroglycerine

INTRODUCTION

The real mechanism through which spasm develops is not at all clear despite the fact that its occurrence during coronary angiography was first described by Gensini et al in 1962 [1]; later extensively demonstrated by Maseri et al in 1975 [2] in patients affected by spontaneous angina; and by Oliva and Breckinridge in 1977 [3] in patients suffering from acute myocardial infarction.

Relief of coronary artery spasm by nitroglycerine [4] is routinely demonstrated in every cardiovascular laboratory where coronary arteriography is performed, but there is still debate concerning a standard method of inducing relief. Coronary artery spasm can be induced effectively in different subjects by pharmacological agents, like ergonovine maleate, acetylcholine, and norepinephrine [5, 6], but also through vagal or sympathetic stimulation [7]. Whether those pharmacological agents act directly on the smooth muscle fibers of the arterial wall or through a secondary neural transmission is yet to be clarified [8].

Spasm of grafted coronary arteries after surgery as a cause of previously undiagnosed variant angina has been demonstrated recently in six cases by Waters et al [9]. The case we happened to observe may shed some more light on the pathogenetic mechanisms of bypass graft failure .

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CASE REPORT

A 49-year-old man with a history of a previous inferoseptal myocardial infarction and later postinfarction angina (Fig. 1) underwent coronary arteriography on February 21, 1979. At that time severe, three-vessel coronary disease was found, with complete occlusion of the proximal right coronary artery (RCA), 90% obstruction of the proximal portion of the left anterior descending artery (LAD), and 80% stenosis of the obtuse marginal branch (MB) of the circumflex artery (Cir).

Ten days later coronary artery surgery was performed and two saphenous vein bypass grafts were connected to the distal RCA and to the MB, while the LAD was judged not suitable for revascularization. Yet it was hoped that the new blood supply to the RCA could give way to enough collateral flow to the LAD through the septal branches. After the operation, despite vigorous treatment with propranolol, digoxin, and nitrates, the patient kept complaining of angina, both on effort and at rest, although a 24-hour Holter monitoring showed only the presence of frequent short runs of ventricular tachycardia.

A bicycle stress test was performed, during which all the twelve standard leads were recorded routinely at every minute, both during effort and the first ten minutes of recovery. An ischemic response developed at 90 watts load, at a heart rate of 148 beats/min and blood pressure level of 190/100 mmHg, with a 1 mm horizontal S-T segment depression in leads I, aVL, V_5, V_6, associated with typical anginal pain. The ECG abnormalities persisted up to the seventh minute of recovery (Fig. 2).

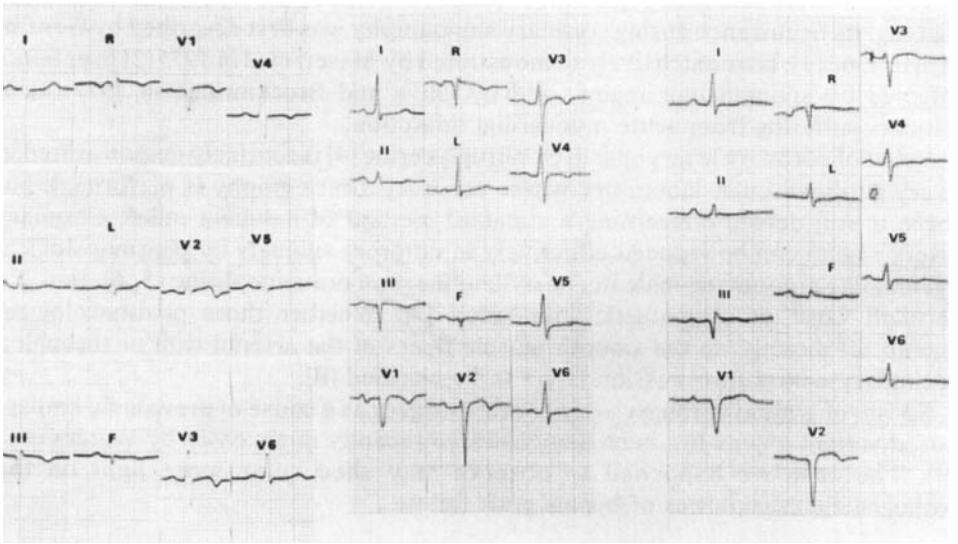

Fig. 1. Left: ECG before surgery showing signs of old inferior-septal necrosis and of anterior-septal ischemia. Center: No significant changes of the ECG pattern after surgery. Right: One month after control angiography a new pattern of anterior-septal necrosis is evident.

Therefore, control coronary arteriography was performed on July 19, 1979, approximately four and a half months after surgery. The left ventricular angiogram was unchanged, as compared to the previous procedure.

The graft to the RCA was injected twice and found wide open (Fig. 3). The proximal RCA was occluded. It took about 5 minutes before the left coronary artery (LCA) could also be injected selectively. After the second injection into the LCA, which was at this time occluded both at the level of the proximal LAD after the first diagonal branch and at the level of the MB but receiving, as shown by the injection into the graft to the RCA, a good amount of collateral flow through the septal branches, the patient complained of severe chest pain and the S-T segment became elevated in leads II and III (Fig. 4). A third injection into the LCA did not show any changes. Two repeated injections into the graft approximately ten minutes after its first opacification showed instead a rapidly progressive occlusion (Figs. 5 and 6).

Nitroglycerine 0.6 mg po was then administered without relief either of angina or of the electrocardiographic and angiographic pattern (Fig. 7). After three minutes intravenous (iv) nitroglycerine 0.35 mg was injected directly into the graft with subsequent rapid reopening and complete, although much slower and less intense, opacification of the RCA down to its smallest distal branches (Fig. 8). The chest pain subsided and the S-T segment elevation regressed, although not completely

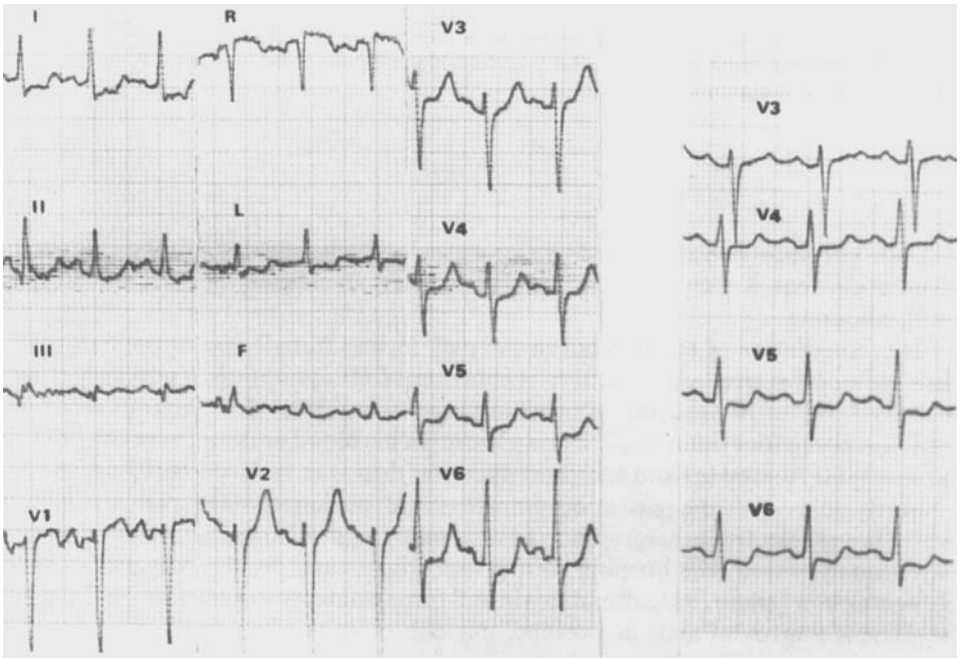

Fig. 2. Exercise ECG before control coronary arteriography. Left: At maximal effort a horizontal 1 mm S-T segment depression is present in leads I, aVL, V5, V_6. Right: During recovery ischemic changes are still present.

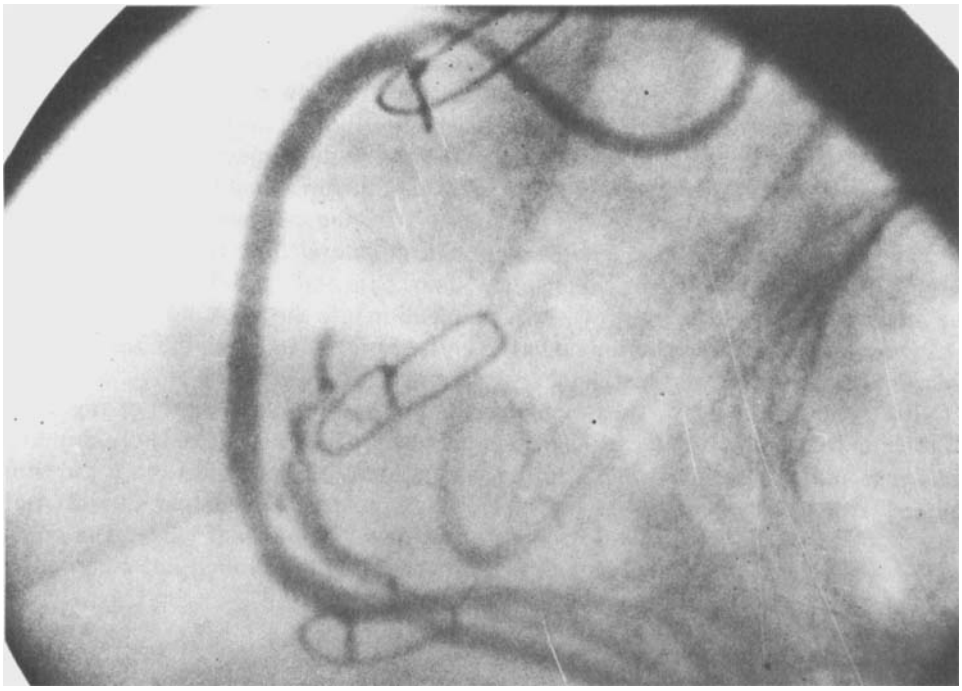

Fig. 3. Left anterior oblique projection (LAO). The graft to the RCA is widely patent. The RCA is opacified both antegrade and retrograde up to its middle portion. The injection was performed through an Amplatz catheter. A Swan-Ganz catheter is positioned in the right cardiac section with the tip in the main pulmonary artery.

(Fig. 4). The second graft to the MB was not selectively injected (on the erroneous assumption that it was occluded) and was later visualized as open on the left ventriculogram.

After completion of the procedure the patient was transferred to the Coronary Care Unit and started on a continous infusion of 60 μg/min of iv nitroglycerine, 40,000 IU/day of iv heparine, oral nifedipine (10 mg every four hours), and propranolol (20 mg four times/day). During the night his blood pressure was considered too low (100/70 mmHg) and the nitroglycerine drip was reduced to 10 μg/min.

Shortly afterwards the patient developed severe, prolonged chest pain and within twelve hours, electrocardiographic and enzymatic signs of anteroseptal myocardial infarction appeared. His hospital course was complicated by the presence of mild left ventricular failure, but, after digoxin and furosemide were added to the therapy, the patient improved and, at present, thirteen months after discharge from the hospital, he is free of angina and has returned to work. No ventricular arrhythmias have been detected at a repeated Holter control.

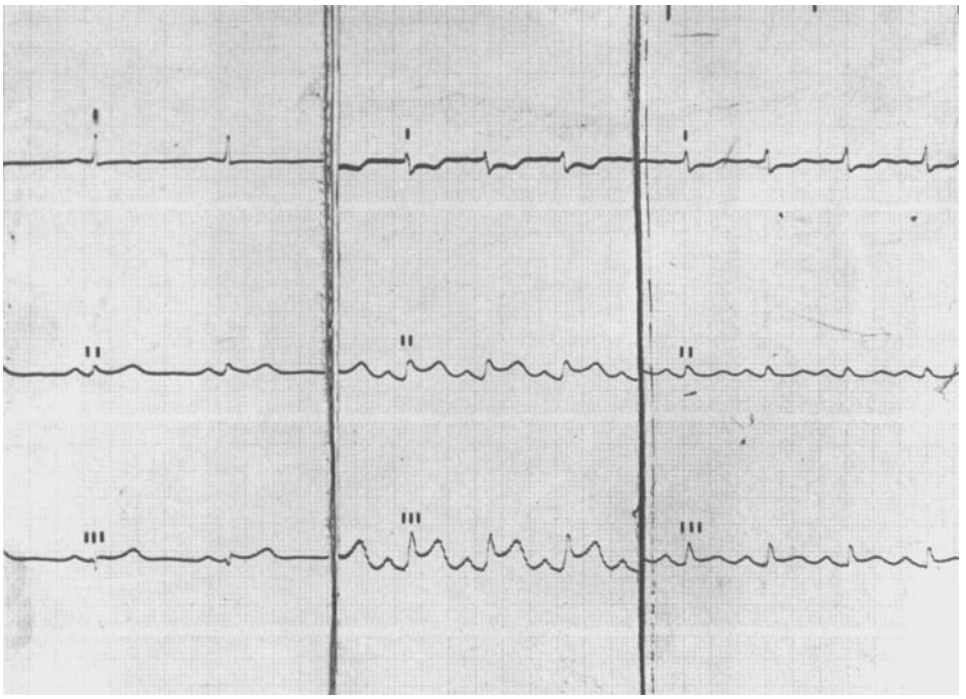

Fig. 4. Left: ECG (leads I, II, III) at beginning of catheterization. Center: While the patient is experiencing severe chest pain, a marked elevation of the S-T segment appears. Right: After direct intragraft injection of nitroglycerine, the chest pain disappears but a slight elevation of the S-T segment is still present.

DISCUSSION

This case raises several questions. While the stress test after surgery showed an ischemic response in the area of left ventricular myocardium supplied by the LCA (leads I, aVL, V_5, V_6), the episode of spontaneous pain during angiography was characterized by ECG changes in the inferior leads II and III and by occlusion of the RCA and its afferent graft. Therefore, it might be argued that the pathogenetic mechanism of ischemia in these two occasions was completely different, being related in the first instance to the discrepancy between the blood flow carried through collaterals from the RCA to the occluded LAD and the oxygen needs of the myocardium that the LAD supplied, while in the other occasion it appeared secondary to spasm either in the RCA or in the graft to the RCA itself.

Obviously one is concerned about the way in which a saphenous vein, which has been stripped by the surgeons of most of its adventitial layer and in such a way deprived of its neural terminations, can present a sudden spastic reaction. On the

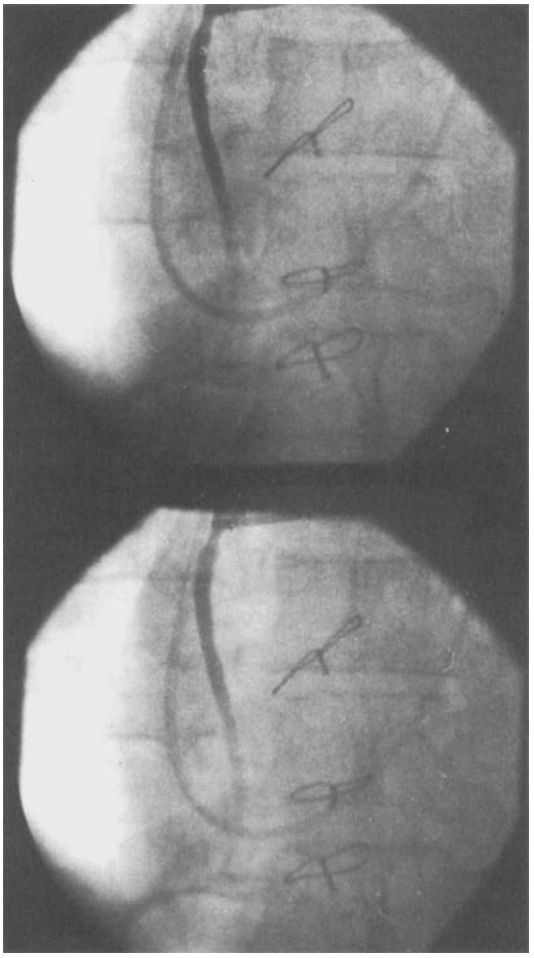

Fig. 5. Shallow LAO: the first injection of the graft by way of a Sones catheter after development of chest pain and ECG related changes, shows almost complete absence of opacification of the RCA and a smooth, progressive tapering of the graft.

other hand the possibilities of a rapid thrombosis or of an intimal dissection (without any angiographic appearance) are ruled out by the prompt reopening of the graft after direct injection of nitroglycerine. No direct sign of embolization either by clots or by air from the catheter was apparent, and furthermore, in the last injections (Fig. 8) all the minor distal branches of the RCA could be visualized.

Such a pattern of complete good filling of the peripheral RCA tree renders unlikely the hypothesis of a primary spasm of the distal RCA with secondary thrombosis into the graft, because the selective injection of the graft after nitroglycerine would have surely dislodged some fragments of the thrombus and sent them to occlude the more peripheral branches of the RCA. Besides the graft was shown occluded within the first 2 cm beyond its origin (Fig. 6), without any progression of the contrast agent, no later than three minutes after the appearance of pain and ECG related changes in a patient who, as is routine in our laboratory, had received full heparinization before coronary angiography.

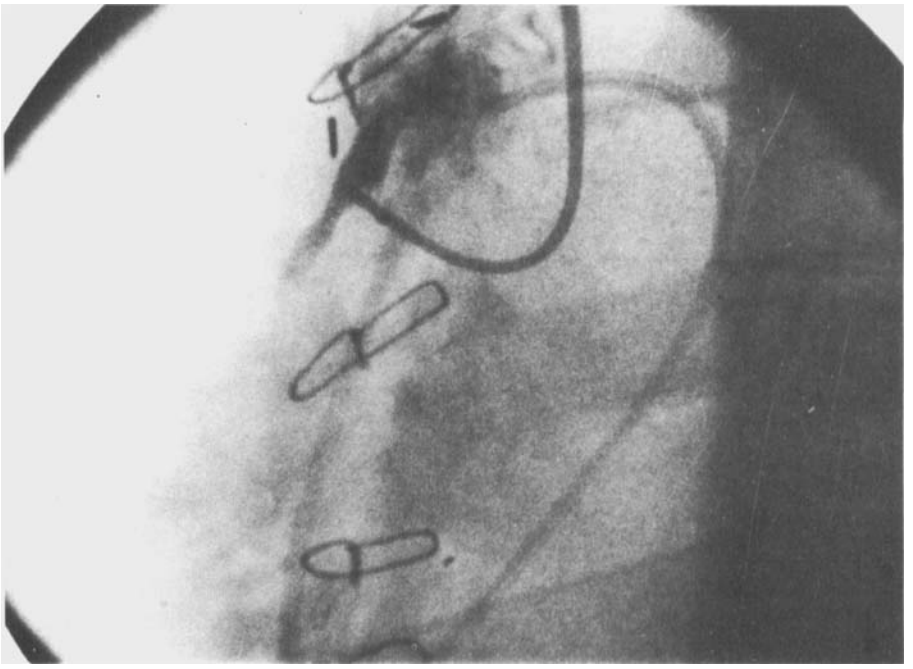

Fig. 6. The graft is completely occluded about 2 cm beyond its aortic orifice and reflux of dye into the aortic root is clearly visible.

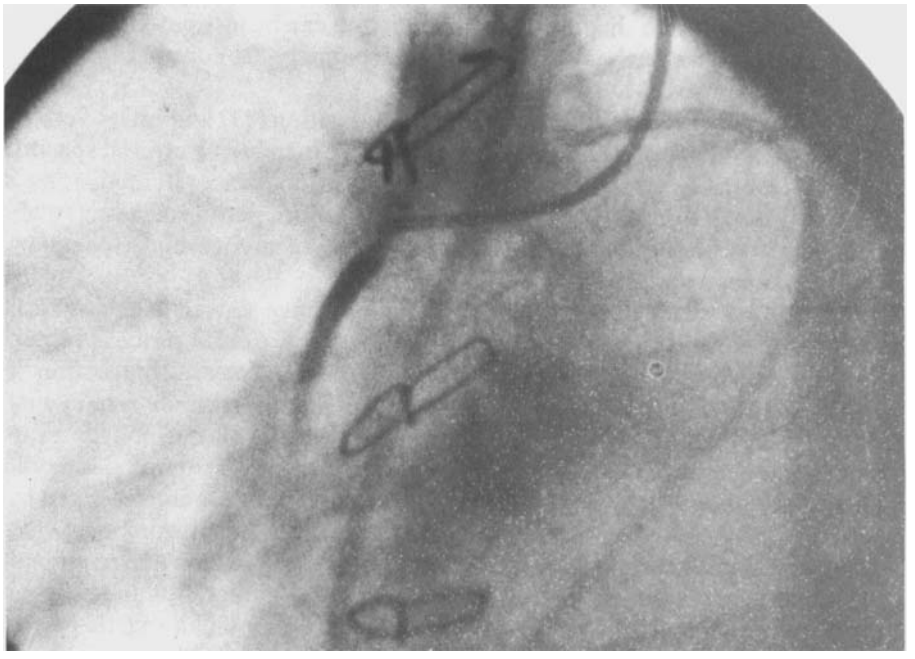

Fig. 7. Three minutes after administration of 0.6 mg of nitroglycerine po, the chest pain is still severe and there is only a slight progression of dye in the first portion of the graft that is still completely occluded.

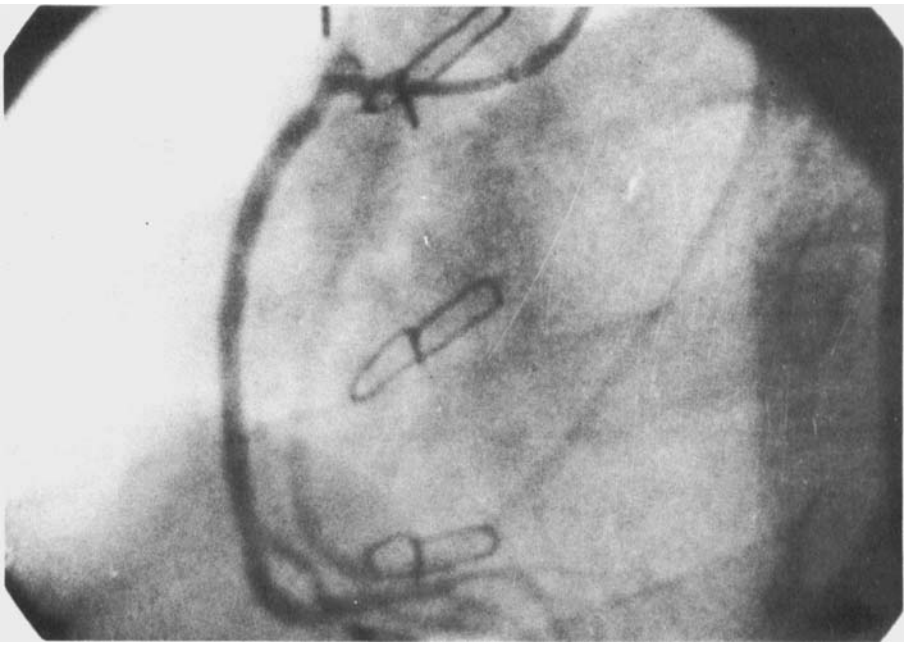

Fig. 8. One minute after direct injection of 0.35 mg of nitroglycerine, the graft appears patent and the RCA is visualized down to its more distal branches. No significant reflux of contrast agent into the aortic root is present at this time.

It has been established that no vasospastic action can be attributed to meglumine diatrizoate (Urografin 76 Squibb) [10] that was routinely the contrast medium used in this case.

According to the recent views on platelet aggregation [11] and on its very labile product Thromboxane A_2, which is extremely active in inducing arterial spasm [12], we could reasonably suppose that after its insertion this graft had been subjected from time to time to bouts of spastic constriction, perhaps leading to alterations in right coronary arterial flow and episodes of myocardial ischemia with clinical spontaneous angina.

Indeed the first two injections into the graft could have started in a way (catheter stimulation or contrast agent?) difficult to define the waterfall process of platelet aggregation with Thromboxane A_2 production leading to spastic contraction of the smooth muscle layer of the saphenous vein, subsequently partially relieved by the direct vasodilating action of nitroglycerine. As soon as the plasma concentration of nitroglycerine decreased to scarcely effective levels, the spastic phenomenon induced by Thromboxane A_2 developed again and, no longer counterbalanced by the vasodilator, led to collapse of the graft and rapid secondary thrombosis.

Although different results have been recently reported in men and in animals on the effectiveness of platelet inhibition in preserving patency of the vein grafts [13, 14], still we cannot reasonably rule out the possibility that a spastic phenomenon could in some occasions be involved initially in the pathologic process of closure of a saphenous vein bypass graft.

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