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Multivessal Minimally Invasive Coronary Surgery With Endoscopic Support

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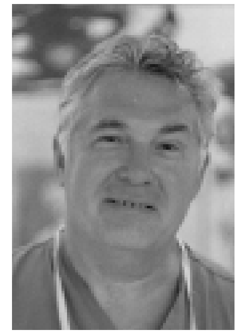

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ABSTRACT

Background: Interest in minimally invasive coronary artery bypass (MICAB) grafting and the MICAB experience have been increasing. The purpose of this study was to develop the multivessel minimally invasive coronary revascularization technique and to estimate the effectiveness of the endoscopic support in this operation.

Methods: From January 1998 through April 1999, 190 patients (ages 38 to 72 years) underwent coronary revascularization without cardiopulmonary bypass. Among them, 69 patients (55 males, 14 females) underwent minimally invasive coronary revascularization, from 1 to 3 vessels, through minithoracotomy and ministernotomy with endoscopically dissected internal mammary artery, gastroepiploic artery, and composite grafts. Preoperative risk factors included unstable angina (n = 15), reoperations (n = 8), low ejection fraction (n = 14), renal insufficiency (n = 4), chronic obstructive pulmonary disease (n = 6), cerebrovascular accident (n = 2), diffuse atherosclerosis (n = 4) and diabetes mellitus (n = 7).

Results: The operative mortality was 1.5% (1/69). Morbidity included wound infections (n = 1), reoperation for management of bleeding (n = 1), acute graft occlusion (n = 1), perioperative miocardial infarction (n = 1). The number of grafts placed in 69 patients was as follows: single, 54; double, 10; triple, 5. Postoperative angiography and Doppler flow assessment of the coronary anastomoses performed in 22 patients (30%) showed that 97% were patent.

Conclusions: The minimally invasive direct coronary artery bypass grafting operation is safe and effective. Endoscopic support makes the use of minimally invasive technology possible in patients with multivessel coronary disease and makes this operation less traumatic.

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INTRODUCTION

Minimally invasive coronary artery bypass grafting (MICABG) is now a widely accepted and effective procedure. The most commonly performed minimally invasive operation is bypass grafting of the left anterior descending (LAD) artery with the use of the left internal mammary artery (LIMA) through a limited thoracotomy. For the most part, the MIDCAB procedure is limited to single-vessel disease because of the lack of the arterial conduits available through a limited access. Application of the endoscopic support and the use of scomposite grafts may solve certain problems of multivessel MICABG.

The purpose of the study was to develop a multivessel minimally invasive coronary revascularization technique and to estimate the effectiveness of endoscopic support in this operation.

MATERIALS AND SURGICAL TECHNIQUES

From January 1998 through April 1999, in the Moscow Research Emergency Center 190 patients (ages 38 to 72 years) underwent coronary revascularization on the beating heart without cardiopulmonary bypass. Among them, 69 patients (55 males, 14 females) underwent minimally invasive revascularization, from 1 to 3 coronary vessels,

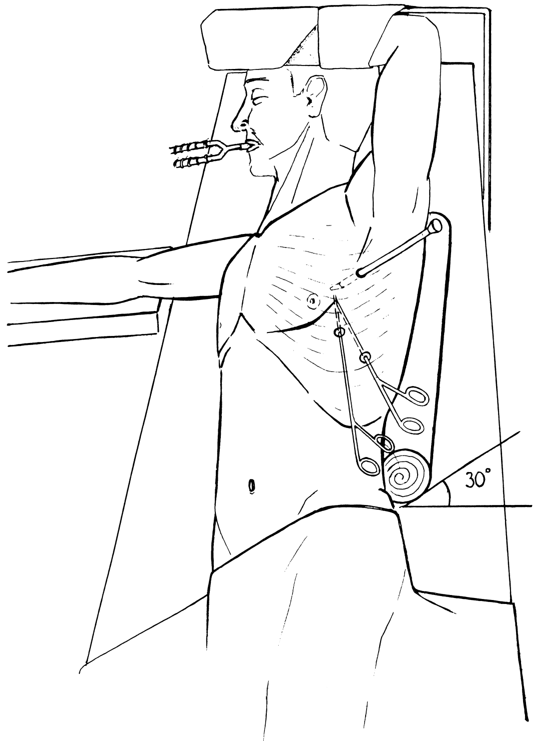

Figure 1. Patient and thoracoports position during LIMA endodissection.

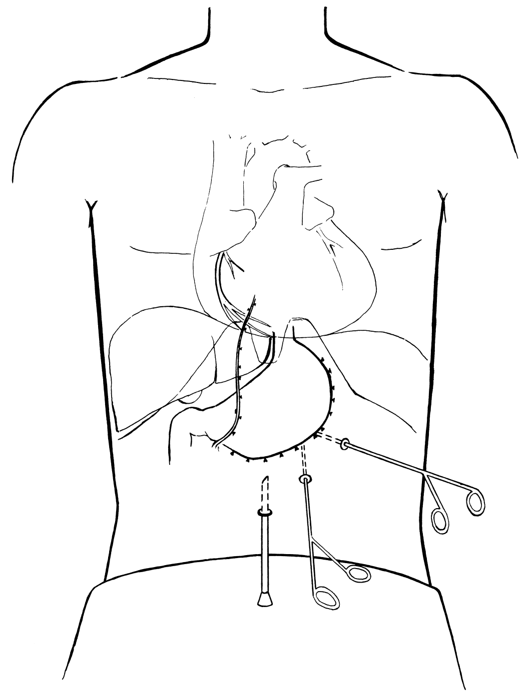

Figure 2. RGEA endodissection.

with endoscopic support. The number of grafts placed was as follows: single 54; double 10; triple 5.

Most of the patients (n = 54) suffered from stable angina, NHYA class 3-4, and had one or several myocardial infarctions. Fourteen patients had coronary restenosis after PTCA. Preoperative risk factors included unstable angina (n = 15), reoperations (n = 8), low ejection fraction (n = 14), renal insufficiency (n = 4), chronic obstructive pulmonary disease (n = 6), cerebrovascular accident (n = 2), diffuse atherosclerosis (n = 4) and diabetes mellitus (n = 7).

Candidates for MICAB grafting included patients who underwent prior CABG with failed saphenous vein grafts (LAD, right coronary artery (RCA), and obtuse marginal artery (OM)) or who had multiple-vessel disease in which cardiopulmonary bypass is associated with a presumed high morbidity: cancer, renal failure, diffuse cerebrovascular and peripheral vasculopathy, old age, and respiratory insufficiency. Other candidates suffered from restenosis after PTCA or had LADs and RCAs unsuitable for PTCA.

As arterial conduits for minimally invasive revascularization, we used endoscopically dissected LIMA and RIMA, right gastroepiploic artery (RGEA), and artery radialis (a. radialis) as a free graft.

LIMA Endodissection.

In all cases (n = 69), single-lung ventilation with a double-lumen endotracheal tube was used to permit collapse of the left lung in order to fully mobilize the LIMA. The patient was placed in a semioblique position with the left arm placed above the head, leaving access for a sternotomy if necessary ("decubitus" position; see Figure 1). Three 10-mm thoracoports were positioned in the left pleural cavity at the level of the third and the seventh intercostal space on the anterior axillary line and at the level of the fifth intercostal spaces along the midaxillary line. A ten millimeter 30 degree rigid thoracoscope, endoscissors, and endoforceps were used to dissect the whole length of the skeletonized LIMA from its origin at the subclavian artery to the bifurcation. The collaterals were clipped or coagulated as required (artery pericardiophrenica and first intercostal artery were clipped in all cases).

Twice (n = 2) the RIMA endodissection was carried out through the same left-sided thoracoports for further applying as a free graft, anastomosed "end-to-side" with the LIMA.

RGEA Endodissection

RGEA endodissection (n = 3) and the LIMA—LAD anastomosis performed simultaneously by two surgical teams.
Air insufflation into the abdominal cavity was performed through the "Veress" needle and then three 10-mm ports were inserted—for thoracoscope, always via the annulus umbilicalis (see Figure 2). We studied several ports' positions for the instruments and concluded that their location to the left of the thoracoscope (in the left mesogastrium) was the best position. Dissection was begun in the middle portion of the RGEA towards its proximal and distal ends with endoscopic scissors and forceps. Surgical clips and electrocautery were applied to secure the side branches of the RGEA. In one case we used an additional port with

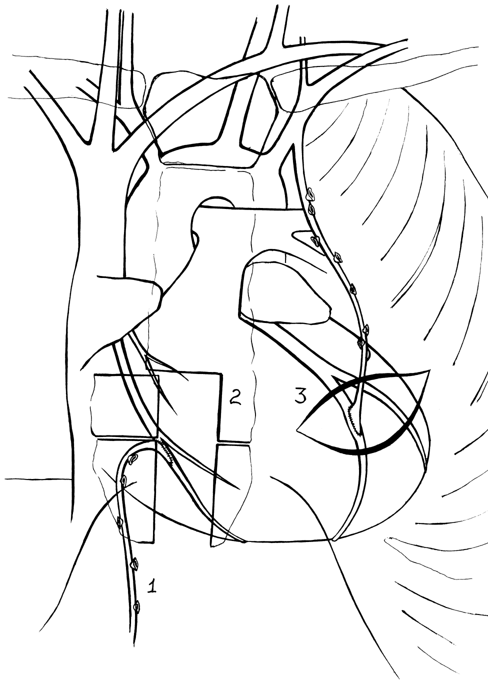

Figure 3. Ministernotomy and minithoracotomy for LAD and RCA revascularization. 1) RGEA, 2) lower ministernotomy, 3) left anterior minithoracotomy.

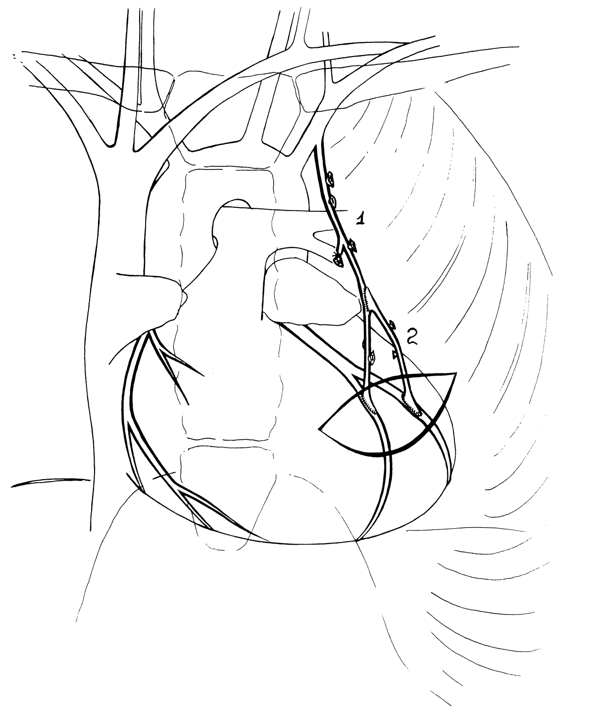

Figure 4. Composite "U" grafts. 1) LIMA, 2) free a. radialis.

"Babcock" forceps to retract the stomach. After complete dissection, the artery was cut off distally and positioned into the pericardium via the endoscopically-made hole in the diaphragm, with care taken to avoid twisting.

In all patients, left anterior minithoracotomy (4–5 cm in the fourth or fifth intercostal space) was performed to expose both LAD and the diagonal branch (DB). The pericardium was incised parallel to the midline and suspended by traction sutures. Little pericardial dissection was carried out in patients undergoing redo operations.

Local coronary occlusion was carried out by placing double-looped 4-0 Prolene sutures proximal and distal to the site of the anastomosis. Routine ischemic preconditioning was performed with 5 minutes of occlusion followed by 5 minutes of reperfusion and then the coronary anastomosis LIMA—LAD was performed with single, continuous 7-0 Prolene sutures.

In cases of multivessel atherosclerosis (n = 15) we used several variants of MICABG technology:

Ministernotomy and Minithoracotomy for LAD and RCA Revascularization

To expose RCA we used an additional 4 cm ministernotomy (see Figure 3 ◎). In three patients RGEA to RCA anastomoses were performed and in one patient RIMA was anastomosed "end-to-side" to the LIMA and then to the RCA.

In two patients we made one incision, 5-cm—"L" ministernotomy to expose LAD and RCA. In patients with vertical heart position (n = 2), it was possible to retract the heart to the right to expose the LAD and then to the left to expose the RCA to facilitate a successfull coronary anastomosis.

Composite "U" Grafts

The diagonal branch was exposed through the same incision as for LAD. In two patients we used a free graft of the radial artery anastomosed proximal "end-to-side" to LIMA and distal to DB; two patients received sequential LIMA grafts.

In patients with atherosclerosis of the LAD and OM (n = 2), we made 6-cm long left thoracotomy in the sixth intercostal space lateral to the nipple. This approach allowed good exposure of both arteries for performing composite "U" graft LIMA to LAD with radial artery extension to the OM (see Figure 4 ◎).

Triple-Vessel MICABG

Five patients with triple-vessel disease (LAD, DB, RCA) underwent MICABG (see Figure 5 ◎) through the left minithoracotomy and ministernotomy described above. Three patients from this group received RGEA to RCA anastomoses and a LIMA-radial composite graft for LAD and DB. Two patients had RCA occlusion. Both of them received a LIMA-radial composite graft anastomosed to the LAD and diagonal. We elongated the distal part of the LIMA with the free radial artery segment and then let retrograde LIMA bloodflow into the distal RCA as shown in Figure 6 (◎).

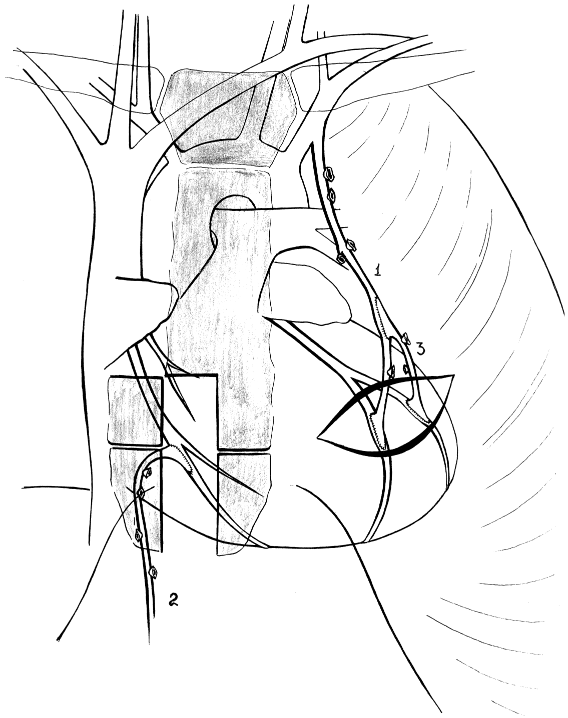

Figure 5. Triple-vessel MICABG. 1) LIMA, 2) RGEA, 3) free a. radialis.

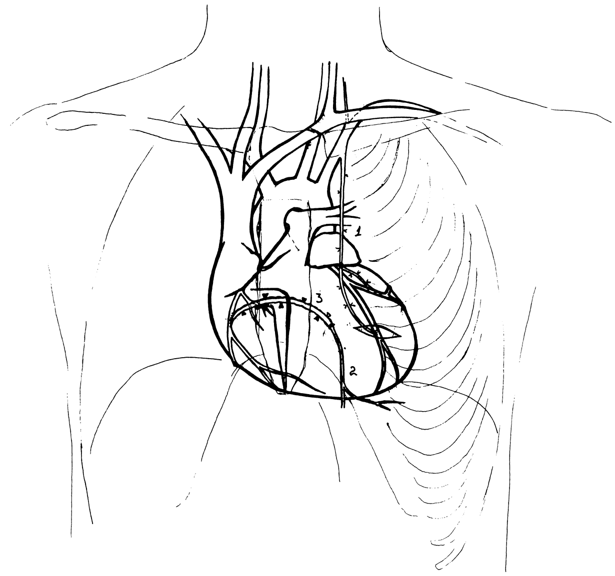

Figure 6. Retrograde LIMA MICABG. 1) LIMA, 2) distal part of LIMA, 3) free a. radialis.

Minimally Invasive Autovenous Coronary Artery Bypass Grafting

Moreover, we had a group of patients (n = 10) receiving MICABG that was not included in the group (n = 69) operated on with endoscopic support. All of them had diffuse vasculopathy, subclavian atherosclerosis, and other preoperative risk factors which precluded the use of conduits. Instead, we used a method of minimally invasive autovenous coronary artery bypass grafting as shown in Figure 7 (see Figure 7 ◎). Upper "L" 4–5-cm ministernotomy was performed to expose the ascending aorta and to carry out 2 to 3 proximal anastomoses with autologous veins. Then in patients with LAD and RCA atherosclerosis (n = 4), a lower 5-cm ministernotomy was applied to accomplish the distal anastomoses. In six patients with LAD, DB, and RCA lesions we had to apply two incisions: low 5-cm ministernotomy for RCA and left 5-cm minithoracotomy for LAD plus diagonal.

RESULTS

The operative mortality rate was 1.5% (1/69). This death was due to non-cardiac cause and occured in a 64-year-old man with diffuse vasculopathy and chronic obstructive pulmonary disease on the 21st postoperative day.

No conversion to a standard sternotomy occurred. Most of the patients (64/69; 92.7%) were extubated in the operating room or within the first three hours and transferred from an intensive care unit within 16 hours postoperatively.

The mean time of the LIMA endodissection was 30 min (range: 20 min to 60 min); the mean time of RGEA endodissection was 50 min (range: 40 min to 80 min). Neither conduit damage nor adjacent anatomical structure damage occurred. In all patients the length of the conduit "in situ" was enough to carry out the anastomosis without any tension.

Postoperative complications occurred in 4 of the 69 patients (5.8%).

A perioperative myocardial infarction patient involving the anterior wall occurred in one patient (patient with LIMA—LAD graft). One patient had postoperative bleeding and thoracoscopic revision was performed. Bleeding originated from the intercostal branch, which was successfully clipped with endoscopic instruments. One patient with chronic obstructive pulmonary disease and pulmonary insufficiency had 72 hours successful postoperative ventilation. One obese woman had a superficial wound infection in the submammary incision.

Postoperative angiography and Doppler flow assessment of the coronary artery anastomoses performed in 22 patients (32%) showed that 97% were patent, with total occlusion in 1 patient and another patient with 30% stenosis at the anastomotic site.

CONCLUSION

Application of the endosurgical support in MICABG technology is effective and solves some problems of multivessel MICAB grafting, including lack of the number and length of arterial conduits. The heart is a relatively retractable organ so we could operate on 2 coronary arteries through the 1 mini-incision only because of endoscopic mobilization of the arterial conduits. There was no need to make an incision of more than 4 to 6 cm for revascular-

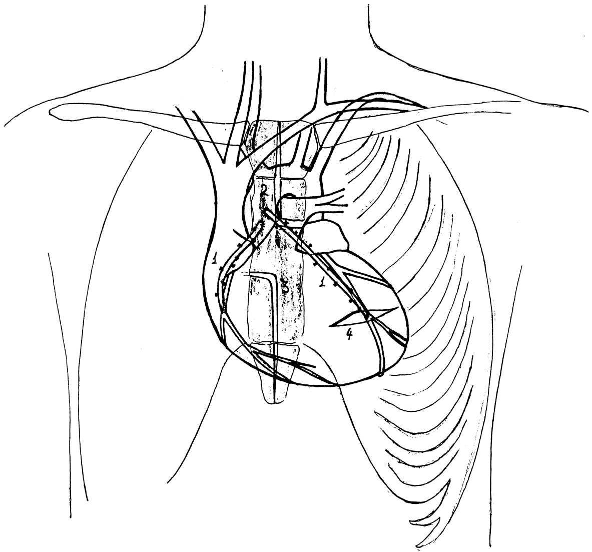

Figure 7. Minimally Invasive Autovenous Coronary Artery Bypass Grafting. 1) autovein, 2) aorta, 3) lower ministernotomy, 4) left anterior minithoracotomy.

ization of 1 to 2 coronary arteries and patients with the triple-vessel disease received only two operative accesses. Thus the MICABG technology may be successfully applied in patients with triple-vessel disease including patients with OM lesions. However, the long-term patency rate should continue to be evaluated.

The endoscopic technique of LIMA, RIMA and RGEA harvesting has obvious advantages such as reduced less trauma, elimination of any concern regarding "steal" syndrome and kinking, easy control of feasible intraoperative and postoperative bleeding, prevention of hernias and the adhesion process.

The endoscopic technique of RGEA harvesting allows the dissection of the whole length from pylorus to the short splenic arteries. The average length of RGEA conduit was 27±2.5 cm. The length of the artery in the pericardium (8 to 14 cm) was enough to perform anastomosis with the RCA in retrograde or anterograde directions and to any other coronary artery.

The alternative approach of autovenous MICABG (see Figure 7 ◎) is a safe and effective procedure that is associated with good early clinical results. It may assume a place among the myocardial revascularizaton techniques in patients with diffuse atherosclerosis.

One third of operations on the beating heart in our center have been performed with the use of MICABG technology using endoscopic support due to the success of the multi-vessel MICABG application.

The multivessel MICABG with endoscopic technique further enlarges the field of minimally invasive coronary surgery. Our current research efforts are devoted to expanding MIDCAB surgery and making it even less invasive.

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