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Limited Left Thoracotomy for Reoperative Coronary Artery Bypass Grafting without Cardiopulmonary Bypass for Circumflex Grafting in Patients with Patent Internal Thoracic Artery Graft

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ABSTRACT

Background: We describe our experience with the limited left thoracotomy strategy for reoperative coronary artery bypass graft (CABG) to the circumflex coronary artery system, emphasizing the indications, our particular operative technique, and early clinical follow-up.

Methods: From January 2001 to January 2002, 8 consecutive patients underwent redo revascularization via limited left thoracotomy and without cardiopulmonary bypass. This operation was indicated for patients with recurrent myocardial ischemia confined to the lateral wall of the left ventricle, especially if a patent left internal thoracic artery (LITA)-to–left anterior descending coronary artery (LAD) graft was present.

Results: All 8 patients underwent successful redo revascularization via limited left thoracotomy. Eight patients received 14 saphenous vein grafts (mean 1.7 grafts/patient). No instances of postoperative myocardial infarction or death occurred. During a follow-up period ranging from 1 to 12 months (mean, 5.2 months), all patients were asymptomatic and without evidence of ischemia or infarction.

Conclusions: For select patients who have patent LITA grafted into the LAD and who need redo CABG to the coronary artery circumflex system, the limited left thoracotomy approach without cardiopulmonary bypass is a safe operation and a less invasive alternative to repeat sternotomy and conventional CABG.

INTRODUCTION

Coronary artery bypass grafting (CABG) relieves symptoms and improves quality of life and survival in patients with coronary artery disease. However, atherosclerosis is a progressive disease that can develop in vein grafts and in ungrafted coronary arteries [Campeau 1983, Motwani 1998]. Vein graft atherosclerosis is the main reason for recurrence of cardiac events and often necessitates reoperation [Fitzgibbon 1996, Lytle 1987].

Reoperation carries a higher risk than the primary procedure, although this increased risk has been less apparent in more recent years [Lytle 1987, Akins 1994]. Conventional reoperation has been associated with increased morbidity and mortality as a result of repeated sternotomy, atheromatous emboli from old patent vein grafts, and incomplete myocardial protection [Keon 1982, Dobell 1984, Fitzgibbon 1996]. With the routine use of the left internal thoracic artery (LITA) for CABG, the number of patients with patent LITA grafts who need reoperation for vein graft disease has increased. The LITA grafted into the left anterior descending coronary artery (LAD) is particularly vulnerable in redo CABG, and injury to the patent LITA pedicle during sternal reentry may lead to a catastrophic situation with perioperative myocardial infarction and death [Akins 1994].

Despite the safety of modern equipment and techniques, such maneuvers as reopening the sternum, dissecting the adhesions necessary for exposure, and myocardial protection for coronary reoperations, situations that need grafts to the lateral wall of the left ventricle, with patent LITA-to-LAD grafts, may place the patient at great potential risk.

This article describes our experience with a limited left thoracotomy strategy for reoperative CABG to the circumflex coronary artery system without cardiopulmonary bypass and emphasizes the indications, our particular operative technique, and early clinical follow-up.

PATIENTS AND METHODS

Eight consecutive patients undergoing redo revascularization of the circumflex coronary artery system via limited left thoracotomy from January 2001 to January 2002 were studied. All patients in the study were operated on by the same surgical team, and all procedures were performed according to similar protocols at the Heart Institute (InCor) of the University of São Paulo Medical School.

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Table 1. Preoperative Clinical Data*

Patient No.	Age, y	Sex	No. of Previous CABG	Time since Previous Surgery, y	Indication for Redo CABG	Indication for Thoracotomy Approach
1	74	M	1	7	Progression of Cx CA disease	Patent LITA-LAD graft
2	67	F	1	9	Progression of Cx CA disease	Patent LITA-LAD graft
3	69	M	1	8	Progression of Cx CA disease	Patent LITA-LAD graft
4	84	M	1	5	Progression of Cx CA disease	Patent LITA-LAD graft
5	68	M	1	7	Progression of Cx CA disease	Patent LITA-LAD graft
6	70	M	2	14, 8	Progression of Cx CA disease	Patent LITA-LAD graft
7	68	M	1	8	Progression of Cx CA disease	Patent LITA-LAD graft
8	61	M	1	6	Progression of Cx CA disease	Patent LITA-LAD graft

*CABG indicates coronary artery bypass graft; Cx CA, circumflex coronary artery; LITA, left internal thoracic artery; LAD, left anterior descending coronary artery.

Seven patients were men and one was a woman. Their ages ranged from 61 to 84 years (mean, 70.1 years). The reoperative CABG was the second CABG in 7 patients and the third in 1 patient. Surgery was performed from 5 to 14 years (mean, 8 years) following the previous procedure.

Patient Selection

Patients selected for redo CABG through limited left thoracotomy had progressive angina despite medical treatment, significant myocardial ischemia confined to the lateral surface of the heart, and patent LITA grafting to the LAD close to or adherent to the sternum in the midline. Included in this group were patients who had disease progression in previously ungrafted circumflex coronary artery systems, development of atherosclerosis in circumflex vein grafts, or both, and who were not good candidates for percutaneous transluminal coronary angioplasty. All patients had surgery indications for redo CABG to the circumflex coronary artery system. No indication for right coronary artery (RCA) revascularization existed. All patients were in stable hemodynamic condition, and the procedures were elective (Table 1).

Surgical Technique

The patients were routinely prepared as for conventional cardiac surgery. External defibrillator patches were placed before anesthesia induction. A double-lumen endotracheal tube and single right lung ventilation were used to facilitate the dissection of pericardial adhesions and the coronary anastomosis.

The patients were placed in the right lateral decubitus position with partial rotation of the pelvis. With the patient properly positioned, adequate exposure of the right leg can be obtained for harvesting an appropriate length of the saphenous vein, enough for 1 or 2 grafts that are usually performed with this method. Also with this position, cannulation for cardiopulmonary bypass could be performed immediately through the left femoral vessels if conversion to cardiopulmonary bypass surgery was deemed necessary.

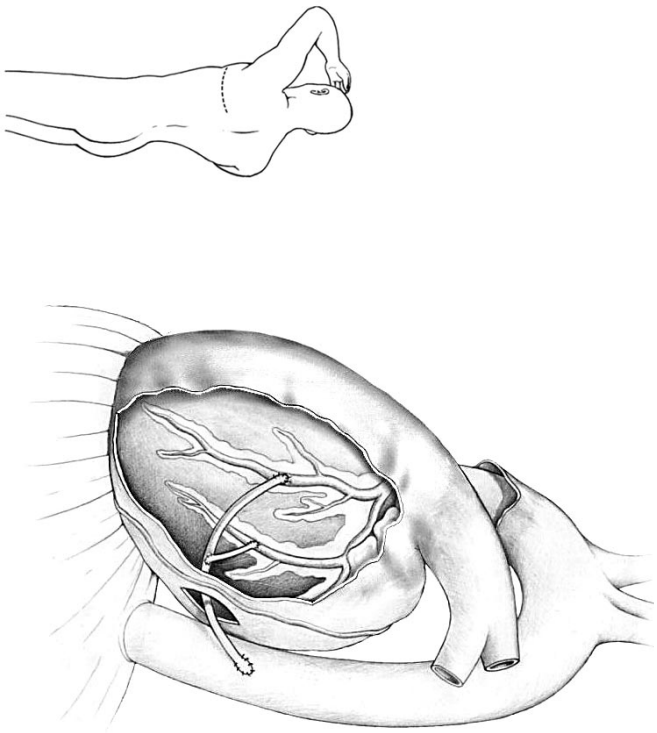
A limited posterolateral left thoracotomy through the fourth or fifth intercostal space was used in all patients. The retractor was positioned in the thoracotomy wound. The inferior pulmonary ligament was divided, and the lung was retracted posteriorly and superiorly. A pericardial incision was usually made posterior to and parallel to the phrenic nerve. To facilitate exposure, it was sometimes useful to mobilize the phrenic nerve from the pericardium. The dissection of pericardial adhesions was minimal, enough to expose the lateral wall of the left ventricle and avoid dissection over the anterior myocardial surface as well as to minimize the potential danger of injury to the patent LITA graft.

The systemic heparinization was done with a half dose (250 IU/kg) that is frequently used in conventional cardiac surgery, enough to keep clotting time activated at 2 or 3 times the baseline value. Traction sutures were placed laterally in the pericardium, allowing stability of the beating heart, thereby facilitating coronary artery anastomosis.

Local coronary artery occlusion was achieved with a 5-0 prolene (Ethicon, SJ Campos, SP, Brazil) suture or with a silastic retractor tape (Quest Medical, Dallas, TX, USA) placed proximally to the site of the coronary arteriotomy. The suture was snared with a thin silicone tube and silastic bolsters to avoid coronary artery injury. A distal suture was made only if necessary to obtain a bloodless field after the coronary arteriotomy; distal retrograde flow was frequently minimal. The coronary artery anastomoses were performed without cardiopulmonary bypass. A mechanical stabilizer (Octopus 3, Medtronic, Minneapolis, MN, USA) was used to provide local epicardial suction and immobilization of the coronary anastomosis area. The saphenous vein grafts were anastomosed at the coronary artery, in the majority of the cases, in the retrograde flow. The marginal and posterolateral branches were advantageously grafted with the same venous conduit in a sequential anastomosis, or with natural Y or constructed Y vein grafts. Alterations suggestive of myocardial ischemia were overcome by the use of an intracoronary shunt. Proximal anastomosis of the venous conduit was made to the descending thoracic aorta with a side-biting clamp. The vein grafts must take an arcuate rather than a straight course to the aorta to prevent lung interference and kinking (Figure).

Postoperative Course

The patients were admitted to the intensive care unit under mechanical ventilation and extubated after showing adequate respiratory effort, normal blood gases, and hemody-



Main figure: saphenous vein anastomosed in Y graft to the left marginal and posterolateral branches from the descending thoracic aorta. The pericardial incision was made posterior to and parallel to the phrenic nerve. The distal anastomoses were constructed in the retrograde flow and the vein grafts take an arcuate course to prevent lung interference and kinking. Inset: Patient position with a 60-degree rotation with partial rotation of the pelvis allows performance through the fourth or fifth intercostal space of limited posterolateral left thoracotomy.

namic stability. The last 2 patients were extubated in the operating room. Blood samples, electrocardiograms, and chest roentgenograms were obtained routinely. Perioperative myocardial infarction was defined by ST-segment change, a small R-wave progression, or the development of a significant new Q wave on postoperative electrocardiograms, associated with elevation of the creatine kinase muscle/brain fraction to greater than 2 times the upper limit of normal.

Follow-up

After discharge, all patients were followed in our outpatient clinic or by their respective cardiologists. All patients complied with the follow-up, which ranged from 1 to 12 months (mean, 5.2 months). During the follow-up period, a prospective evaluation was conducted of the occurrence of new cardiac events, such as refractory angina requiring redo CABG or angioplasty, acute myocardial infarction, or cardiac death.

RESULTS

All 8 patients underwent successful revascularization of the circumflex coronary artery system via limited left thoracotomy without cardiopulmonary bypass. No patients required conversion via median sternotomy and cardiopulmonary bypass because of inadequate exposure of the obtuse marginal or posterolateral branches, or hemodynamic instability.

A total of 14 saphenous vein grafts were performed in 8 patients (mean, 1.7 grafts/patient). The coronary arteries grafted were the obtuse marginal (3), the marginal branch (7), and the posterolateral branch (4). The distal anastomosis was constructed in a retrograde flow and the grafts followed an arcuate course to the aorta, below the hilum of the lung. Each patient received only 1 proximal anastomosis to the descending thoracic aorta. The other anastomoses were constructed in a sequential anastomosis (2), constructed Y vein graft (3), and natural Y vein graft (1).

Low amounts of postoperative bleeding occurred and ranged from 150 mL to 390 mL (mean, 300 mL) in the first 24 hours and from 160 mL to 850 mL (mean, 500 mL) in the first 48 hours. Only 2 patients needed a blood transfusion (1 needed 1 unit and the other needed 2 units of blood). No instances of postoperative myocardial infarction or low cardiac output occurred. Despite the fact that the descending thoracic aorta has more atherosclerotic disease and that the proximal anastomosis is performed with side clamping, neither renal nor vascular problems were encountered. No postoperative neurologic complications occurred either. Two patients had atrial fibrillation that reverted with amiodarone. One patient had a pulmonary infection controlled with antibiotics, and 1 patient had a lung hernia. No postoperative deaths occurred, and the patients were discharged from intensive care on the first postoperative day. The duration of the hospital stay ranged from 6 to 17 days (mean, 8 days) (Table 2).

During a follow-up period ranging from 1 to 12 months (mean, 5.2 months), all patients were asymptomatic and without evidence of ischemia or infarction. No other surgical or interventional procedures were performed during the postoperative follow-up period. Routine postoperative coronary angiography was not done.

DISCUSSION

Although reoperative CABG can be performed with low mortality and morbidity, it is fraught with certain hazards. The main features that affect surgical mortality and morbidity in redo CABG are reopening of the sternum and manipulation of the heart [Dobell 1984]. Injury to the heart, great vessels, or patent grafts can occur not only during repeat sternotomy but also during the insertion of the retractor and spreading of the wound. The manipulation of the heart and principally the manipulation of the old patent grafts may produce atheroembolization into the coronary artery, myocardial infarction, and death [Fitzgibbon 1996, Keon 1982].

The left thoracotomy approach for reoperative CABG has been performed as an alternative to repeat sternotomy by Grosner et al since 1971 [Grosner 1990], and its successful results have been reported sporadically by others authors [Cheung 1982, Faro 1982, Ungerleider 1985, Walker 1986, Burlingame 1988, Gandjbakhch 1989, Suma 1995]. In 1974, Faro et al [1982] performed reoperative CABG via a left thoracotomy without cardiopulmonary bypass, but the majority of these procedures were performed by others using

Table 2. Postoperative Clinical Data*

Patient No.	Thoracotomy Approach	CPB	Conversion to Sternotomy	Procedure	Postoperative Course	Follow-up (Mean, 5.2 mo)
1	Limited left thoracotomy	No	No	SVG to MB and PLB from DTA	Uneventful	Alive and asymptomatic
2	Limited left thoracotomy	No	No	SVG to MB from DTA	Uneventful	Alive and asymptomatic
3	Limited left thoracotomy	No	No	SVG to MB from DTA	Uneventful	Alive and asymptomatic
4	Limited left thoracotomy	No	No	SVG to MB and PLB from DTA	Uneventful	Alive and asymptomatic
5	Limited left thoracotomy	No	No	SVG to MB and PLB from DTA	Uneventful	Alive and asymptomatic
6	Limited left thoracotomy	No	No	SVG to OM and MB from DTA	Uneventful	Alive and asymptomatic
7	Limited left thoracotomy	No	No	SVG to OM, MB and PLB from DTA	Uneventful	Alive and asymptomatic
8	Limited left thoracotomy	No	No	SVG to OM from DTA	Uneventful	Alive and asymptomatic

*CPB indicates cardiopulmonary bypass; SVG, saphenous venous graft; MB, marginal branch; PLB, posterolateral branch; DTA, descending thoracic aorta; OM, obtuse marginal artery.

cardiopulmonary bypass with left atrial and left femoral vein to left femoral artery bypass [Cheung 1982, Burlingame 1988, Gandjbakhch 1989, Grosner 1990, Suma 1995]. Alternatively, venous drainage can be established from the pulmonary artery and arterial return to the descending thoracic aorta [Ungerleider 1985, Walker 1986, Gandjbakhch 1989].

The left thoracotomy approach provides some advantages: (1) reduced risk of hemorrhage, because resternotomy is avoided (2) decreased risk of atherosclerotic emboli from old diseased grafts, reducing heart manipulation, (3) diminished risk of injury to patent anterior grafts, (4) excellent exposure to the lateral wall of the left ventricle, (5) direct access to the circumflex coronary artery system, and (6) shorter operative time and minimal need for intrapericardial dissection.

In recent years, minimally invasive direct coronary artery bypass (MIDCAB) in primary procedures [Calafiore 1996, Subramanian 1997, Oliveira 2002] or redo CABG [Doty 1998, Miyaji 1999] has been performed via a small anterior thoracotomy without cardiopulmonary bypass, primarily to the LAD or diagonal branch revascularization with the LITA. With the rapid evolution of surgical devices designed for anterior MIDCAB, such as the mechanical stabilizers that provide stability for the beating heart and thus make coronary anastomosis easier and safer, the number of CABG off-pump procedures has been increasing.

With the anterior MIDCAB, the circumflex coronary artery system is not easily accessible. The limited lateral thoracotomy approach is adapted from previous experience with thoracotomy for reoperative CABG to the circumflex coronary system. However, these less invasive procedures have additional advantages that include the avoidance of cardiopulmonary bypass and reduction in the manipulation of great vessels. In our experience, all 8 patients underwent successful redo CABG via limited left thoracotomy without cardiopulmonary bypass. No patients had inadequate exposure or hemodynamic instability requiring conversion via median sternotomy and cardiopulmonary bypass. Neither hemorrhage nor neurologic complications occurred. These successful early results were also observed by others [Fonger 1997, Baumgartner 1999, Lajos 2000, Dewey 2001].

When isolated circumflex coronary artery grafting is needed, the limited left thoracotomy strategy minimizes concern and can be indicated in some conditions such as (1) patent nonatherosclerotic vein graft to the RCA or LAD that might be injured during resternotomy [Ungerleider 1985, Burlingame 1988]; (2) prior mitral valve replacement, so that lifting of the heart must be avoided [Faro 1982]; (3) prior mediastinitis or sternal wound complications [Suma 1995]; (4) a calcified ascending aorta necessitating the avoidance of cross-clamping [Faro 1982, Suma 1995]; (5) prior mediastinal irradiation [Ungerleider 1985, Gandjbakhch 1989]; and (6) planned concomitant left pulmonary procedure or descending thoracic aorta procedure [Faro 1982, Ungerleider 1985, Grosner 1990].

In our experience, the selection of patients for limited left thoracotomy approach was based on a combination of 2 factors: (1) isolated reoperative CABG to the circumflex coronary artery system and (2) patent LITA grafting to the LAD, close to or adherent to the sternum in the midline. Although the LITA grafted to the LAD is usually to the left of the midline, it may be exposed to injury if the intact pleura displaces the LITA graft to the midline. Since 1983, we have avoided this problem with the LITA pedicle when, in the first CABG, the left pleura is open and the LITA grafting to the LAD is mobilized through the left pleural space and passes through a wide pericardial incision close to the phrenic nerve. In a reoperative CABG, the LITA graft is protected by the pleural adipose tissue and by the left lung, and the repeat sternotomy can be performed safely. When RITA is used as a pedicle to diagonal branches or to the circumflex system, we pass it behind the aorta (through the transverse sinus) or it is free in composite Y grafts with LITA, so the RITA graft does not cross the anterior mediastinum close the sternum [Puig 1984].

Through miniaccess, the number of grafts that can be easily made is limited. We used the limited posterolateral thoracotomy for the isolated circumflex coronary artery system revascularization with a mean of 1.7 vein grafts/patient. With a full posterolateral thoracotomy, grafting can be performed to the LAD, diagonal, marginal, or posterolateral branches [Grosner 1990, Suma 1995]. Arterial grafts, as radial or gastroepiploic arteries, can be used also with this same technique [Suma 1995, Dewey 2001].

The proximal anastomosis can be applied to the descending thoracic aorta with a side-biting clamp, as we did, or

alternatively to the aortic isthmus or to the left subclavian artery in cases with severe atherosclerotic disease in the descending aorta [Faro 1982, Ungerleider 1985, Gandjbakhch 1989, Suma 1995].

The limited left thoracotomy approach has some disadvantages: (1) the left saphenous vein is inaccessible, unless it is harvested before final positioning of the patient, (2) no access is available to the right ventricle or right atrium, (3) the ascending aorta is relatively inaccessible, and (4) access to the LAD or RCA is poor. The main reasons for performing redo CABG through the reopen sternum in patients with patent LITA-to-LAD grafts is to allow for placement of multiple grafts to both sides of the heart.

In this study, neither intraoperative mortality nor postoperative myocardial infarction occurred. During a mean follow-up of 5.2 months, all 8 patients remained asymptomatic without evidence of new cardiac events. However, postoperative coronary angiography was not performed. Some surgeons using this technique [Faro 1982, Grosner 1990, Suma 1995] performed early postoperative angiography with excellent graft patency rates (>95%).

In conclusion, for select patients who have patent LITA grafted into the LAD and who need redo CABG to the circumflex coronary artery system, the limited left thoracotomy approach without cardiopulmonary bypass is a safe operation and a less invasive alternative to repeat sternotomy and conventional CABG. However, this procedure is not free of risk, and for routine reoperative CABG, the sternotomy approach may be preferable.

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