Mid to Long-Term Results of Circumflex Coronary Artery Revascularization With Left Internal Thoracic Artery Grafts

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SUMMARY

The current trend in coronary artery surgery is to revascularize the left coronary artery branches with bilateral internal thoracic arteries (ITA). For this procedure, the right ITA is usually grafted to the left anterior descending coronary artery while the circumflex coronary artery is revascularized by the left ITA. The mid to long-term results of the left ITA on the circumflex system were examined in this study.

Forty of 48 patients operated on between 1996 and 1998 who had undergone revascularization of the left coronary artery with both ITAs and who fulfilled the study criteria underwent control coronary arteriography to determine the mid to long-term patency of LITA grafts on the circumflex artery. The median time for follow-up was 53 months (range, 49 to 70 months). Of the 40 angiographically controlled patients, 35 had patent left ITA to circumflex artery anastomosis (87.5%). One graft stenosis and four graft occlusions were observed. In the same group, right ITA to left anterior descending coronary artery anastomoses were patent in 38 patients (95%).

Left ITA grafts seem to be the conduit of choice for revascularization of the circumflex coronary artery. In combination with the in-situ right ITA to left anterior descending coronary artery anastomosis, in situ left ITA grafting to the circumflex system can be done with acceptably low mortality and excellent long-term patency rates. Its utilization is particularly advised in young patients where the importance of left coronary artery revascularization by bilateral ITA grafts is increased. (Jpn Heart J 2004; 45: 23-30)

Key words: Internal thoracic artery, Left coronary artery, Left anterior descending coronary artery, Circumflex coronary artery

The excellent results obtained using the left internal thoracic artery (LITA) to revascularize the left anterior descending coronary artery (LAD) have made this graft the “gold standard” conduit for these procedures. In order to benefit more from these advantages and to enhance the results of coronary artery surgery, the
focus has been directed towards extensive internal thoracic artery (ITA) grafting using bilateral or sequential ITA grafts in recent years. 1-5)

The current trend in coronary artery surgery is to make every effort to use both ITA grafts for the left coronary system following the reports of Schmidt 6) and Pick. 7) The authors have reported the superiority of this revascularization strategy when the 10 year follow-up results concerning recurrence of angina, new myocardial infarction rate, and long-term survival are compared to patients in which only LITA was used and also to those in which the right internal thoracic artery (RITA) was used to revascularize the right coronary artery in addition to LITA to LAD anastomosis. 6-8)

With the extension of this new strategy of bilateral ITA usage, many surgical teams have reported that the patency of RITA on LAD was not different from the classical LITA to LAD anastomosis. However, there have not been a similar amount of studies concerning the results of ITA grafts on the circumflex coronary artery. Two different strategies are now available to revascularize the left coronary system with both ITA grafts and different opinions still exist on which sided ITA should be used for the circumflex coronary artery, as well as on the patency of ITA grafts on this coronary artery. The main objective of this study was to report on the mid to long-term results of LITA grafts on the circumflex coronary artery.

**METHODS**

Revascularization of the left coronary system with bilateral ITA grafts was initiated at our institution in February 1996 and about 300 patients have undergone this procedure since that date. Our revascularization strategy is to graft the RITA to the LAD, while the major obtuse marginal branch of the circumflex coronary artery is revascularized by the LITA.

In order to determine the mid to long-term results of circumflex coronary artery revascularization by the LITA, 48 out of 72 patients operated on between February 1996 and December 1998 and fulfilling the study criteria were selected for control coronary arteriography. The exclusion criteria and the reasons for exclusion from the study were as follows: Follow-up interval less than 4 years, 9 patients with target coronary artery stenosis < 70% (as stenosis < 70% may cause flow competition between an ITA graft and the native coronary artery and may affect the patency of the graft), 6 patients in whom LITA was used as a free graft (as the patency of a free graft may differ from a pedicled LITA), 7 patients with combined surgical procedure to the coronary artery bypass grafting as valve replacement, left ventricular aneurysm resection or carotid endarterectomy (as these procedures might modify the long-term prognosis of these patients), and 2
patients with endarterectomy of the LITA grafted artery (as this procedure has a negative effect on the long-term patency rate).

Of the 48 patients selected for control studies, 40 underwent control coronary arteriography. In all of these patients controlled by arteriography, the RITA was used to revascularize LAD. In addition to the ITA grafts, 83 anastomoses were performed with saphenous vein grafts (57 for the right coronary artery, 16 for the diagonal branch of LAD, and 10 for the obtuse marginal branches other than the ITA grafted branch of the circumflex coronary artery). The demographic data are listed in the Table. The median period for control coronary arteriography was 53 months (range, 49 to 70 months).

**Surgical technique:** The sternum was opened via a sternotomy incision. The LITA and RITA were harvested with a large pedicle containing both veins by the aid of electrocautery. Following systemic heparinization (4 mg/kg), both ITAs were transected after their bifurcations and diluted papaverine solution was injected through one of these side branches. Cardiopulmonary bypass was initiated by aortic and right atrial cannulation. Following a cooling period to 28 to 32°C, the aorta was cross-clamped and cardioplegic arrest was established by

![Figure 1. Arteriographic samples of patent left internal thoracic artery to the obtuse marginal branch of the circumflex coronary artery anastomosis: 52 months (A), 57 months (B), and 63 months (C) after the operation.](image)

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cold blood cardioplegia infused through the aortic root and via the coronary sinus which was repeated every 20 minutes. Saphenous vein distal anastomoses were performed first, followed by LITA to the obtuse marginal artery and RITA to LAD anastomoses using 7:0 polypropylene sutures. The aortic cross-clamp was then released and a saphenous vein proximal anastomosis, if needed, was performed during the warming period under a partial aortic clamp. Following the warming period, the patient was weaned from the cardiopulmonary bypass and the sternum was closed after completion of hemostasis.

**Control coronary arteriography:** The coronary arteriographies were performed via the right femoral artery with Philips Integris H 3000 and Philips Integris HM 3000C devices equipped with Quinton monitorization systems (Philips Company, Eindhoven, The Netherlands). All stenoses of LITA greater than 50% were defined as "graft stenosis", and the nonvisualization of the contrast material after a certain point of the graft, at the anastomosis line or nonfilling of the host coronary artery, was defined as "graft occlusion".

**RESULTS**

**Post-operative period:** There was no operative mortality among the 48 patients fulfilling the study criteria. The mean aortic clamp time was 76.43 (± 19.46) minutes and the mean cardiopulmonary bypass time was 123.76 (± 30.23) minutes. The mean number of distal anastomoses performed was 4.07 (± 0.76) per patient. One patient required intra-aortic balloon pump assistance for weaning from the cardiopulmonary bypass (2.08%). Two patients were taken back to the operating room the evening of the operation for bleeding revision (4.16%). Perioperative myocardial infarction, characterized by a new Q-wave appearance on the postoperative electrocardiograph, was diagnosed in one patient (2.08%) and it was located inferiorly. Left pleural fluid collection was observed in one patient (2.08%) on the 6th postoperative day and was drained by a pleural tube insertion. One patient developed a cerebrovascular event characterized by left hemiplegia (2.08%). All patients were discharged from the hospital.

**Follow-up period:** All patients were called for clinical control by telephone calls and coronary arteriography was proposed to the patients. Two patients could not be reached. There were 4 late deaths, 2 were noncardiac in origin (one patient died from pulmonary malignancy and the other from chronic renal failure). The two cardiac deaths (4.16%) occurred in the 25th postoperative month (sudden death) and 31st month (during hospitalization for congestive heart failure at another center), respectively.

Thirty-four of 42 patients (80.95%) who came for follow-up control were in NYHA class 1 functional capacity without recurrence of angina. Four patients
described exertional angina symptoms. One patient had already undergone percutaneous transluminal coronary angioplasty (PTCA) of his native circumflex coronary artery at another center due to stenosis of his LITA graft in the postoperative 16th month. Two patients described exertional dyspnea symptoms which were considered as from ischemic origin. One patient was in NYHA class 3 functional capacity and was taking congestive heart failure medication.

**Control coronary arteriographies:** Two patients refused control coronary arteriography and these patients were symptom-free. Forty of 42 patients, available at the time of follow-up, underwent control coronary arteriography (95.23%). Coronary arteriography revealed that 35 of 40 LITA to obtuse marginal artery anastomoses were fully patent (87.5%) for a median follow-up time of 53 months (range, 49 to 70 months) (Figure 1). There were 32 of 34 patients without any symptoms, 2 patients describing exertional dyspnea symptoms, and one patient with exertional angina symptoms. The latter patient had an occluded saphenous vein graft to the right coronary artery. One patient with angina pectoris symptoms showed 60% stenosis of the anastomosis line. This patient had a negative treadmill test. Four of the LITA grafts were found to be totally occluded. The patient who had undergone PTCA was included in this group. One of these patients underwent PTCA with stent placement of his native circumflex coronary artery, while a reoperation decision was made for a patient with occluded grafts, including the LITA. The patient with congestive heart failure had occluded RITA-LAD

![Figure 2](image.png)

**Figure 2.** Comparative patency of right internal thoracic artery (RITA) grafts on the left anterior descending coronary artery (LAD) to the left internal thoracic artery (LITA) graft on the circumflex coronary artery (Cx). (median follow-up, 53 months, range, 49 to 70 months)
and saphenous vein to the right coronary anastomosis in addition to the occluded LITA graft. This patient was judged inoperable because of severe distal disease.

Overall, 35 patients (87.5%) had patent anastomoses; 1 had graft stenosis (2.5%), and 4 (10%) had graft occlusion.

The arteriographic examination also revealed that 38 RITA to LAD anastomoses were patent (95%) (Figure 2). Of the 83 saphenous vein anastomoses, 59 were patent (71.08%). Twelve of 57 vein grafts for the right coronary artery, eight of 16 vein grafts for the diagonal branch of the LAD, and four of 10 vein grafts for the obtuse marginal artery were occluded. Arteriographic appearance of wall irregularities of the saphenous vein with patent anastomosis was noticed in some vein grafts.

**DISCUSSION**

The most important determinant of late results of coronary artery surgery is the type of bypass conduit used for grafting. 9) Within the last several years the importance of ITA for coronary revascularization has increased rapidly following the reports on the more favorable patency rate of this graft compared to vein grafts. Along with this trend, bilateral ITAs have been employed more frequently in an effort to increase the number of distal ITA anastomoses. During the first attempts, it was claimed that this procedure resulted in an increased rate of postoperative bleeding and sternal infections in a prolonged hospital stay, and that it did not contribute positively to the long-term survival when compared to unilateral ITA usage. 10) However, the earlier fears regarding increased early mortality and morbidity after bilateral ITA surgery were not confirmed by subsequent studies and bilateral ITA grafting, especially in young patients, gained in popularity. 11) During the first years of bilateral ITA surgery, the RITA was usually grafted to revascularize the right coronary artery while the LITA was reserved for LAD. However, improved long-term survival rates have been reported in the following years when both ITAs were grafted to the left coronary system. 6,12) Pick, et al stated that revascularization of the left coronary artery with bilateral ITA grafts was an independent factor of lower rates of angina recurrence, late myocardial infarction, and the composite end point of any cardiac event. 7) Nowadays, most of the surgical teams reserve both ITAs for the revascularization of the left coronary artery branches.

Actually, there are two different alternatives to revascularize the left ventricle with bilateral ITAs. The first is to graft the LITA to the LAD in the classical way and to rotate the RITA through the transverse sinus for circumflex coronary artery branches. The second option is to graft the RITA to the LAD and revascularize the circumflex coronary artery by the LITA. At the beginning, some serious
reservations have been expressed about the second alternative, stating that there was no need to change the target coronary artery for LITA grafts which have an already proven patency rate. However, with increasing experience, the patency rates of the RITA on the LAD are reported to be similar to that of the LITA on the LAD.\textsuperscript{13,14} In our experience with the 40 arteriographically controlled patients for a minimum period of 49 months, 38 RITA to LAD anastomoses were found to be fully open (95\%), which is in accordance with other studies in the literature. As both ITAs have similar patency rates on LAD, the choice of the ITA to be used and the patency of this graft on the circumflex coronary artery will determine the long-term results of the revascularization of the left coronary artery by bilateral ITA grafts.

It is generally acknowledged that the patency of ITA grafts is somewhat lower on target coronary arteries other than the LAD, but even this patency rate is much better than the results for venous grafts which have reported late patency rates changes between 50 to 70\% for 5 years.\textsuperscript{15-17} An 87.5\% patency rate for the LITA on the circumflex coronary artery for at least 4 years, as observed in our study, is an acceptable result for circumflex coronary artery revascularization. We therefore think that ITA grafts are the ideal conduit for this coronary artery. Despite some good patency rates for RITA grafts rotated through the transverse sinus for obtuse marginal branches of the circumflex coronary artery,\textsuperscript{18-20} this option is also reported to have a worse prognosis than LITA grafts due to stretching of the graft and to the pressure caused on the artery by the aorta.\textsuperscript{13,21} We also noticed some patients with early occlusion of the RITA grafts rotated through the transverse sinus so this method has been discontinued. This is the main reason why we prefer LITA grafts for revascularization of the circumflex coronary artery. Reports in the literature comparing the results of both ITA on the circumflex artery also recommend the use of LITA with better patency rates.\textsuperscript{13,22,23}

In conclusion, LITA grafts seem to be the conduit of choice for revascularization of the circumflex coronary artery. In combination with \textit{in situ} RITA to LAD anastomosis, \textit{in situ} LITA grafting to the circumflex system can be done with acceptably low mortality and excellent long-term patency rates. Its utilization is particularly recommended for young patients in whom the importance of left coronary artery revascularization by bilateral ITA grafts is increased.

REFERENCES