International Journal of Cardiac Imaging 4: 45–47, 1989
© 1989 *Kluwer Academic Publishers. Printed in the Netherlands*

The surgical complications of acute myocardial infarction: Color Doppler evaluation

Jos R.T.C. Roelandt, John H. Smyllie & George R. Sutherland
Department of Echocardiography, Thoraxcenter, University Hospital Rotterdam-Dijkzigt and Erasmus University, The Netherlands

Summary

Two-dimensional echocardiography in combination with Doppler and color Doppler flow mapping is now considered the technique of choice for the early diagnosis and assessment of the 'surgical' complications of acute myocardial infarction. It has the advantage of being a rapid, safe technique with ease of portability and repeatability, at relatively low cost. Transesophageal echocardiography may provide an alternative 'window' for imaging cardiac structure and function, but as yet its value in the diagnosis of the complications of myocardial function is not proven.

In the acute phase, color Doppler flow mapping can diagnose the cause of hemodynamic deterioration by distinguishing primary pump failure from the mechanical complications such as ventricular septal rupture or papillary muscle rupture. In the subacute phase, complications including left ventricular true and false aneurysms may be detected and this information allows optimal management decisions to be made. Thus, color Doppler flow mapping has become an indispensable technique in the coronary care unit. It provides a complete picture of cardiac structure and function making it superior to other methods in the clinical situation of an acute myocardial infarction which has such a volatile and unpredictable course.

Introduction

Two-dimensional echocardiography is a useful technique for the diagnosis of patients presenting with myocardial infarction. It can rapidly differentiate acute myocardial infarction from other causes of acute severe chest pain such as thoracic aortic dissection, pericarditis and aortic valve disease. Two-dimensional echocardiography in combination with color Doppler flow mapping has become the major diagnostic tool for the detection of the mechanical complications of myocardial infarction which in many cases can be corrected by surgical intervention. These include rupture of the left ventricular free wall, ventricular septal rupture and papillary muscle rupture or dysfunction. Both Doppler echocardiography and color Doppler flow mapping are used to assess the hemodynamic and blood flow abnormalities resulting from these complications so that their presence and severity can be readily evaluated at the bedside in the coronary care unit.

The diagnostic potential of color Doppler flow mapping may be extended by the transesophageal approach offering an alternative window to the heart when the precordial windows provide poor quality images. This is especially true in immobile, supine patients who are on ventilators or who have an intra-aortic counterpulsation devise in situ. However, at the present time the reported experience with transesophageal echocardiography in the assessment of the acute complications of myocardial infarction is limited.

Rupture of the left ventricular free wall

Free wall rupture of the left ventricle causes approximately 10% of fatalities following myocardial infarction. The diagnosis is difficult as hemodynamic collapse and electromechanical dissociation occur so rapidly. Occasionally the rupture may be contained by adherent pericardium which prevents fatal tamponade and this leads to the development of a left

ventricular false or pseudoaneurysm [1]. Due to the propensity for pseudoaneurysms to rupture, early diagnosis is essential so that subsequent surgical repair can be performed.

The two-dimensional echocardiographic features of a left ventricular pseudoaneurysm have been well described [2]. They are: 1) an extra myocardial cavity which is delineated by pericardium and/or extracardiac tissue; 2) an orifice size which is small compared to the maximal cavity dimension; and 3) like a true left ventricular aneurysm, pseudoaneurysms exhibit akinetic or dyskinetic motion and frequently contain thrombus.

Color Doppler flow mapping highly facilitates the diagnosis of a pseudoaneurysm by demonstrating transmyocardial blood flow passing to and fro across the free wall defect [3, 4]. This is particularly important when the myocardial rupture is small and cannot be visualized by two-dimensional imaging alone [4]. In this instance the differential diagnosis of an extramyocardial cavity would be between a pseudoaneurysm, a loculated pericardial effusion, a simple haematoma or a pericardial cyst. Color Doppler flow mapping by demonstrating turbulent blood flow passing between the left ventricle and the extramyocardial cavity, thus confirms the presence of a communication and hence the diagnosis of a pseudoaneurysm.

Ventricular septal rupture

Rupture of the ventricular septum occurs in about 2% of hospitalised patients following myocardial infarction and usually develops within the first week. The mortality of this condition is high and early surgery remains the treatment of choice. The echocardiographic diagnosis of ventricular septal rupture can be difficult. The septum may show an echo free area, dyskinesis or aneurysm formation, but these signs are not always diagnostic for ventricular septal rupture. Furthermore small defects may be impossible to visualize and in some series only about 35% of defects were readily visualized by two-dimensional echocardiography alone [5]. An injection of peripheral contrast can visualize right-to-left flow by the appearance of microbubbles within the left ventricle, while negative echocontrast in the right ventricle confirms left-to-right shunting which predominates in these patients.

Simultaneous pulsed Doppler and two-dimensional imaging may provide the diagnosis when a ventricular septal rupture is suspected, by detecting the high velocity right ventricular systolic flow disturbance which occurs in these patients. However repeated interrogation of the interventricular septum is often required to detect any left to right shunt and this can be time consuming. Also the pulsed Doppler technique is inaccurate at predicting the precise septal rupture site in some cases [5].

Color Doppler flow mapping has been found to be highly sensitive for the diagnosis of postinfarction ventricular septal rupture. By demonstrating the area of transseptal flow it can give an accurate prediction of the detect site or multiple sites [5]. The combination of two-dimensional echocardiography and color Doppler flow mapping can provide detailed information regarding left ventricular function, the presence and site of the septal rupture and the presence and grading of any co-existing mitral and/or tricuspid regurgitation. Thus left ventricular cineangiography prior to surgical repair can be avoided.

Postinfarction mitral regurgitation

Papillary muscle rupture or dysfunction may cause acute mitral and/or tricuspid regurgitation after myocardial infarction. In our experience the incidence of papillary muscle rupture is much less frequent than ventricular septal rupture. Papillary muscle rupture usually develops between 2 to 7 days after the onset of myocardial infarction with a median survival of only 3 days [6]. Immediate diagnosis is therefore mandatory so that mitral valve replacement can be performed.

The echocardiographic diagnosis of papillary muscle rupture may be recognized by rupture of the trunk of one of the papillary muscles with a mobile mass appearing during systole in the left atrium and in diastole in the left ventricle, by non-coaptation of the mitral leaflets or by accentuated holosystolic prolapse. There is also relative hyperkinesis of left ventricular wall motion.

Myocardial dyskinesis may cause mitral regurgitation by papillary muscle dysfunction. Two-dimensional echocardiography reveals a unique pattern of incomplete mitral leaflet closure in the majority of patients with de novo mitral regurgitation after

myocardial infarction. Also dyskinesis appears to involve the left ventricular myocardium beneath one of the papillary muscles, thus producing increased tension on the mitral leaflets and preventing normal closure. Doppler echocardiography and color Doppler flow mapping are highly sensitive techniques for detecting the presence of mitral regurgitation and both can be used to give a semi-quantitative assessment of severity. This usually involves delineating the extension of the regurgitant velocities into the left atrium or by mapping the regurgitant area and expressing it as a ratio of the left atrial size [7]. It should be noted, however, that these methods have been performed on patients with chronic mitral regurgitation. Our observations suggest these methods are not always reliable in the grading of acute mitral regurgitation encountered after myocardial infarction. We would advise that no single Doppler technique be used to assess the severity of mitral regurgitation but that a combination of the left ventricular function, the appearance of the mitral valve, the velocity of forward flow, the dynamics of retrograde flow and the regurgitant area should all be used to assess severity.

References

1. Roberts WG, Morrow AG. Pseudoaneurysm of the left ventricle. An unusual sequel of myocardial infarction and rupture of the heart. Am J Med 1967; 43: 639–44.
2. Roelandt J, v.d. Brand M, Vletter WB, Nauta J, Hugenholtz PG. Echocardiographic diagnosis of pseudoaneurysm of the left ventricle. Circulation 1975; 52: 466–72.
3. Roelandt JRTC, Sutherland GR, Yoshida K, Yoshikawa J. Improved diagnosis and characterisation of left ventricular pseudoaneurysm by Doppler colour flow imaging. J Am Coll Cardiol 1988; 85: 807–11.
4. Sutherland GR, Smyllie JH, Roelandt JRTC. Advantages of colour flow imaging in the diagnosis of left ventricular pseudoaneurysm. Br Heart J 1989; 61: 59–64.
5. Smyllie JH, Dawkins K, Conway N, Sutherland GR. The diagnosis of ventricular septal defect following myocardial infarction: the value of colour flow mapping. Br Heart J: In press.
6. Wei JY, Hutchins GM, Bulkley BH. Papillary muscle rupture in fatal acute myocardial infarction: a potentially treatable form of cardiogenic shock. Ann Intern Med 1979; 90: 149–152.
7. Helmcke F, Nanda NC, Hsiung MC et al. Color Doppler assessment of mitral regurgitation with orthogonal planes. Circulation 1987; 75: 175–83.