ever, activation of these systems subsides by the end of the second year, even on a program of low-intensity anticoagulation with low-dose antiplatelet agent.

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ASSESSMENT OF LONG-TERM LEFT INTERNAL THORACIC ARTERY GRAFT PATENCY BY EXERCISE DOPPLER ECHOCARDIOGRAPHY

Yuki Yoshida, MT,^a Masatoshi Fujita, MD,^b Yasuki Kihara, MD,^b Shigeru Kubo, MT,^a Terumitsu Tanaka, MD,^c Tomoyuki Iwase, MD,^c Shun-ichi Tamaki, MD,^c Tatsuro Sato, MD,^d Chang-Hee Park, MD,^d and Ario Yamazato, MD,^d *Kyoto, Japan*

Internal thoracic artery grafting is preferable to grafting with saphenous veins because of the higher long-term patency rate.¹ Coronary arteriography is still a gold standard for left internal thoracic artery (LITA) graft patency. However, the angiographic approach is limited in evaluating physiologic response to increased myocardial oxygen demand and in repeated investigations during the long-term follow-up period. Doppler echocardiography is reported to be a reliable method to noninvasively assess the LITA flow pattern.²⁻⁴ However, to our best knowledge, there is no report on LITA graft flow characteristics during exercise. In the present study, therefore, we hypothesized that Doppler echocardiography during exercise would provide more precise information about patency of the LITA graft during the long follow-up period.

Methods. Among 38 consecutive cases of coronary artery bypass grafting with the LITA to the left anterior descending coronary artery (LAD), exercise Doppler echocardiography was performed in 22 patients (20 men, 2 women, 60 ± 7 [standard deviation] years) who had not had a previous anterior myocardial infarction and had 90% to 100% diameter stenosis in the LAD proximal to the anastomotic site. These patients were selected to be studied, and after their Doppler study they all underwent

a second coronary angiography. The time interval between the operation and the Doppler study was 20.9 ± 7.0 days.

Supine bicycle exercise testing was conducted at a constant workload of 25 W until either chest pain or leg fatigue appeared. After a 24-hour withdrawal of all medications, Doppler echocardiographic studies were performed with a Toshiba SSA-260A echocardiograph with a 5 MHz transducer. The transducer was positioned at the left supraclavicular fossa, the ultrasonic beam was directed toward the caudal site from the transducer, and the LITA graft was observed on the two-dimensional echocardiogram.³ The sample volume was placed on the graft, and graft blood flow was detected by means of pulsed-wave Doppler echocardiography. Doppler signals were recorded for 30 seconds at rest and for 30 seconds immediately after the cessation of exercise on a videotape for later analysis.

On the basis of the angiographic data, 22 patients were divided into two groups: group A, 15 patients with a patent LITA graft (<25% diameter stenosis); group B, seven patients with a severely stenosed LITA graft (75% to 99% diameter stenosis) at the site of the anastomosis with the LAD. No stenosis was found in the proximal site of the LITA graft where flow velocities were measured. Ten of 15 patients in group A were restudied 10 months after the operation to evaluate the long-term LITA graft patency.

Results. In all patients, optimal Doppler signal recordings were obtained at rest and during exercise. There were no significant differences in the diastolic/systolic peak velocity ratio and diastolic fraction of time-velocity integral at rest between groups A and B (Fig. 1). The exercise to rest ratio of mean diastolic velocity (the index of LITA flow reserve) was 2.03 ± 0.48 in group A, being significantly higher than 1.26 ± 0.20 in group B ($p < 0.01$) (Fig. 2). There were no significant differences in pressure-rate

From the Departments of Clinical Laboratory,^a Cardiology,^c and Cardiovascular Surgery,^d Takeda Hospital, and College of Medical Technology, Kyoto University,^b Kyoto, Japan.

Received for publication July 18, 1997; accepted for publication Oct. 7, 1997.

Address for reprints: Masatoshi Fujita, M.D., Professor, College of Medical Technology, Kyoto University, 53 Kawaharacho, Shogoin, Sakyo-ku, Kyoto, 606-01, Japan.

J Thorac Cardiovasc Surg 1998;115:954-6

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0022-5223/98 \$5.00 + 0 12/54/86715

Fig. 1. Comparison of resting velocity parameters between groups A and B. *DI*, Diastolic time-velocity integral; *DPV*, diastolic peak velocity; *SI*, systolic time-velocity integral; *SPV*, systolic peak velocity.

products between groups A and B either at rest ($9,642 \pm 1,921$ vs $9,645 \pm 1,102$ mm Hg $\cdot$ beats/min) or during exercise ($17,228 \pm 3,494$ vs $16,405 \pm 1,331$ mm Hg $\cdot$ beats/min).

Of 15 group A patients with a patent LITA graft, 10 patients had a total occlusion of the LAD, and the remaining five patients had 90% to 99% stenosis of the LAD. There were no significant differences in the diastolic/systolic peak velocity ratio and diastolic fraction of time-velocity integral at rest, and the index of LITA flow reserve between patients with a total occlusion and severe stenosis of the LAD.

Follow-up study was conducted in 10 of 15 patients in group A at a mean of 9.9 ± 4.0 months after bypass grafting. In one patient, follow-up study was performed 4 months later, because a follow-up treadmill stress test had revealed the significant ST-segment depression without chest pain. Stress myocardial ^{201}Tl scintigraphy had also revealed a reversible defect in the anteroseptal wall. In this patient, the index of LITA flow reserve was decreased from 2.00 to 1.14 at the follow-up study. Coronary angiography disclosed a 99% LITA graft stenosis at the site of anastomosis with the LAD. The patient was then successfully treated with percutaneous transluminal coronary angioplasty. The index remained unchanged in the remaining nine patients during the follow-up period.

Discussion. Our study demonstrated that it is possible to noninvasively evaluate the LITA graft flow during exercise by Doppler echocardiography. This method appears to be very useful for evaluation of the LITA graft patency and can be performed repeatedly during the follow-up period. Although angiographic follow-up remains a gold standard for assessing the condition of the LITA graft, it is not suitable for repetitive assessment. Exercise Doppler echocardiography can be applied to ambulatory patients to determine the indication of catheterization as a noninvasive diagnostic test. However, the response of the LITA graft flow to exercise may be

EXERCISE/REST MEAN DIASTOLIC VELOCITY RATIO

Fig. 2. Comparison of exercise/rest mean diastolic velocity ratio between groups A and B.

variable, because the size of perfusion area, myocardial functional status, the degree of LAD stenosis, and the number of the remnant side branches of the LITA are different among patients.

In our study, no differences were found in the diastolic/systolic peak velocity ratio and the diastolic fraction of time-velocity integral in the resting state between patients with and without severe LITA graft stenosis. These results indicate that the diastolic flow is maintained at rest even in patients with severe graft stenosis of LITA. With the

increase in the pressure-rate products by exercise, a statistically significant difference ($p < 0.01$) was observed in the index of LITA flow reserve between groups A and B. This finding is consistent with previous observations regarding the coronary flow reserve assessed with a vasodilator.⁵

In conclusion, exercise Doppler echocardiography enabled us to make a noninvasive evaluation of the LITA graft patency. This method was useful for routine postoperative follow-up of patients with LITA grafts.

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AXILLOCORONARY BYPASS FOR SEVERELY ATHEROSCLEROTIC AORTA IN CORONARY ARTERY BYPASS GRAFTING

Johannes Bonatti, MD, Herbert Hangler, MD, Herwig Antretter, MD, and Ludwig C. Müller, MD, *Innsbruck, Austria*

Stroke after coronary artery bypass grafting (CABG) is one of the most feared complications in cardiac operations. Cannulation and clamping of a severely atherosclerotic ascending aorta can lead to cerebral embolization of atheromatous debris and should therefore be absolutely avoided. Alternatives to ascending aortic cannulation and crossclamping have included proximal descending aortic or femoral artery cannulation with placement of arterial in situ grafts¹ or innominate artery-to-coronary artery vein grafts² on the fibrillating or beating heart. Replacement of the ascending aorta with a synthetic graft in deep hypothermic cardiocirculatory arrest and implantation of vein grafts into the prosthesis has been applied clinically as well.³

In this brief communication we report a case of severely atherosclerotic ascending aorta detected during CABG. As an alternative to aortic crossclamping, an axillocoronary saphenous vein graft was placed to the right coronary artery (RCA) in addition to a left internal thoracic artery in situ graft to the left anterior descending artery (LAD).

From the University Clinic of Surgery, Cardiac Surgery, Anichstrasse 35, A-6020 Innsbruck, Austria.

Received for publication Sept. 16, 1997; accepted for publication Oct. 29, 1997.

Address for reprints: Johannes Bonatti, MD, University Clinic of Surgery, Cardiac Surgery, Anichstrasse 35, A-6020 Innsbruck, Austria.

J Thorac Cardiovasc Surg 1998;115:956-7

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0022-5223/98 \$5.00 + 0 12/54/87223

The procedure was carried out on the beating heart with cardiopulmonary bypass and proximal aortic arch cannulation. The postoperative course was uneventful, no neurologic deficit was detectable, and the axillocoronary bypass showed excellent flow.

Clinical summary. A 73-year-old woman was scheduled to undergo CABG for two-vessel disease. Cardiovascular risk factors included arterial hypertension and hypercholesterolemia. An anterior wall myocardial infarction was reported 6 years before CABG and LAD percutaneous transluminal coronary angioplasty shortly thereafter. The patient complained of angina on exertion; coronary angiography showed an 80% proximal LAD stenosis and a 99% proximal RCA stenosis.

After median sternotomy and harvesting of the internal thoracic artery, the pericardium was opened. Inspection of the ascending aorta showed a heavily atherosclerotic vessel with numerous calcified plaques on the anterior wall. By gentle palpation and epiaortic echography a soft spot on the proximal aortic arch could be detected for arterial cannulation.

The right axillary artery was exposed between the pectoralis major and deltoid muscle above the anterior axillary fold (Fig. 1). After systemic heparinization, the axillary artery was clamped and incised. A piece of saphenous vein harvested from the right leg was sutured to the axillary artery using 6-0 Prolene polypropylene (Ethicon, Inc., Somerville, N.J.). The right pleura was opened, and a wide hole in the intercostal space adjacent to the axillary artery anastomotic site was created digitally. The saphenous vein graft was brought through this intercostal opening. Adequate blood flow was detected. Car-