

## Recycling thoracic arteries for redo coronary artery bypass grafting: Long-term follow-up

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**R**edo coronary artery bypass graft (redo CABG) procedures are a surgical challenge, especially when one or both internal thoracic arteries (ITAs) have been previously harvested. The lack of available ITA grafts at reoperation might jeopardize the long-term outcomes, because pedicle ITAs have shown longer patency than have other grafts.<sup>1,2</sup>

Early and midterm results after recycling of ITA grafts in coronary reoperations were demonstrated to be satisfactory.<sup>3-5</sup> We report clinical and angiographic long-term follow-up of this procedure.

### Patients and Methods

From January 1990 to December 2005, 9 patients (7 men and 2 women) underwent redo CABG, recycling the previously implanted ITAs. Patients were evaluated with regard to clinical, echocardiographic, and angiographic findings. They were prospectively followed up by direct visit, echocardiography, and stress test (Table 1). Between June 2006 and December 2006, a coronary angiographic follow-up was performed in all survivors (8 patients). Outcome variables included perioperative (30-day) mortality and morbidity, long-term survival, and ITA graft patency.

### Results

The mean age of the population was  $59.3 \pm 13.3$  years (range 38–76 years). The preoperative transthoracic echocardiographic ejection fraction was  $50.2\% \pm 8.1\%$ . Preoperative coronary angiography excluded proximal stenoses of the ITA grafts that were recycled as pedicle grafts.

The mean interval between operations was  $27.7 \pm 42.3$  months (range 1–132 months). Five patients underwent early reoperation (<6 months) for stenosis at the anastomotic site. The remaining 4 patients had late reoperation owing to progression of native coronary disease.

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The operation was performed on pump during cardioplegic arrest. The recycled grafts included 8 left and 2 right ITAs. One patient had both ITAs recycled. In 7 cases the left ITA had been previously anastomosed to the left anterior descending artery (LAD). In patient 3, it was transposed from an obtuse marginal branch to the LAD and the right gastroepiploic artery was anastomosed to the obtuse marginal branch. One young patient (No. 2) required the interposition of a short segment of saphenous vein between the left pedicle ITA and target LAD. The recycled right ITA was used to anastomose the right coronary artery distal to the previous anastomosis.

There were no operative or perioperative (30-day) deaths. The postoperative course was uneventful. Cumulative follow-up time was 1016.0 patient-months and was 100% complete. Complete follow-up ranged from 48 to 192 months (mean  $112.8 \pm 17.6$  months, median 113 months).

At follow-up, 1 patient died of noncardiac causes 78 months after reoperation. The Kaplan–Meier overall survival estimate at 15 years was  $83.3\% \pm 15.2\%$ . The actuarial freedom from heart-related mortality was 100%.

There were 2 coronary angioplasty procedures at follow-up. Patient 2 underwent percutaneous transluminal coronary angioplasty and stenting on the anastomosis that was constructed to



**Figure 1.** Long-term angiographic follow-up of a patient who underwent redo coronary artery bypass grafting. The angiogram documented the patency of the recycled left ITA to LAD.

TABLE 1. Operative data and follow-up of patients

Pt No.	Age (y)	Previous operation	Interval between operations (mo)	Location and extent of stenosis	Recycled ITA	Reoperation	Follow-up (mo)
1	38	AVR (Sorin 23) and LMC plasty (Takayasu arteritis); 3 y later, RITA to RCA	1	RITA to RCA (distal anastomosis, 90%)	RITA	RITA to RCA	192
2	40	LITA to LAD; RITA to PDA; SVG to OM	5	LITA to LAD (distal anastomosis 99%); RITA to PDA (distal anastomosis 80%); SVG to OM (proximal anastomosis 80%)	LITA, RITA	LITA to LAD (SVG interposed); RITA to RCA; SVG to PDA; new proximal anastomosis of SVG to OM	171; PTCA on LITA to LAD with interposed SVG after 123 mo
3	65	LITA to OM; SVG to PDA and PLA	35	LAD (75%), LITA to OM (distal anastomosis 99%); SVG to PDA and PLA (70%)	LITA	LITA to LAD; RGEA to OM; sequential SVG to PDA and PLA	148
4	56	LITA to LAD; SVG to OM	15	LITA to LAD (distal anastomosis, 90%) 1st DIAG (70%); PDA (70%)	LITA	LITA to LAD; RGEA to PDA; SVG to 1 <sup>st</sup> DIAG	142
5	59	LITA to LAD SVG to RCA	5	LITA to LAD (distal anastomosis 90%)	LITA	LITA to LAD	113
6	76	LITA to LAD	132	LITA to LAD	LITA	LITA to LAD	78; died
7	63	LITA to LAD; SVG to PLA and OM	48	LITA to LAD; SVG to PLA and OM	LITA	LITA to LAD; sequential SVG to PLA and OM	65
8	62	LITA to LAD	5	LITA to LAD	LITA	LITA to LAD	59
9	75	LITA to LAD	4	LITA to LAD	LITA	LITA to LAD; SVG to PDA	48; (PTCA on CFX after 19 mo)

AVR, Aortic valve replacement; CFX, circumflex artery; DIAG, diagonal artery; ITA, internal thoracic artery; LITA, left internal thoracic artery; LMC, left main coronary artery; LAD, left anterior descending artery; OM, obtuse marginal artery; PDA, posterior descending artery; PLA, posterolateral artery; PTCA, percutaneous transluminal coronary angioplasty; RCA, right coronary artery; RGEA, right gastroepiploic artery; RITA, right internal thoracic artery; SVG, saphenous vein graft.

elongate the left ITA with an interposed saphenous vein graft, and patient 8 underwent angioplasty on the circumflex artery for the progression of coronary artery disease. The other patients had no recurrent angina and no abnormalities on stress testing. At long-term follow-up, coronary angiography showed patency of the recycled ITAs in all cases (Figure 1). Actuarial freedom from restenosis of recycled ITA graft at 15 years was 75.0% ± 21.7%.

### Discussion

ITA is the graft of choice in terms of patency and durability, as it has been proven to improve long-term outcomes.<sup>1,2</sup> These benefits

could be helpful even in patients who undergo redo surgical myocardial revascularization, above all in younger patients who have a longer life expectancy.

The recycling of ITA grafts can be performed with excellent clinical results, although it introduces further technical difficulties to a challenging operation.<sup>3-5</sup> In this limited experience, we reused previously placed ITA grafts with no perioperative deaths or complications. The long-term clinical and angiographic follow-up demonstrated that recycled ITAs maintain a high rate of patency even at long-term follow-up. Only 1 patient needed angioplasty of the graft, but the restenosis was located

at the anastomosis between the ITA and the saphenous vein elongation.

The recycling of ITA grafts can be performed in only a selected redo CABG population,<sup>3</sup> when the ITA is patent but stenotic in the perianastomotic area, when there is a stenosis in the coronary artery distal to the anastomosis, and when an interventional cardiologic approach is not feasible. Preoperative selective angiography of the used ITA is helpful to exclude proximal stenosis, to locate its relationship, and to provide anatomic details that may suggest this possible alternative approach during redo CABG surgery.

In conclusion, our limited experience confirmed that the recycling of ITA grafts in redo CABG can produce satisfactory outcomes in selected patients even at long-term follow-up.

## References

1. Burfeind WR Jr, Glower DD, Wechsler AS, Tuttle RH, Shaw LK, Harrel FE Jr, et al. Single versus multiple internal mammary artery grafting for coronary artery bypass: 15 year follow-up of a clinical practice trial. *Circulation*. 2004;110(Suppl):II27-35.
2. Cameron A, Davis KB, Green G, Schaff HV. Coronary bypass surgery with internal-thoracic artery grafts: effects on survival over a 15-year period. *N Engl J Med*. 1996;334:216-9.
3. Noyez L, Lacquet LK. Recycling of the internal mammary artery in coronary reoperation. *Ann Thorac Surg*. 1993;55:597-9.
4. Antona C, Parolari A, Zanobini M, Arena V, Biglioli P. Midterm angiographic study of five recycled mammary arteries during four coronary redos. *Ann Thorac Surg*. 1996;61:702-5.
5. Noirhomme PH, Underwood MJ, El Khoury GA, Glineur D, Elias B, d'Udekem Y, et al. Recycling of arterial grafts during reoperative coronary artery operations. *Ann Thorac Surg*. 1999;67:641-4.

## Complete vascular ring presenting in adulthood: An unusual management dilemma

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### Clinical Summary

**Patient 1.** An otherwise fit 47-year-old woman presented with progressive dyspnea and wheeze on minimal exertion over several years. After a negligible response to bronchodilators, bronchoscopy demonstrated extrinsic compression causing midtracheal collapse. A computed tomographic (CT) scan indicated a right-sided aortic arch with a Kommerell diverticulum and a retroesophageal left subclavian artery (Figure 1). She underwent a left posterior lateral thoracotomy through the fifth intercostal space. The ligamentum arteriosum (completing the type 3 ring) appeared to be the principal cause of tracheal compromise and was divided to achieve complete decompression. Recovery was uneventful, and she is symptom-free 12 months later.

**Patient 2.** A 37-year-old female nonsmoker described limited exercise tolerance and exertional wheeze since childhood. Medical attention was sought only after significant symptom exacerbation during pregnancy. Physical examination was unremarkable, but the flow-volume loop suggested large airway obstruction. Flexible bronchoscopy revealed erythema and extrinsic compression imme-

diately proximal to the carina in the anteroposterior plane. In addition, the origin of the right upper lobe bronchus arose directly from the carina. CT suggested these bronchoscopic findings to be attributable to a right aortic arch with an aberrant retroesophageal left subclavian artery arising from a Kommerell diverticulum. A decision was made to intervene surgically. At the fourth-space left thoracotomy, the complete vascular ring (type 3) was confirmed by the presence of the left ductal remnant, which was divided to allow distraction of the diverticulum away from the esophagus. Despite initial improvement, she relapsed 5 years later. A 3-dimensional CT reconstruction demonstrated the diverticulum compressing the trachea posteriorly. Right thoracotomy was performed to approach the aberrant left subclavian artery, the origin of which was divided and oversewn. The Kommerell diverticulum was then resected, and primary repair of the aorta was undertaken. Tracheal decompression was satisfactory, and the patient is symptom-free 12 months later.

### Discussion

The right aortic arch can form a complete vascular ring through the presence of a ligamentum arteriosum (or persistent duct). In these circumstances, tracheoesophageal compression might typically occur from the embarrassment of either the ligamentum or a Kommerell diverticulum, an aortic pouch from which the aberrant subclavian artery arises. The anomaly typically becomes evident in infancy and requires, at minimum, the surgical release of the ligamentum. Recurrence occurs in a small proportion of cases and has been attributed to aneurysmal dilatation of the Kommerell diverticula, which usually require subsequent resection.<sup>1</sup>

Primary presentations in adulthood are extremely unusual but might masquerade as chronic asthma<sup>2</sup> until identification, occasionally as late as the seventh decade.<sup>3</sup> This report highlights 2

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