Video-Assisted Minimally Invasive Coronary Artery Bypass Grafting – The Early and Late Results

(#2001-6887 … June 27, 2001)

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Presented at the Fourth Annual Scientific Meeting of the International Society for Minimally Invasive Cardiac Surgery, June 27-30, 2001, Munich, Germany.

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ABSTRACT

Introduction: Minimally invasive direct coronary artery bypass (MIDCAB) is the method of surgical treatment in patients (pts) with left anterior descending artery (LAD) lesion. Left internal thoracic artery (LITA) is the graft of choice for LAD grafting due to excellent long-term patency. The implementation of the video-assisted LITA harvesting allows harvesting it completely and atraumatically and lessens chest wall trauma and reduces length of minithoracotomy.

Materials and Methods: Between June 1998 and December 2000, we performed 147 MIDCABs (108 male, 39 female, mean age 57.5 ± 18.1 years). In all the cases the video-assisted LITA harvest was employed. The LITA-LAD anastomosis was performed through left minithoracotomy without use of the cardiopulmonary bypass. The criteria of eligibility to MIDCAB were: type B or C lesion in 6^{th} or 7^{th} segment, restenosis after PTCA and/or stenting.

Results: There were no early and late deaths. Baseline CCS class was 1.8 ± 0.7 versus 1.1 ± 0.3 after 6 month ($p<0,001$). Follow-up period was 3 to 32 months. Coronary control angiography was performed in 95 pts (64.6%). Angiographic studies showed patent LITA-LAD graft in 93 pts (98%). We showed good quality of anastomosis in 91 pts (95.8%). Conversion to sternotomy (2.8%) and complications rates (4.1%) were low

and did not have the influence on composite end-point (death, myocardial infarction and repeated revascularization).

Conclusion: The MIDCAB procedure is safe and effective treatment of the proximal LAD lesion. MIDCAB with video-assisted LITA harvesting allows reducing operative trauma improves the quality of anastomosis and reduces postoperative pain

INTRODUCTION

Minimally invasive direct coronary artery bypass grafting (MIDCAB) without use of the cardiopulmonary bypass using left minithoracotomy is the first least invasive method aimed to reduce surgical trauma by elimination of the extracorporeal circulation [Benetti 1995, Benetti 1996, Calafiore 1996, Cisowski 2000, Diegeler, Duhalongsod 1998, Subramanian 1998].

MIDCAB operation is indicated in patients with one vessel coronary disease – left minithoracotomy provides good access for the LAD and diagonal branches. This method is especially useful in young patients with very progressive atherosclerosis or in old patients with coexisting comorbidities who are very prone for complications due to the cardiopulmonary bypass and/or sternotomy [Benetti 1996, Cisowski 2000, Nataf 1997b].

MIDCAB is also indicated in patients who developed restenosis after PTCA and/or stenting of the LAD and in patients with multivessel coronary disease in whom so called hybrid procedure can be used (two stage procedure: MIDCAB operation and PTCA/stenting). Hybrid procedure allows avoiding cardiopulmonary bypass (CPB) and performing complete revascularization by use of minimally invasive methods in patients with multivessel disease [Calafiore 1996, Cisowski 2000, Duhalongsod 1998, Subramanian 1998, Wittwer 2000].

The implementation of coronary stenting to clinical practice reduced risk of restenosis development but the results of stenting are still worsened by restenosis development. This risk is especially high in patients in type C lesion in proximal LAD and insulin dependent diabetes mellitus. When one has to cope with completely occluded LAD despite use of rotablation and stenting, one can expect a high risk of complications and restenosis rate [Mariani 1997].

In Borst's and Mariani's opinion the MIDCAB with the use of left internal thoracic artery (LITA) can be the alternative treatment for this group of patients [Mariani 1997, Nataf 1997a].

LITA is usually harvested under direct vision through left minithoracotomy. The use of rib retractors in this method causes bigger surgical trauma and increases

postoperative pain. This access also does not allow harvesting LITA completely and properly – the opened tributaries can cause coronary steal syndrome. Insufficient pedicled graft length may cause tension or kinking what may compromise blood flow [Cisowski 2000, Duhalongsod 1998, Nataf 1997a, Nataf 1997b].

The use of video assisted LITA harvesting allows to harvest it precisely and completely without thoracotomy and diminishes surgical trauma by reducing the length of left minithoracotomy to 6-8 cm [Cisowski 2000, Nataf 1997a, Nataf 1997b Yim 2000]. The LITA-LAD anastomosis is completed under direct vision by left anterolateral minithoracotomy.

The aim of the study is to answer the question whether MIDCAB operation using video-assisted LITA harvesting can be performed effectively and safely.

MATERIAL AND METHODS

Between April 1998, and December 2000 we performed 147 MIDCAB operations with the use of video-assisted LITA harvesting. The indications for MIDCAB were:

1. type C or B lesion (American College of Cardiology, American Heart Association) in proximal or mid segment of the LAD
2. restenosis after PTCA or stenting
3. multivessel coronary artery disease in pts who were eligible for hybrid procedure (Table 1).

Contraindications for this procedure were: previous Q-wave anterior wall infarction without any evidence of viable myocardium in this region, unstable coronary disease, concomitant valvular disease, pleural adhesions, and patient's intolerability for one lung ventilation.

The LITA was harvested using video-assisted method. The LITA-LAD anastomosis was performed via anterolateral minithoractotomy under direct vision without the use of CPB.

During the operation monitoring was as follows: ECG, heart rate, CVP, global and regional contractility (TTE), nasopharyngeal and esophageal temperature, and O_2 capillary blood saturation.

In the early (30 days) postoperative period we observed: total operation time, anastomosis completion time, total incisions' length, the need of conversion to sternotomy, total mortality, incidence of myocardial infarction, CCS class (Canadian Cardiology Society score), need for reintervention (Re-do CABG, Re-do PTCA), wounds healing, and total hospital stay.

The late follow-up was obtained in all the patients and the following parameters were assessed: mortality rate, new onset myocardial infarction, new onset angina, need for reintervention (Re-do CABG, Re-do PTCA), postoperative pain, and control coronary angiography.

RESULTS

Patients' demographics and early results are shown in Tables 2, 3, and 4. There was no early deaths and 2 pts (1.4%) developed perioperative MI. The average CCS class was significantly lower after MIDCAB (2.6 ± 0.7 vs. 1.1 ± 0.3, $p<0.001$) (Table 4).

Six pts (4.2%) required conversion to sternotomy – in 4 pts (2.8%) one performed LITA-LAD anastomosis on beating heart without CPB, and 2 pts (1.4%) who suffered from intraoperative MI needed extracorporeal circulation (Table 3).

Three pts (2.1%) developed superficial wound infection what extended hospital stay. One of them (0.7%) needed plastic reconstruction of tissue defect.

Total operation time, LITA video-assisted harvesting time (Figure 1) and incision length became shorter in latter series of pts and paralleled surgical team's experience. Initially total operation time was 3-6 hours, and, in last year was 2-2.5 hours.

The follow-up period was 30 days up to 32 months (22.0 ± 10.4 months). The late results are shown in table 5 and 6. There were two (1.4%) deaths during follow-up period (one of cardiac origin and another one of non-cardiac origin – stroke) and 2 pts (1.4%) developed new onset angina needed repeated revascularization (Table 5).

We performed 55 (64.6%) control coronary angiograms. There was very good patency of anastomosis in 98% of pts (no kinking, conduit stenosis and open side branches). Control coronary angiograms showed moderate graft stenosis (grade A) in 2 pts (2.1%), and graft occlusion (Grade 0) in 2 (2.1%) pts. We use Fitzgibbon's score [FitzGibbon 1996] which is based on over 5000 control coronary angiograms in order to standardize the interpretation of the results (Table 6).

In 58 (56.5%) pts elective coronary angiograms were performed, in another 35 (41.4%) there were integral part of hybrid procedure, and in 2 (2.1%) the indication for coronary angiogram was new onset angina. In 1 patient angiography performed 3 months after MIDCAB showed LITA-LAD anastomosis stenosis, and in another 1 native vessel stenosis distally to LITA-LAD anastomosis. In both pts successful PTCA was performed.

DISCUSSION

We observed very good long-term result in 147 pts during follow-up (maximal follow-up period was 2 years). We observed significant reduction of patients' CCS class (2.6±0.7 vs. 1.1±0.3, $p<0.001$ before and after MIDCAB respectively).
Two pts (1.4%) developed symptoms of angina during follow-up. Control coronary angiograms showed stenoses, which were successfully treated with PTCA.

The survey forms were sent to all the pts and they showed very high satisfaction with this method of treatment. Over 91% of pts did not complain of chest pain. These pts did not require painkillers except non steroid anti inflammatory drugs – this is probably the chief advantage of video-assisted LITA harvesting over direct harvesting which is associated with significant pain [Cisowski 2000, Duhalongsod 1998, Nataf 1997b, Pagini 1998].

Although a few pts had postoperative complications (bleeding – 2.8%, pneumothorax – 1.4%, wound infection – 2.1%, conversion to sternotomy – 4.2%) but it had not any influence on final endpoints: death and/or myocardial infarction. If one take into consideration predictable very good long term result of LITA-LAD anastomosis which was proven in previous investigations the risk of perioperative complications seems to be acceptable [Cisowski 2000, Duhalongsod 1998, Nataf 1997a, Nataf 1997b]. As we did not perform control coronary angiograms in all the pts yet the precise assessment of long-term results of MIDCAB's with video-assisted LITA harvesting will be available in the future.

Diegeler comparing 6 months results after MIDCAB and PTCA with stenting by means of control coronary angiography showed much higher restenosis and reintervention rates after PTCA (25.4 vs. 4.0%, respectively) [Diegeler 2000].

Mack showed results of control coronary angiograms in 100 pts who were operated on by use of MIDCAB with excellent results (99% patent anastomoses and 91% anastomoses of very good quality) [Mack 1999].

Two years after implementation of MIDCAB operation with video-assisted LITA harvesting in our center, we can say that it is safe and provides good long-term result. It gives the patient short hospital stay, good cosmetic result and is relatively painless. It allows patient to recover quickly and be active after short period of time.
There is a need for further long-term follow-up to assess such endpoints like death and freedom from angina in order to compare least invasive techniques with other methods.

CONCLUSION

MIDCAB operation with video-assisted LITA harvesting is safe and shifts pts to lower CCS class. Video-assisted LITA harvesting is feasible and provides full-length

pedicle graft of very good quality. It also allows reducing thoracotomy length and diminishing surgical trauma.

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Table 1. Angiographic preoperative data (n = 147)

Single vessel disease		**112 (76.2%)**
LAD, segment 6 or 7	type C* lesion	82 (73.2%)
	type B* lesion	15 (13.4%)
LAD, restenosis in PTCA/stent		15 (13. 4%)
Two vessel disease		**35 (23.8%)**
LAD and RCA	LAD (type C*), RCA (type A*)	20 (57.2%)
	LAD (type B*), RCA(type A*)	8 (22.8%)
LAD and OM_1	LAD (type C*), OM_1 (type A*)	7 (20.0%)

*American College of Cardiology, American Heart Association

Table 2. Demographic Data

Nº of patients	147
Male	108 (73.5%)
Female	39 (26.5%)
Age (years)	57.5 ± 18.1
Hypertension	89 (60.5%)
Stroke	2 (1.4%)
Peripheral arterial desease	12 (10%)
Diabetes mellitus	24 (16.3%)
Hypercholesterolemia	68 (46.3%)
Angina Class (average CCS* score)	2.6 ± 0.7
Previous MI in LAD region	78 (53.1%)
Q-wave	21 (14.3%)
non Q-wave	57 (38.7%)
Previous MI in other regions	20 (13.6%)
Average LVEF (%)	48.4 ± 13.9
Good (> 50%)	68 (46.3%)
Moderate (35 – 50%)	69 (46.9%)
Poor (< 35%)	10 (6.8%)

Table 3. Operative data and complications

Thoracoscopic	**75 (51%)**
Thoracoscopic + AESOP	**72 (49%)**
LIMA – LAD (single vessel)	109 (74.1%)
LIMA - LAD (re-do)	3 (2.1%)
Hybrid procedure (double vessel)	35 (23.8%)
Length of incision (cm)	5.6 ± 2.2
Endoscopic LITA harvest time (min)	33.6 ± 14.6
Anastomosis time (min)	14.8 ± 4.4
Operating time (min)	157.6 ± 33.4
Conversion to the CPB (Ao - LAD, Ao - RCA)	**2 (1.4%)**
Low cardiac output	2 (1.4%)
Conversion to the OPCAB (Ao-LAD)	**4 (2.7%)**
LITA injury	2 (1.4%)
Bleeding (thoracoscopic procedure)	1 (0.7%)
Respiratory failure	1 (0.7%)
Re-exploration for bleeding	4 (2.8%)
Intubation time (hours)	3.4 ± 2.6
Atrial fibrillation	29 (19.7%)
Ventricular ectopics	3 (2.1%)
Total chest tube drainage (per 24 hours)	426.5 ± 312.6
Pneumothorax	2 (1.4%)
Pleural effusion	10 (6.8%)
Wound infection	3 (2.1%)

Table 4. Early results. (147 patients, follow-up period - 30 days)

Mortality	0		
Perioperative myocardial infarction	2 (1.4%)		
Reintervention	**2 (1.4%)**		
Re-CABG	2 (1.4%)		
Re-PTCA	0		
Angina Class (Average CCS* score)	Preoperative	Postoperative	P
	2.6 ± 0.7	1.1 ± 0.3	< 0.001
Isotropic support (Dopamine > 3 _ g/kg/h)	6 (4.1%)		
Hospital stay (days)	5.7 ± 1.7		

Table 5. Long term follow-up. 147 patients, follow-up period from 6 to 32 months.

Mortality	**2 (1.4%)**
Cardiogenic	1 (0.7%)
Non-cardiogenic	1 (0.7%)
Stroke	1 (0.7%)
New onset angina	**2 (1.4%)**
Myocardial infarction (Q-wave)	1 (0.7%)
Repeated revascularization – PTCA	**7 (4.7%)**
After PTCA/stent (hybrid procedure)	5 (3.4%)
After surgery	2 (1.4%)
Event-free survival	**138 (93.8%)**
Wound pain	
No pain	135 (91.8%)
Moderate	4 (2.7%)
severe (need for painkillers)	8 (5.4%)

Table 6. Graft assessment in the 95 patients, follow-up period from 3 to 32 months

Variable	N° of Patients (n = 147)
Angiograms	**95 (64.6%)**
Elective	58 (56.5%)
Recurrent angina	2 (2.1%)
Hybrid procedure	35 (41.4%)
Overall patency rate	**93 (97.9%)**
Grade A	91 (95.8%)
Grade B	2 (2.1%)
Grade 0	2 (2.1)

FitzGibbon Score -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 harvest time: mean [min] – 32.4 ± 10.6