Composite lengthened arterial conduits: Long-term angiographic results of an uncommon surgical strategy

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Background: We sought to evaluate the long-term patency rate of composite lengthened conduits.

Methods and Results: From December 1991 to April 2000, 43 patients had a composite lengthened arterial conduit. There was a mean of 2.83 ± 1.23 anastomoses per patient. No 30-day mortality occurred. Five patients died from 3 to 84 months after the operation (mean, 38.6 ± 34.6 months). After a mean follow-up of 57.0 ± 32.3 months (range, 3-99 months), all the survivors are asymptomatic. The only cardiac major events recorded were 2 (4.6%) late acute myocardial infarctions in the patients who died. Eight-year survival and event-free survival were both $80.4\% \pm 9.1\%$ (range, 3%-93%). In the early period (13.5 ± 4.8 days) in 26 patients, 26 arterial composite lengthened conduits and 37 distal anastomoses had postoperative angiographic control; all the anastomoses were rates as grade A, according to Fitzgibbon classification. In the late period (29 ± 30 months) in 23 patients, 23 arterial composite lengthened conduits and 34 distal anastomoses were checked; the patency rate was 22 (95.6%) of 23 for the composite lengthened conduits and 33 (97%) of 34 for the distal anastomoses.

Conclusions: In particular situations, when the length of an arterial conduit is not enough to allow a correct use of the graft, lengthening of an arterial conduit can be a safe and effective technique.

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Composite arterial grafting has been described by many authors¹⁻⁴ but mainly as a T or Y graft. The possibility of lengthening an arterial conduit (AC) with another AC (composite lengthened conduit [CLC]) has seldom been explored and only when related to the technical feasibility in the left anterior small thoracotomy procedure.⁵

We reviewed our long-term experience with this strategy, which, in selected cases, represents an effective solution to reach distant target anastomotic sites.

Patients and Methods

From December 1991 to April 2000, 43 patients (1.3% of the patients submitted to myocardial revascularization in the same period of time) underwent isolated myocardial revascularization through a median sternotomy by using a composite arterial lengthened conduit. Indications to this strategy were mainly the impossibility for an arterial graft (in situ or anastomosed to the proximal aorta) to reach the target coronary vessel because of reduced length or because of injury during harvesting that forced exclusion of part of the graft.

Figure 1. Actuarial survival and event-free survival.

Figure 2. Late follow-up angiogram (8 years and 9 months). Arrow shows end-to-end anastomosis between right ITA (*RIMA*) and inferior epigastric artery (*IEA*) grafted to posterior descending artery (*PDA*).

Preoperative data are shown in Table 1.

In 41 (95.4%) patients the donor AC was an internal thoracic artery (ITA; pedicled in 22 and skeletonized in 19), and a radial artery was used in 2 (4.6%) patients. The second conduit was an ITA in 6 patients (pedicled in 2 and skeletonized in 4), a radial artery in 22 patients, and an inferior epigastric artery in 15 patients.

Surgical Technique

Harvesting of the ITA and of the radial and epigastric arteries was previously described.⁶ The lengthening conduit was connected to the donor conduit with an end-to-end anastomosis before starting the procedure. The surgical technique has been previously reported.^{5,7}

It is necessary to put the CLC over the heart to avoid any distortion of the graft. As a result of inner pressure, the graft will always be suitably oriented. If there is any doubt, methylene blue

TABLE 1. Preoperative data

Male/female	34/9
Age (y)	60.7 ± 8.2
Elective/urgent	28/15
LVEF (%)	60.5 ± 12.4
Two-vessel disease	7 (16.2%)
Three-vessel disease	36 (83.7%)
LM	0
Redo operation	5 (11.6%)

Results are expressed as means ± standard deviation unless otherwise indicated. LVEF, Left ventricular ejection fraction; LM, left main.

TABLE 2. Arterial CLCs

LITA + IEA	5
LITA + RITA	4
LITA + RA	6
RITA + IEA	9
RITA + LITA	1
RITA + RA	16
RA + IEA	1
RA + LITA	1

LITA, Left ITA; IEA, inferior epigastric artery; RITA, right ITA; RA, radial artery.

can be used to mark the right direction. As soon as the aorta was unclamped (or when the last anastomosis was accomplished without cardiopulmonary bypass [CPB]), a continuous infusion of diltiazem or nitroglycerin was begun and continued up to the first postoperative day, when oral diltiazem was started (60 mg 3 times a day for 4 weeks).

From the operating theater, the patients were transferred to the intensive care unit, where they generally remained up to the first postoperative day, after which they were moved to the general ward.

Follow-up

All the patients were followed up in our outpatients clinic at 3, 6, 12 months after the operation and every year thereafter. Clinical follow-up was 100% complete. Survival and survival free from cardiac events (ie, acute myocardial infarction or need to repeat interventional or surgical revascularization) were considered. In all but one of the patients, angiography was performed electively.

Statistical Analysis

Results are expressed as means ± standard deviation unless otherwise indicated. Survival and event-free survival curves were obtained with the Kaplan-Meier method (SPSS software; SPSS, Inc, Chicago, Ill).

Results

In 7 patients the myocardial revascularization was performed without CPB. In the remaining patients the CPB

TABLE 3. Distribution of the distal anastomoses performed with arterial CLCs

	LAD	Diagonal	Circumflex system	RCA	PDA	Total
LITA + IEA	—	2	4	—	—	6
LITA + RITA	2	—	1	—	—	3
LITA + RA	—	1	7	1	1	10
RITA + IEA	1	—	1	5	2	9
RITA + LITA	1	1	—	—	—	2
RITA + RA	3	1	14	1	6	25
RA + IEA	—	—	1	—	—	1
RA + LITA	1	—	—	—	—	1
Total	8	5	28	7	9	57

LAD, Left anterior descending artery; RCA, right coronary artery; PDA, posterior descending artery; LITA, left ITA; IEA, inferior epigastric artery; RITA, right ITA; RA, radial artery.

TABLE 4. Postoperative follow-up angiograms

	Early* (n = 26)	Late† (n = 23)
Arterial CLC		
Intermediate anastomosis	26/26 (100%)	22/23 (95.6%)
Distal anastomosis	37/37 (100%)	33/34 (97%)
LITA	15/15 (100%)	13/13 (100%)
RITA	5/5 (100%)	4/4 (100%)
RGEA	2/2 (100%)	2/2 (100%)
IEA	12/12 (100%)	11/11 (100%)
RA	4/4 (100%)	3/3 (100%)
SVG	8/8 (100%)	7/7 (100%)

LITA, Left ITA; RITA, right ITA; RGEA, right gastroepiploic artery; IEA, inferior epigastric artery; RA, radial artery; SVG, saphenous vein graft.

*Early = 13.5 ± 4.8 days (range, 5-28 days).

†Late = 29 ± 30 months (range, 6-93 months).

time was 64.0 ± 27.0 minutes, and the aortic crossclamp time was 45.5 ± 22.7 minutes. In 43 patients a mean of 2.8 ± 1.2 anastomoses were performed, and in 34 (65%) patients a total arterial myocardial revascularization was carried out.

Table 2 shows the arrangement of lengthened conduits. In 43 patients the CLC was used for 57 distal anastomoses (1.3 ± 0.6); a sequential graft was performed 12 times. The distribution of the distal anastomoses is shown in Table 3.

After a mean of 28.7 ± 16.5 hours in the intensive care unit, all the patients were transferred to the general ward. After 10.5 ± 10.9 days, they were discharged home.

No patient died within 30 days from the operation. Only one (2.3%) patient showed ventricular arrhythmias in the postoperative course, and these were treated with drug therapy. One patient had a wound-healing complication and required a surgical revision.

Follow-up

After a mean follow-up period of 57.0 ± 32.3 months (range, 3-99 months), 38 (88.4%) patients are alive and

asymptomatic without any major complications, such as acute myocardial infarction, redo operations, or interventional revascularization. Five late deaths were recorded, 2 as a result of cardiac causes (acute myocardial infarction 20 and 84 months after the operation, respectively) and 3 as a result of noncardiac causes (2 patients with gastric bleeding at 5 and 72 months after the operation, respectively, and the 1 patient with leukemia 56 months after the operation). The only major cardiac events recorded in the follow-up period were 2 (4.6%) late acute myocardial infarctions that occurred in the patients who died.

Eight-year survival and event-free survival were both 80.4% ± 9.1% (Figure 1).

Follow-up Angiograms

Twenty-six (60.5%) patients had an early angiogram, and 23 (60.5%) of the survivors had a late postoperative angiogram (Figure 2). In the early period (13.5 ± 4.8 days) 26 patients with arterial CLCs and 37 patients with distal anastomoses had a postoperative angiographic examinations; all the anastomoses were rated as grade A, according to the Fitzgibbon

classification.⁸ Of 23 (60.5%) patients who had late angiographic examinations (29 ± 30 months), only an ITA lengthened with a radial artery on the posterior descending artery was occluded because of progression of coronary disease. This patient had a postoperative angiogram after an abnormal myocardial scintiscan on the inferior wall. The patient at present is asymptomatic with medical treatment. Twenty-two (95.6%) of 23 intermediate and 33 (97.0%) of 34 distal anastomoses were rated as grade A, according to the Fitzgibbon classification. The angiographic results of arterial CLC and of the other grafts used are shown in Table 4. The patency rate of the arterial CLC distal anastomoses in the early (37/37 [100%]) and in the late (33/34 [95.6%]) period are comparable with the ITA's patency rate (early, 20/20; late, 17/17; $P =$ not significant).

Discussion

In selected patients the possibility of lengthening an AC with another AC can be a technical solution when the donor graft is too short to reach the target coronary vessel. In previous reports, good long-term patency of the Y or T grafts was demonstrated.^{1,3,9} To the best of our knowledge, the results of arterial CLC anastomoses have not been evaluated, at least in the long term.

We reported our experience with arterial CLCs in the left anterior small thoracotomy operation,⁵ in which the left ITA was lengthened with the inferior epigastric artery. These patients had follow-up angiograms 87.5 ± 23.3 days after the operation, with a satisfying patency rate of 21 (95.4%) of 22.

From this study, it was evident that the intermediate anastomosis between 2 ACs was not a weak point of the strategy of composite grafting and that its failure was rare.

Seldom is the surgeon forced to lengthen another AC because of the great availability of such conduits. However, when an AC is harvested, an injury can force the discarding of part of an in situ conduit, making its lengthening the only possible solution. Our study was able to demonstrate that, if necessary, lengthening of an AC can be a safe and effective technique.

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