Integrated Minimally Invasive Direct Coronary Artery Bypass (MIDCAB) Grafting and Angioplasty for Coronary Artery Revascularization

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ABSTRACT

Introduction: Minimally invasive direct coronary artery bypass through an anterolateral minithoracotomy has become a promising therapeutic option in patients (pts) with single vessel disease (especially in elderly and reoperative pts with type C or B lesions). To expand the benefits of MIDCAB concept to patients with multivessel disease, a hybrid procedure combining surgical revascularization of the left anterior descending (LAD) artery with interventional procedures for additional coronary lesions has recently been introduced.

Materials and Methods: Between April 1998 and December 2000, 35 pts (26 male, 9 female, mean age 54.8 ± 20.1 years) underwent a “hybrid” revascularization. MIDCAB procedure with endoscopic left internal mammary artery (LIMA) harvesting followed by staged angioplasty and stenting of additional coronary lesions. Follow-up period was up to 28 months. Control coronary angiography was performed in all the patients.

Results: Angiographic studies showed patent LIMA-LAD graft in 35 pts (100%). We showed good quality of anastomosis in 34 pts (97.2%). There was significant stenosis of the LIMA-LAD anastomosis in one patient (2.8%) and the PTCA of the anastomosis with good result was performed. Five pts (14.3%) developed restenosis after PTCA – re-do PTCA was performed successfully. The early and mid-term results were excellent in terms of all endpoints of this study.

Conclusion: The hybrid procedures are safe and effective method for complete revascularization in selected pts with multivessel coronary artery disease (pts with type C lesion in the proximal LAD). This method allows performing complete revascularization with minimization of surgical trauma.

INTRODUCTION

Revascularization for multivessel coronary artery disease with left internal thoracic artery (LITA) and additional vein grafts using cardiopulmonary bypass and cardioplegic arrest currently represents the standard technique in coronary surgery. Minimally invasive direct coronary artery bypass (MIDCAB) surgery is becoming widely accepted as an alternative method for revascularization in single vessel coronary artery disease.

It is possible to perform surgical myocardial revascularization through a left anterior small thoracotomy (LAST) access in the selective group of patients. However this technique can be used only in patients with single vessel disease of the left anterior descending artery (LAD) or diagonal branch [Nataf 1996, Nataf 1997].

To extend the benefits of MIDCAB to patients with multivessel disease, a "hybrid" procedure combining surgical revascularization of the LAD with interventional procedures (PTCA) for additionally coronary lesions is considered to be an attractive treatment option for some coronary patients.

The fusion of these two methods enables for abandon of typical cardiac operation using ECC, and to avoid of ECC related trauma and for improvement of treatment and rehabilitation level. It seems to be possible to isolate selective group of patients, who have been referred to CABG so far and to offer them the double-step less invasive "hybrid" procedure [Cisowski 1999, Diegeler 2000, Lloyd 1999, Wittwer 2000]. We present the preliminary results of our initial series.

MATERIALS AND METHODS

In the Department of Cardiac Surgery and Department of Cardiology, Silesian School of Medicine in Katowice, between January 1998 and December 2000, 35 patients (24 male/11 female, mean age 58.9 ± 7.5 years) underwent MIDCAB and angioplasty for multi- vessel disease.

Patients selection

Patients were qualified for double-stage treatment by consulting cardiologist and cardiac surgeon. I stage: less invasive operating – Video-assisted MIDCAB to

revascularize the LAD and II stage: percutaneous angioplasty (PTCA) using/or not stent. The inclusion and exclusion criteria are summarized in Table 1.

Surgical technique

Harvesting of the LITA is performed by a thoracoscopy and the LITA-LAD anastomosis is performed on the beating heart through a LAST. The technique of thoracoscopic LITA harvesting and MIDCAB have been described elsewhere [Benetti 1995, Benetti 1996, Cisowski 1999, Nataf 1996, Nataf 1997], but a few things have been changed and modified. The LITA is harvested from its bed from the superior border of the first rib to the fifth or sixth rib with low-flow carbon dioxide insuflation and the Harmonic Scalpel (Ethicon Endo-Surgery, Cincinnati, OH) and with robotic arm AESOP® assistance (Computer Motion, Inc, Goleta, CA) - Figure 1. All side branches of the LITA are occluded and divided with the Harmonic Scalpel.

A LAST (5-6cm) incision is made through the fourth or fifth intercostal space. We do not advocate the routine excision of costal cartilage, because adequate exposure can be gained with retraction of the ribs alone. The LAD is incised and the anastomosis is performed with a single 7-0 polypropylene running suture under mechanical stabilization (CTS, Cuperino, CA, and recently Computer Motion, Inc, Goleta, CA)(Figures 2 - 3). In all the patients, release of creatine kinase and its myocardial isoform (CK and CK-MB, 3 samples within 24 hours) and Troponin T (pre-ischemic, 8 and 14 hours) was investigated to evaluate the generation of intraoperative ischemia associated with the temporary occlusion of the LAD.

Angioplasty technique

Standard access for PTCA is achieved via cannulation the femoral artery with the use of a 6 or 8 French guiding catheter. An initial diagnostic angiography is performed to assess the quality of the LITA-LAD anastomosis and confirming the anatomy of the lesions for angioplasty. The lesions are cannulated with a 0.014-in steerable guide wire, followed by balloon dilatation with or without additional stenting. Heparinization is used throughout the procedure. Once it is completed, the patient is started on antiplatelet therapy – aspirin when angioplasty alone is performed and aspirin in conjunction with ticlopidine when stents have been deployed. All the patients had a delay of the PTCA after minimum of 24 hours recovery following the MIDCAB procedure.

RESULTS

In total we have operated on 35 patients, with complete revascularization in all of them. The preoperative demographic data are summarized in Table 2. All the patients

had two-vessel disease at initial angiography – Table 3. There were no early and late deaths. Baseline CCS class was 1.77 ± 0.7, versus 1.12 ± 0.3 after 24 month (p<0,001). Following initial surgical revascularization all the patients had an uneventful postoperative course without myocardial infarction (MI), and major cardiac events (MACE) requiring reintervention, stroke or wound healing complication - Table 4. One patient (2.8%) was returned to the operating room following bleeding requiring reintervention. After liberal heparin regimen the average postoperative bleeding amounted 426.5 ± 312.6 ml per 24 hours. The blood transfusion was necessary in only 5.6%. Pleural effusion we observed in one patient (2.6%) and was secondary drained. In all the patients analyzed for intraoperative ischemia Troponin T levels ranged below a critical value of 0.1 ng/mL. Thus, the temporary LAD occlusion appeared not to be associated with a significant myocardial damage. Average primary postoperative hospital stay was 4.4 ± 1.7 days (range 3-8 days) (Table 4).

The follow-up period was 3 to 24 months. The late results are shown in table 5. The average CCS class was significantly lower after MIDCAB (2.4±0.3 vs. 1.3±0.7, p<0.001). There were no early and late deaths.

Six patients (17.1%) developed new onset angina requiring repeated revascularization – table 5. There was significant stenosis of the LIMA-LAD anastomosis in one patient (2.8%) and the PTCA of the anastomosis with good result was performed. Five pts (14.3%) developed restenosis after PTCA or stent – table 5. In all the pts successful PTCA was performed.

Coronary control angiography was performed in all the patients. All the LITA-LAD anastomoses were patent. There was very good patency of anastomosis in 34 (97.2%) of pts (no kinking, conduit stenoses and open side branches). Control coronary angiograms showed moderate graft stenosis (grade A) in 1 patient (2.8%). We use Fitzgibbon's score [FitzGibbon 1996, Mack 1999] which is based on over 5000 control coronary angiograms in order to standardize the interpretation of the results – table 6.

DISSCUSION

Application of less-invasive methods in cardiac surgery is still considered as a completely new procedure, which is taken under thorough investigation and often critical assessment. In general, under this is hidden a great desire to limit surgical access and this way to minimize operation-related trauma.

In cardiac surgery one can understand the meaning of "less invasive" and the possibility of performing the operation without using extracorporeal circulation. Extracorporeal circulation has it's own advantages (e.g. operating on 'arrested' or open

heart), as well as drawbacks like risk of serious complications (about 70% in CABG) which are due to use of ECC appliances. The limited operating access has inferior meaning however you can not neglect aspects, like cosmetic effect, less pain as well as better rehabilitation and quicker come back to normal life [Benetti 1996, Loop 1998, Nataf 1996, Westaby 1996].

Cardiologists performing percutaneous procedures (PTCA and/or stenting) offer less invasive and painless methods of myocardial revascularization. Another advantage is lower cost of treatment [Loop 1998]. Cardiologists and cardiac surgeons dissatisfied with long-term results of coronaroplasty, began to figure which method of treatment would be the best option for myocardial revascularization. It is believed that the 1-year restenosis rate after angioplasty is valued at 40% and at 15-20% in case of stent implantation [Loop 1998, Mariani 1997, Park 2000, Serruys 2000]. In contrast, it is known that implantation of mammary artery gives 95% patency after 10 years after operation [Cameron 1996, Loop 1996, Loop 1986Tonz 1993]. There are multiple randomized comparable trials, which are conducted to evaluate the efficiency of both methods.

These two methods undoubtedly bring some limitations. In case of angioplasty, it is very risky or even impossible to be carried out in patient with multiple stenosis or with total stenosis of LAD [Loop 1998, Mariani 1997, Park 2000, Serruys 2000]. The main limitation of less-invasive procedures using “mini-access” is the feasibility of revascularization virtually only one artery [Nataf 1996, Nataf 1997, Westaby 1996].

The purpose of implementing “hybrid procedure” into clinical practice was to expand the indications and to enlarge the group of patients who can avoid conventional CABG operations with use of ECC. Moreover, it seems that both techniques supplement each other and it allows performing complex treatment of group of patients with multivessel coronary disease where the application of each of methods separately could not be possible.

Our preliminary report is the best example of new challenges. It concerns the group of pts who should be referred to routine cardiac operation, according to classical indications. Less-invasive cardiac operation lets to perform safe and precise grafting using mammary artery. Employment of video harvesting of LIMA and stabilizer for better immobilization of operating field surged the safety standards and precision of cardiac surgery [Benetti 1995, benetti 1996, Calafiore 1996, Nataf 1997, Subramanian 1996].

It seems that we are facing some overvalues and making new conceptions concerning the choice of coronary disease treatment.

Approaching of new surgical, less-invasive methods of treatment gives the opportunity to looking for some solutions in that matter. One can expect, that criteria for such procedures will become less strict. We know, that so called “off-pump operations” are desirable in patients with severely impaired left ventricle, older people with disseminated atherosclerosis of the aorta and other arteries and patients with severe dysfunction of internal organs.

The steady advance in invasive cardiology (e.g. new technology of stent production) aiming improvement of long-term results of coronaroplasty and stenting, comes to one conclusion: cardiologists as well as cardiac surgeons should combine their desires to improve safety and comfort standards of their patients.

CONCLUSION

The hybrid procedures are safe and effective method for complete revascularization in selected pts with multivessel coronary artery disease (pts with type C lesion in the proximal LAD). This method allows performing complete revascularization with minimization of surgical trauma.

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Table 1. Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
The LAD lesion with high risk of restenosis after PTCA (type C lesion, 6th and, 7th segment lesion)	Buried coronary artery
Restenosis after PTCA or in-stent restenosis	Unstable angina
Diabetic patients	Acute MI
Young individuals with very progressive atherosclerosis	Decompensated heart failure
Patients with comorbidities subject to develop complications after cardiopulmonary bypass	Significant arrhytmia
Redo operations	Obesity
Patient's preference (Jehowa Witness)	

Table 2. Patients demographics (n=35)

Variable	
Age mean (years) ± SD	58.9 ± 7.5
Sex, male/female	24/11
Risk factors	
Hypertension	30 (86%)
Diabetes mellitus	12 (34%)
Hypercholesterolemia	22 (62%)
Previous MI in LAD region	18 (51%)
Previous MI in other regions	8 (23%)
Mean LVEF (%) mean ± SD	52.6 ±
Good (> 50%)	11.9
Moderate (35 – 50%)	30 (62%)
Poor (< 35%)	11 (32%)
	2 (6%)

Table 3. Angiographic characteristics of 35 patients

Target vessels	N° of patients
LAD (type C*), RCA (type A*)	20 (57, 2%)
LAD (type B*), RCA (type A*)	8 (22, 8%)
LAD (type C*), OM1 (type A*)	7 (20,0%)

Table 4. Operative and postoperative data, n =35 pts, follow-up period - 30 days

Variable	results
Endoscopic LITA harvest time (min)	32.4 ± 10.6
Lenght of incision (cm)	5.7 ± 2.3
Anastomosis completion time (min)	15.3 ± 4.5
Postoperative bleeding /24hours (ml)	426.5 ± 312.6
Conversion	0
Morbidity	2 (5.6%)
Reexploration for bleeding	1 (2.8%)
Pneumothorax	1 (2.8%)
N° patients transfused	2 (5.6%)
Mortality	0
Perioperative MI	0
MACE reqiring reintervention	0
Hospital stay mean ± SD(days)	4.4 ± 1.7

Table 5. Long-term results, n=35 pts, follow-up period - 24 months

Variable	Results		
Mortality	0		
MI	0		
Stroke	0		
Average CCS score	before operation		after operation
	2.4 ± 0.3	p<0.001	1.3 ± 0.7
MACE	3 (8.6%)		
Reintervention (re-CABG)	0		
Reintervention	**6 (17.1%)**		
After angioplasty	5 (14.3%)		
- restenosis after PTCA	3 (8.6%)		
- in-stent restenosis	2 (5.6%)		
After surgery - stenosis at the anastomotic site	1 (2.8%)		

Table 6. Angiografic control of anastomosis, 35 hybrid procedure, follow-up period from 3 to 24 months

Overall patency rate	35 (100%)
Grade A	34 (97,2%)
Grade B	1 (2,8%)
Grade 0	0

Grade A - excellent graft, Grade B – stenosis reducing proximal, distal anastomosis or trunk up to 50% of grafted coronary artery, Grade 0 – occlusion

Figure 1. Thoracoscopic LITA harvesting with AESOP® assistance

Figure 2. Higer retractor and stabilizer to the MIDCAB procedure (CTS, Cuperino, CA) below retractor and LITA occluder to the EACAB – Endoscopic Atraumatic Coronary Artery Bypass procedure (Computer Motion, Inc, Goleta, CA)

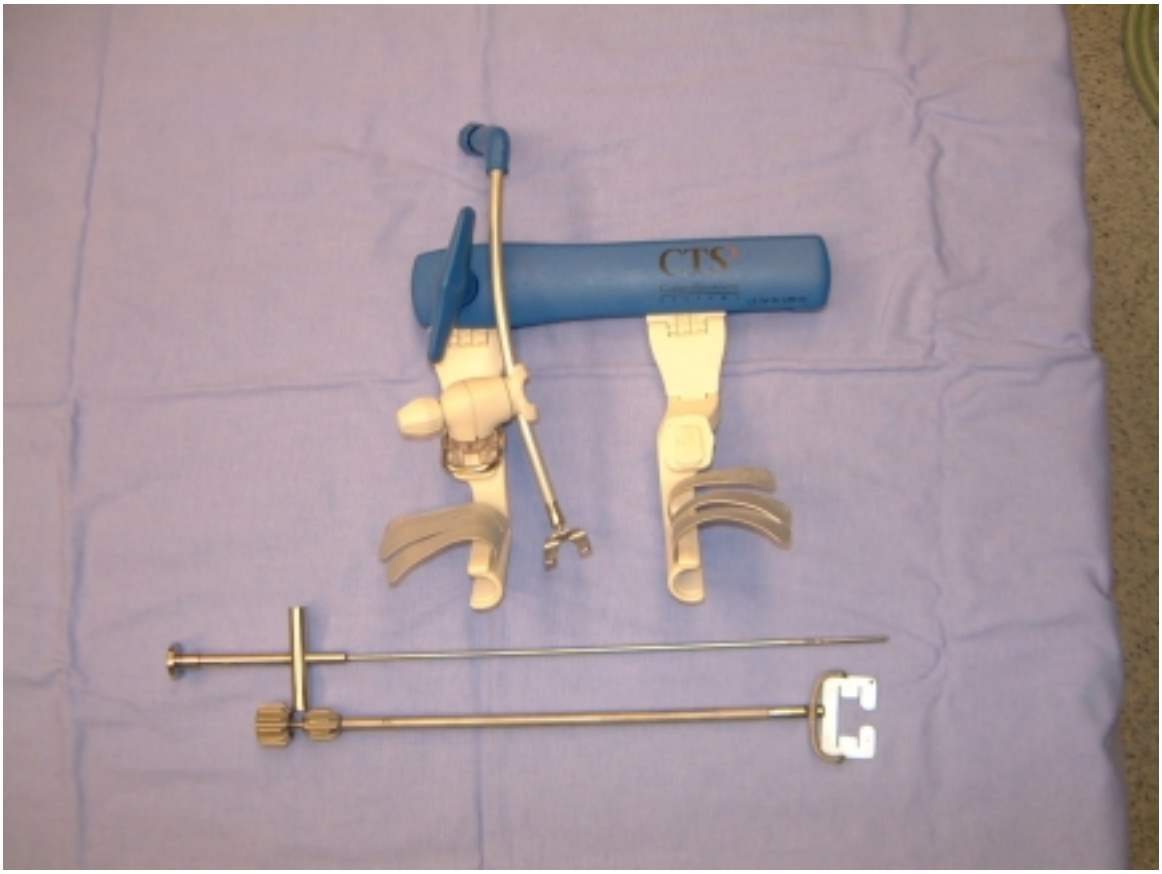

Figure 3. AECAB procedure