

Biventricular Pacing With Coronary Bypass and Dor's Ventriculoplasty

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We applied biventricular pacing to a patient with severe ischemic dilated cardiomyopathy (left ventricular [LV] ejection fraction 19%, LV end-diastolic volume 360 mL, and complete left bundle branch block). An epicardial LV lead was surgically implanted concomitant with on-pump beating coronary artery bypass grafting and Dor's endoventricular circular patch plasty. Biventricular pacing immediately achieved the resynchronization of the LV contraction, and improved cardiac function as well as reducing mitral regurgitation. Biventricular pacing combined with cardiac surgery for patients with cardiomyopathy and complete left bundle branch block may produce beneficial effects on LV function.

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Dor's endoventricular circular patch plasty, by excluding postinfarction left ventricular (LV) akinetic scar, has been proved to aid recovery of LV function in cases of ischemic cardiomyopathy [1]. Biventricular pacing (BVP) therapy, by electromechanically resynchronizing left ventricular contraction and reducing mitral regurgitation, has also been shown to be beneficial for dilated cardiomyopathy with complete left bundle branch block [2, 3]. We conducted BVP in a patient with severe ischemic dilated cardiomyopathy who underwent multiple coronary artery bypass grafting (CABG) and Dor's endoventricular circular patch plasty, and obtained good results.

A 66-year-old man was referred to our hospital because of postinfarction angina pectoris on effort and chronic heart failure. He had experienced previous myocardial infarctions in areas fed by the left anterior descending and right coronary arteries. His chest roentgenogram showed a slight increase in the cardiothoracic ratio, and electrocardiography revealed complete left bundle branch block (CLBBB; width of QRS wave, 150 milliseconds). Ultrasonic echocardiographic measurements indicated poor LV function and dilation (LV diastolic dimension 91 mm, LV systolic dimension 81 mm, LV end-

diastolic volume 360 mL, LV end-systolic volume 292 mL, and LV ejection fraction 19%). The anteroseptal wall was akinetic, and the inferior wall was diffusely severely hypokinetic. Left ventricular contraction appeared to be asynchronous and caused by CLBBB. Mitral regurgitation was moderate. The patient's coronary arteriogram showed multiple severely stenotic lesions in all three vessels.

Surgery was performed through a median sternotomy. The left internal mammary artery and saphenous veins were harvested. Coronary artery bypass grafting and Dor's endoventricular circular patch plasty were performed on the beating heart with support from cardiopulmonary bypass. Five distal coronary anastomoses were made. A saphenous vein graft was sewn sequentially to the atrioventricular branch and the posterodescending artery; another graft was sewn sequentially to the left anterior descending artery and the diagonal branches. The left internal mammary artery was anastomosed to the high lateral branch. Just after each distal anastomosis, coronary perfusion in the grafted area was immediately established through a coronary perfusion cannula connected to the cardiopulmonary bypass circuit to minimize ischemic damage. After all distal anastomoses, two saphenous vein grafts were anastomosed to the ascending aorta. Dor's endoventricular circular patch plasty was then performed. For BVP, a permanent screw-in-type epicardial lead (5071-55, Medtronic, Minneapolis, MN) was fixed on the posterolateral wall near the atrioventricular groove, and the other two leads (5071-35 and 4951M-53, Medtronic, Minneapolis, MN) were placed near the right ventricular outflow tract and on the right atrium. The patient was weaned off of cardiopulmonary bypass with the aid of several doses of dobutamine.

In the intensive care unit, BVP was started with a temporary atrioventricular (AV) pacemaker (AV interval; 120 msec), and increased systolic blood pressure from 95 to 105 mm Hg and left ventricular stroke work index from 18.5 to 21.1 $\text{mg} \cdot \text{M}/\text{beat}/\text{m}^2$. Biventricular pacing also reduced mitral regurgitation and pulmonary arterial wedge pressure. During the patient's postoperative rehabilitation in the ward, BVP was continued with the temporary pacemaker. Postoperative ultrasonic echocardiography showed marked LV volume reduction (LV diastolic dimension 71 mm, LV systolic dimension 65 mm, and LV end-diastolic volume from 360 mL to 204 mL), and LV ejection fraction was improved to 24%.

Before discharge, we did an on-off test of BVP and evaluated LV function by electrocardiography and ultrasonic echocardiography. When BVP was off, mitral regurgitation was moderate and LV contraction asynchronous. The patient complained of shortness of breath on exertion after a 500-m walk in an exercise stress test. However, when BVP was on, the QRS segment on the patient's electrocardiogram became narrow, and ultrasonic echocardiography revealed the reduction of mitral regurgitation from moderate to mild and the resynchronization of LV wall contraction. The patient was asymptomatic even after the exercise. After surgery, without BVP, LV dysfunction remained, with mild clini-

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cal symptoms of heart failure; therefore, we decided to apply permanent BVP to the patient. A permanent pacemaker (KDR701, Medtronic) was implanted in the left subcostal space, and the three leads were connected to the pacemaker with a Y-adaptor (5866-38M, Medtronic). We set the pacemaker to dual chamber pacing, dual chamber sensing, dual mode of response (DDD) pacing with an AV delay of 120 milliseconds. The threshold of the LV ventricular lead was 1.5 V at a pulse width of 0.4 milliseconds. Fifteen months after surgery, the patient is doing well, without special limitations on his daily life.

Comment

Most surgical treatments for severe congestive heart failure remain challenging. Endoventricular circular patch plasty with CABG ameliorates clinical symptoms and aids long-term survival in patients with ischemic cardiomyopathy [1]. Biventricular pacing has also been shown to improve cardiac contractility and clinical symptoms in patients with severe chronic heart failure and interventricular conduction delay, especially CLBBB [2, 3]. Cardiac inefficiency occurring in CLBBB is due to dyssynchronous LV contraction. Biventricular pacing restores systolic contractile synchrony (resynchronization), which also results in efficient LV contraction and reduces mitral regurgitation [2]. The AV interval is shortened to optimize ventricular filling, thus also decreasing presystolic mitral regurgitation [3].

Preoperative evaluation of our patient showed good indication for BVP (CLBBB on electrocardiography and severe LV dysfunction on ultrasonic echocardiography). Because intravenous coronary sinus lead implantation for BVP has not been approved in Japan, we decided to implant an epicardial LV lead that would be available for temporary or permanent use for BVP. Just after surgery, BVP increased blood pressure and LV stroke work index, and reduced mitral regurgitation and pulmonary arterial wedge pressure. Because of the significant improvement obtained by BVP, the pacing was continued with a temporary pacemaker, and a permanent generator was implanted 1 month after the initial operation. Recently, intravenous lead implantation for BVP has become common, but the success rate of coronary sinus lead implantation is reported to be low (53.3% to 83%) [4, 5]. Surgical implantation of epicardial LV leads during primary surgery is more reliable than intravenous implantation, and may be an optional strategy for cardiac surgery patients with severe LV dysfunction and CLBBB.

It is extremely important to minimize ischemic injury of viable myocardium in surgery for patients with severely impaired LV function. In recent years, off-pump CABG has been reported to induce less myocardial injury than conventional CABG using cardioplegic solution [6]. To protect the viable myocardium during surgery, we performed all procedures on the beating heart with the assistance of cardiopulmonary bypass, and immediately perfused the grafted area after each distal anastomosis through a coronary perfusion cannula connected to the cardiopulmonary bypass circuit. This

method allows continuous coronary perfusion to be maintained except for the short-term regional cardiac ischemia that occurs during creation of distal anastomoses.

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Severe Hemoptysis 6 Years After Coronary Artery Bypass Grafting

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A patient with a history of coronary artery bypass grafting was admitted with severe hemoptysis. Bronchoscopy showed recent bleeding with clot formation in the lingular bronchus, but no tumor was visualized. Several biopsies of the underlying mucosa were negative. Coronary angiography showed patent venous and arterial bypass grafts. Selective angiography of the left internal mammary artery revealed one large and two smaller aberrant bronchial side branches, which probably caused the lingular hemorrhage. We performed embolization of the largest aberrant branch. After a follow-up of 3 months, hemoptysis had not recurred.

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