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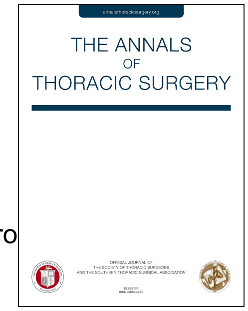

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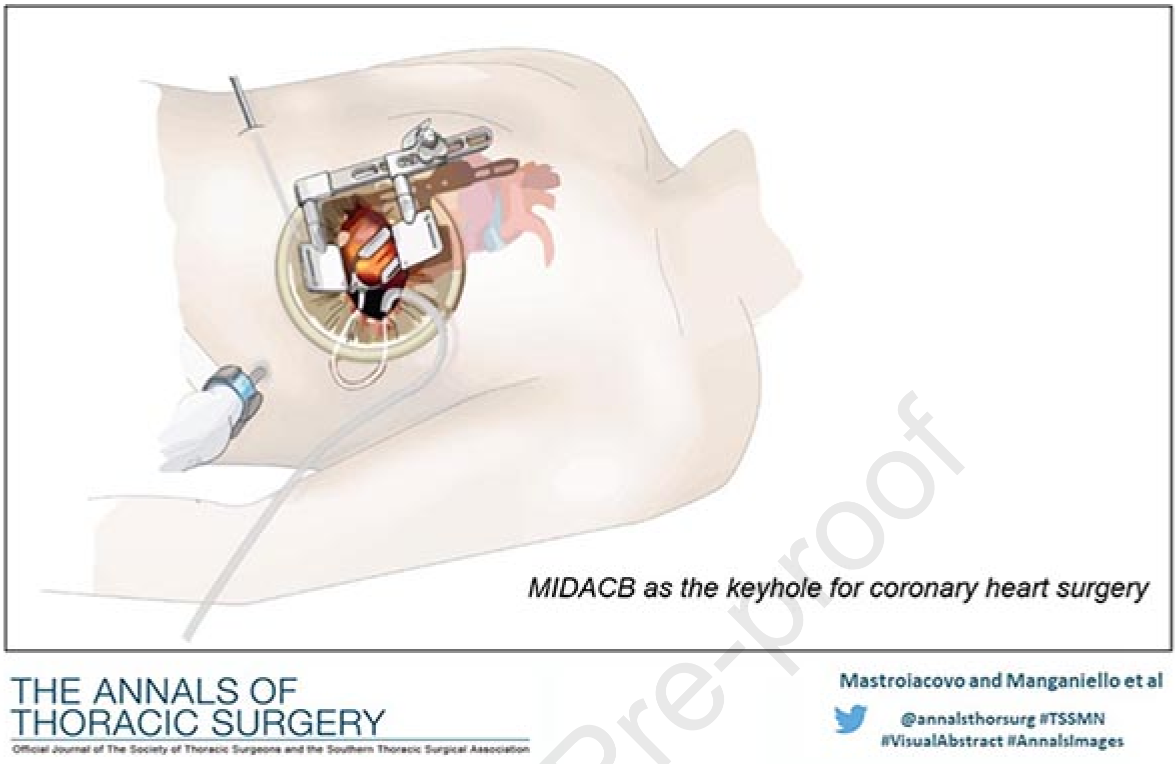
MIDACB as the keyhole for coronary heart surgery
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Very long-term outcome of Minimally Invasive Direct Coronary Artery Bypass

Running head: Long term outcome of minimally bypass

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Abstract

Background: Minimally invasive direct coronary artery bypass (MIDCAB) is a well-established low-impact surgical procedure for revascularization of left descending coronary artery with the left internal mammary artery. This work aims to evaluate safety, overall survival and freedom from major adverse cardio-cerebral events (MACCE) after 20 years of MIDCAB.

Methods: We retrospectively collected a series of 141 patients who underwent MIDCAB between 1997 and 2017 to assess long-term outcome. Therefore, we analysed 133 patients who consequently underwent revascularization of left descending coronary artery with left mammary artery via a full median sternotomy.

Results: Actuarial survival rate at Kaplan-Meier curve was 100%, 95%, 90%, 83% and 70% at 1, 5, 10, 15 and 20 years, respectively. Freedom from MACCE, defined as myocardial infarction, stroke and cardiac death, was 97%, 90%, 79%, 75% and 61% at 1,5,10,15 and 20 years, respectively. At Cox multivariable analysis, age, cancer and chronic renal insufficiency have been found to be independent predictors affecting long-term survival, with a hazard ratio of 1,12 (p 0.007), 17,63 ($p<0.001$) and 5.16 (p 0.03), respectively. MIDCAB group showed a significantly lower rate of in-hospital stay, blood transfusions, cardiac-related and all-causes events compared to full sternotomy group (p=0,02 and p=0,0001, respectively).

Conclusions: Very long-term clinical outcome of MIDCAB is satisfactory in terms of survival and freedom from MACCE. MIDCAB significantly reduces in-hospital stay and blood transfusions when compared to full sternotomy bypass surgery on left descending coronary artery and appears to effectively improve prognosis in terms of cardiac- and all-causes events.

Keywords: MIDCAB, coronary artery bypass, long-term survival, retrospective study.

List of abbreviations:

CABG: coronary artery bypass grafting

CAD: coronary artery disease

COPD: chronic obstructive pulmonary disease

CRD: chronic renal disease

Cx: circumflex artery

FSCABG: full sternotomy coronary artery bypass

HCR: hybrid coronary revascularization

LAD: left descending coronary artery

LIMA: left internal mammary artery

LVEF: left ventricular ejection fraction

MACCE: major adverse cardio-cerebral events

MIDCAB: minimally invasive direct coronary artery bypass

PCI: percutaneous coronary interventions

PTCA: percutaneous transluminal coronary angioplasty

RCA: right coronary artery

TVR: target vessel revascularization

The treatment of coronary artery disease (CAD) has become increasingly challenging mainly due to advanced patient's age and significant comorbidities impacting prognosis as well as healthcare costs (1). In this regard, the role played by heart teams to choose the optimal revascularization strategy for each patient is critical. The balance between efficacy of revascularization and surgical trauma is today a major issue, as the only difference in the treatment of left descending coronary artery (LAD) disease of low or intermediate anatomical complexity between percutaneous coronary interventions (PCI) and coronary artery bypass grafting (CABG) at 5 years is the event-free survival in favour of CABG (2, 3).
Minimally invasive direct coronary artery bypass (MIDCAB) is today a well-established low-impact surgical procedure for revascularization of LAD with the left internal mammary artery (LIMA). Satisfactory early and mid-term clinical and angiographic results have been consistently reported by several authors (4-7). Notably, MIDCAB has been favourably compared with conventional coronary artery bypass operations with LIMA to LAD requiring full sternotomy. Yang et al (8), have reported in this regard that MIDCAB can significantly reduce postoperative in-hospital stay and intraoperative blood transfusions when compared to CABG, and, more importantly, appears to effectively improve prognosis in terms of cardiac related events, cerebrovascular events and sudden death. Remarkably, MIDCAB has also favourably confronted with LAD revascularization by means of PCI (9). In a meta-analysis aimed to ascertain the efficacy of MIDCAB vs. PCI in patients with isolated LAD lesions, Xiao-Wen Wang and co-workers (10) showed that the incidence of target vessel revascularization (TVR), major adverse cardiovascular events (MACE) and angina recurrence were lower in the MIDCAB group. In addition, MIDCAB has been confirmed more effective than PCI alone as part of an integrated hybrid surgical/percutaneous strategy to achieve complete revascularization in multi-vessel CAD (11,12).

However, despite such evidences, MIDCAB has not yet been widespread adopted in the routine armamentarium of heart teams. A partial explanation may be that both CABG and PCI have a class IA indication for isolated LAD disease in current guidelines; another problem relies in the lack of complete information about efficacy in the very long-term of MIDCAB. In this regard, new data on outcome together with additional knowledge of its major determinants may be helpful to better stake off MIDCAB place as stand-alone therapy or as adjunct to hybrid procedures in LAD revascularization.

In the present study, we sought to retrospectively investigate clinical variables related to very long-term outcome (20 years) in a series of 141 consecutive MIDCAB patients.

Patients and Methods

Patients

From March 1997 to May 2017, 141 consecutive patients underwent myocardial revascularization on a beating heart through a left anterior thoracotomy performed by two surgeons (GP, CA). All operations have been performed electively. Decision-making process for MIDCAB included a careful assessment of LAD anatomy as well as of patients' characteristics. We therefore collected data from 133 consecutive patients undergone single LIMA-LAD bypass via a full median sternotomy (FSCABG) from 2004 to 2018 in our Centre.

Ethical Committee

This work is based on a retrospective chart review with follow-up information retrieved by telephone calls. Patients consent was obtained for research purposes. The informed consent was approved by the local Ethics Committee (CCM 1049), April 2019.

Inclusion Criteria

MIDCAB was mainly performed in case of isolated LAD disease in which PCI was not advisable for anatomical reasons or not successful (91/141 patients 64,5%, of which 68 patients were not amenable to PCI for anatomical reason and 23 because of PCI failure). In those patients with a multivessel coronary artery disease, MIDCAB on LAD was elected for a contraindication to sternotomy, hybrid revascularization approach, not graftable or very poor peripheral coronary artery bed other than LAD.

Special attention has been paid to the anatomic feature of LAD at angiography. Intramyocardial, calcified or small-sized (<1.5 mm) LAD were considered anatomic contraindications to MIDCAB. The post-operative anti-platelet regimen was mainly acetylsalicylic acid 100 mg/die. Angiographic indications for hybrid cardiac revascularization (HCR) were the following: presence of a significant stenosis in the proximal LAD, LAD anatomy amenable to minimally invasive LIMA-LAD bypass, and non-LAD lesions amenable to routine PCI.

Exclusion Criteria

Main exclusion criteria were hostile chest, previous left thoracotomy, obesity and severe respiratory insufficiency. The percentage of patients not susceptible to PCI and excluded from MIDACB for hostile chest, previous left thoracotomy, obesity, severe respiratory insufficiency and surgeon choice was 74%. All these patients underwent conventional CABG with median sternotomy.

Operative Technique

A conventional single-lumen endotracheal tube was used in all patients. The chest was opened via a small (8-10 cm) left anterior thoracotomy in the fourth or fifth intercostal space. The pleural cavity was opened routinely and a moist sponge was used to partially collapse the left lung. LIMA-to-LAD anastomoses were performed with a 7/0 or 8/0 running polypropylene sutures.

The surgical technique has been modified over the 20-years period of the study. In the first 47 cases, (February 1997 - December 1998), the LIMA was directly harvested through the thoracotomy for the distal segment, and indirectly through a thoracoscope (Olympus, Hamburg, Germany) for the proximal portion, as previously described (12) (Fig. 1).

Local immobilization of the anastomotic site was achieved using epicardial 5/0 polypropylene sutures placed twice to surround the LAD proximally and distally to the target site.

Starting from 1999 (case 48), the adoption of a special spreader (Autosuture International Inc., Norwalk, USA) and a myocardial wall stabilizer (Octopus, Medtronic) allowed for full-length LIMA harvesting under direct vision and a motionless anastomosis, respectively.

Finally, from June 1999 (case 63), we have routinely adopted intracoronary shunts (Medtronic Inc., Minneapolis, USA) allowing bloodless anastomosis avoiding LAD occlusion. The average time for the LIMA-LAD anastomosis was 25,7±3,3 min, while the mean operation time was 83,8±12,4 min.

Follow-up

All patients were subsequently followed in our outpatient clinic and the follow-up was completed in 100% of patients, despite the long-follow-up period. Repeated LAD revascularization and new cardiac events (recurrence of angina, acute myocardial infarction, new revascularization procedures, whether percutaneous or surgical) as well as survival data were collected.

Statistical Analysis

Values were expressed as mean ± standard deviation or frequencies plus percentages for continuous and categorical variables, respectively. T-test was used for the comparison of continuous variables between two groups, Chi-square or Fisher exact test was used for the comparison of categorical variables between two groups. Kaplan-Meier analysis was used to calculate event-free survival and MACCE. Determinants of long-term cardiac outcome (LAD revascularization and new cardiac events) were identified using Cox proportional-hazards regression model. Predictors considered in this analysis were: gender, age, left ventricular ejection fraction (LVEF) <50%, chronic obstructive pulmonary disease (COPD), chronic renal disease (CRD), pregressive neoplasia, insulin-dependent diabetes and multi-vessel coronary artery disease. Probability values below 0.05 were considered as significant. All analyses were performed using the SAS statistical package v8 9.4 (SAS Institute, Cary NC, USA).

Results

In-hospital Outcome

Patient baseline characteristics of both groups are depicted in Table 1. Early clinical results of the two groups are shown in Table 2. No in-hospital deaths occurred in MIDCAB group. In one patient (0,7%) who experienced a perioperative myocardial infarction showing LIMA-LAD anastomotic stenosis, a perioperative percutaneous transluminal coronary angioplasty (PTCA) on proximal LAD was performed. In other 2 cases (1,4%) a surgical revision recycling the LIMA graft was necessary for a critical stenosis of LIMA-LAD anastomosis. In total, the need for in-hospital repeated mechanical revascularization was 2,1%. Three patients (2,1%) required reoperation for bleeding. Transfusion rate was 7,1% (10 patients). The more frequent in-hospital complication was transient postoperative atrial fibrillation, which was experienced by nineteen patients (13,5%).

One patient only experienced respiratory acute insufficiency and peripheral embolism (0,7%). One patient (0,7%) suffered from right upper limb plegia regressed after few hours since the onset of the symptom with no evidence of brain lesions at CT scan. Eight patients showed pleural effusion (5,7%) and in 2 cases a pericardial effusion was detected (1,4%), not requiring surgical evacuation. Two patients showed renal acute insufficiency (1,4%), pharmacologically treated. The mean post-operative hospitalization stay was 6.6±2,1 days (range 2 – 13). MIDCAB group showed a significantly lower rate of blood transfusion and both intensive care unit and in-hospital stays ($p<0.001$) compared to the FSCABG group.

Clinical Outcome at Follow-up

The follow-up period was from 2 to 264 months (mean 133 months) and from 6 to 185 months (mean 98 months) for the MIDCAB and FSCABG, respectively. In the first group, thirteen patients died at a mean of 109 months postoperatively; 1/13 (7,7%) for a cardiac cause, 1/13 (7,7%) for lymphoma, 3/13 (23%) for pulmonary neoplasm, in the remaining 8 cases the cause of death remained unknown because of a non-retrievable information by relatives (Table 3). Actuarial survival rate at Kaplan-Meier curve was 100%, 95%, 90%, 83% and 70% at 1, 5, 10, 15 and 20 years respectively (Fig 2). Therefore Kaplan-Meier curves show an increased survival for MIDCAB patients compared to the FSCABG group both for all-cause event and cardiac mortality (Fig.3).

Twenty-two patients (15.6%) in the MIDCAB group experienced recurrent myocardial ischemia during follow-up, at a mean of 50.8±16 months postoperatively (range 1-219 months). One patient (0.7%) showed acute myocardial infarction 15 months after surgery. Freedom from MACCE defined as myocardial infarction, stroke and cardiac death, was 97%, 90%, 79%, 75% and 61% at 1,5,10,15 and 20 years respectively (Fig 4).

In a Cox multivariable analysis, age, cancer and chronic renal disease (CRD) have been found to be independent predictors affecting long-term survival, with a hazard ratio of 1,12 (p 0.007), 17,63 ($p<0.001$) and 5.16 (p 0.03), respectively (Table 4).

Repeated Revascularization During Follow-up

During the follow-up period, in the MIDCAB group 26 patients (18,4 %) underwent angiographic reinvestigation, 18 (69 %) for signs of recurrent myocardial ischemia, 3 (11,5%) during routine evaluation for valve replacement, in the remaining 5 cases the cause of angiographic reinvestigation is not known.

New coronary lesions were found in 19 cases (73 %), of which in 8 cases (42,1 %) LAD and/or LIMA were involved. Three patients showed a significant lesion at LIMA-LAD anastomotic site, in 1 case a LIMA "string sign" and 4 a new LAD lesion proximally or distally to the anastomotic site were detected. The remaining 11 patients (57,9%) showed new lesions in coronary vessels other than LAD.

Globally 14 out of the 19 patients (73,7%) underwent a revascularization procedure during the follow-up period after a mean period of 61,5±66,1 month from MIDCAB. Four patients were surgically treated with conventional CABG by median sternotomy, of which 2 reoperation were performed at LIMA-LAD anastomotic site alone, one reoperation on LIMA-LAD anastomotic site associated with revascularization of right coronary artery (RCA) and circumflex artery (Cx) and the last one was a reoperation on LIMA-LAD anastomotic site associated with the revascularization of RCA. Ten patients required PTCA, of which 2 cases of single LAD revascularization, 3 single Cx, 2 single RCA, 1 case of bi-vessels revascularization (Cx and RCA), and eventually 2 cases of tri-vessels revascularization (LAD, Cx and RCA) (Table 5). Overall, in discharged patients, in 20 years from MIDCAB the rate of repeated revascularization on LIMA-LAD anastomosis, LAD and in vessels other than LAD were 3,5%, 1,42%, 7,1% respectively. Freedom from any coronary vessel and LIMA-LAD/LAD revascularization were in this time frame 88% and 95,1%, respectively.

At multivariable Cox regression analysis (Table 6), female gender and LVEF < 50% were found the two independent risk variables for any vessel revascularization with a hazard ratio of 4.7 (p=0.005) and 13 (p=0.0001), respectively. Age was found as a borderline significant factor (p=0,068).

Moreover, LVEF<50% was shown to be associated with an increased risk of LAD revascularization, with a hazard ratio of 9,6 (p=0.0015).

Comment

Several studies have shown that myocardial revascularization by PCI or CABG more effectively relieves angina, reduces the use of anti-angina drugs, and improves exercise capacity and quality of life compared with medical therapy alone in a short- and long-term follow-up (14).

Predicted surgical mortality, the anatomical complexity of CAD, and the anticipated completeness of myocardial revascularization are important criteria for decision-making with respect to the choice of mechanical revascularization (15). In patients referred to CABG, advanced age, diabetes, renal failure, hypertension, stroke, LVEF, and COPD typically represent increasingly frequent comorbidities impacting on early- and long-term outcome (16). In this regard, due to a reduced surgical impact, MIDCAB may be viewed as an appealing surgical alternative when a lesser trauma is desirable. In our own experience, MIDCAB patients show indeed a combination of those aforementioned comorbidities. MIDCAB is now considered a safe operation with low postoperative mortality and morbidity and with excellent short-term and long-term results. It is a viable option compared to both PCI and conventional surgery for LAD revascularization (17). Reduction of postoperative pain and infections, and a rapid return to active life are main goals of such a surgical strategy. We showed that MIDCAB significantly reduces the in-hospital stay and the rate of blood transfusion when compared to conventional CABG. These results are in line with those from Yang and co-workers (8) and Florisson et al. that demonstrated a reduction of both postoperative intensive care and total hospital stay (18).

Obviously, these benefits cannot be achieved at the cost of a reduced graft patency rate when compared to conventional CABG. LIMA harvesting, LAD exposure and stabilization, bleeding control during anastomosis tailoring are technically challenging variables that may affect graft patency and, consequently, freedom from repeated revascularization (19). Halcos et al (20) have documented an increased repeat revascularization rate and increased frequency of LIMA-LAD anastomotic lesions when MIDCAB is compared to conventional CABG. In a previous report of early angiographic reinvestigation after MIDCAB, we have shown that the anastomotic perfect patency rate was 54/57 (94.7%), supporting that MIDCAB is a technically-demanding operation and requires an experienced surgeon and dedicated programs to be optimally performed. This observation agrees with findings by Stainbridge et al (21), who have reported in a meta-analysis that graft stenosis was greater in MIDCAB, but there was a reduction after utilization of myocardial stabilization.

As for long-term results, compared to off-pump CABG, MIDCAB did not increase the risk of late mortality (0-3%) (18). Our study confirmed that MIDCAB in discharged patients is a safe technique with satisfactory very long-term results in terms of freedom from LIMA-LAD/LAD repeated revascularization, which was found as high as 88% at 20 years. At the best of our knowledge, this is the longest MIDCAB survey, that favourably compares with results reported by Holzhey et al (22) in a 13-year single-centre experience showing a 70.9% freedom from angina recurrence at 10 years from MIDCAB. Same Authors have reported at 10-year a freedom from MACCE of 85.3% and a survival rate of 76.6%. These results are confirmed in our study. The overall survival at 5-10-15-20 years was as high as 95-90-83-70%, respectively. Freedom of MACCE was also satisfactory in the long-term follow-up (75% and 61% at 15 and 20 years, respectively).

Interestingly, our multivariate analysis suggested CRD, age and malignancy as independent pre-operative factors for all-cause death, whereas LVEF<50% only was associated with an increased risk of repeated revascularization.

HCR is an approach that aims to achieve a complete minimally invasive revascularization taking advantage of both surgical and percutaneous revascularization. Rodriguez M. et al showed that HCR can be safely performed in high-risk patients through different strategies (PCI or CABG first or concomitantly) [23]. When an HCR was envisaged, we routinely elected a two-stage strategy (MIDCAB first and then PCI) during the same hospitalization. When feasible, we believe that this HCR strategy has the double advantage to achieve a complete coronary revascularization minimizing procedural risks.

Finally, according to the most recent Guidelines [24], the choice between CABG or PCI for LAD revascularization is mainly based on anatomical complexity of CAD and long-term mortality and morbidity. The available evidence from randomized trials and meta-analyses comparing CABG with PCI for LAD suggests equivalent results as for a composite endpoint of death, myocardial infarction and stroke up to 5 years of follow-up [25]. However, the revascularization rate at follow-up is more frequent after PCI than after CABG, even in patients with low or intermediate anatomical complexity [3]. In a recent meta-analysis, Indja B. et al [26] confirmed that MIDCAB for LAD remains superior to first- or second-generation PCI with drug eluting stent in term of long-term freedom from myocardial infarction and target vessel revascularization as well as of improved overall long-term survival.

More recently, it has been shown that MIDCAB can further benefit from robotic surgery in terms of minimizing surgical trauma, reducing hospitalization time and post-operative pain and improved cosmesis. [27].

Study Limitations

This is a retrospective monocentric observational study. A significant difference in patients distribution throughout the study period (23 patients/year in the first 2 years and 5 patients/year in the remaining 18 years) may represent a selection bias. This is mainly due to the relentless progresses of percutaneous techniques in the field of coronary angioplasty, and to the reluctance of interventional cardiologists to consider MIDACB as part of an effective HCR. However, this issue can be partly overcome since two surgeons only have performed the entire casuistry.

Conclusions

In summary, we here report the longest follow-up so far available in MIDCAB. We have shown that very long-term clinical outcome of MIDCAB is excellent in terms of survival, freedom from MACCE and repeated revascularization rate. Moreover, we have identified variables associated with poorer outcome. Nonetheless MIDCAB can significantly reduce in-hospital stay and blood transfusions when compared to conventional bypass surgery on LAD and appears to effectively improve overall and cardiac survivals. MIDCAB is confirmed as a viable option of LAD revascularization in selected patients.

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Table 1. Preoperative data

Variable	*Value MIDCAB*	*Value CABG*	*p-value*
Mean Age (years)	62.1± 9.9	67.6± 9.4	<0.0001
Sex (male)	116 (82,2%)	99 (74.4%)	0.11
EuroSCORE II	1.8 ± 2.1	2.9 ± 2.75	0.9
Previous MI	70 (49.6%)	54 (40.6%)	0.16
LVEF<50%	13 (9.2 %)	36 (27.1 %)	<0.0001
Renal Insufficiency	13 (9.2 %)	31 (23.3 %)	0.001
COPD	19 (13,5%)	11 (8.2%)	0.2
Cerebrovascular disease	11 (7.8 %)	15 (11.2%)	0.3
Malignancies	15 (10.6 %)	12 (9%)	0.65
Coronary lesions			
1-vessel disease	91 (64.5 %)	63 (47.5%)	
2-vessel disease	33 (23.4%)	23 (17.2%)	0.0002
3-vessel disease	17 (12.1%)	47 (35.3%)	

MI=myocardial infarction; LVEF=left ventricular ejection fraction; COPD=chronic obstructive pulmonary disease.

Table 2: Comparison of post-operative results of MIDCAB vs traditional CABG

	MIDCAB	CABG	p-value
Death	0(%)	0(%)	-
Off pump CABG	141 (100%)	113 (85%)	<0.0001
Intensive care unit stay (days)	1,48±0,34	1,87±0,65	<0.0001
Perioperative MI	1 (0,7%)	1 (0,8%)	1
Redo for bleeding	3 (2,1%)	6 (4,5 %)	0,3
Blood transfusion	10 (7,1%)	38 (28,6%)	<0,0001
Sternal reconstruction	0(0%)	3 (2,3%)	0,07
AF	19 (13,5%)	24 (18%)	0.3
Respiratory acute insufficiency	1 (0,7%)	1 (0,8%)	1
Peripheral embolism	1 (0,7%)	2 (1,5%)	1
Pericardial effusion	8 (5,7%)	14 (10,5%)	0,14
Pleural effusion	9(6,4%)	9 (6,8%)	0,9
Renal acute insufficiency	2 (1,4%)	9 (6,8%)	0,03
Neurological complications	1 (0,7%)	1 (0,8%)	1
Hospital stays (days)	6,6±2,1	17,96±14,36	<0,0001

LAD repeated revascularization (2 CABG, 1 PTCA)	3 (2,1%)	2 (1,5%)	1

AF= Atrial Fibrillation; LAD= Left Anterior Descending; CABG= Coronary Artery Bypass Graft; PTCA= Percutaneous Transluminal Coronary Angioplasty.

Table 3. Causes of death

Patient	*Cause of death*	*Months*
A.S.	Unknown	24
R.S.	Pulmonary cancer	24
D.F.	Pulmonary cancer	35
M.L.	Unknown	37
T.R.	Unknown	51
A.G.	Pulmonary cancer	69
B.S.	Lymphoma	88
L.R..	Unknown	96
C.G.	Unknown	147
B.I.	Unknown	173
C.F.	Unknown	219
C.A.	Myocardial infarction	227
G.B.	Unknown	234

Table 4: Determinants of long-term mortality (Cox proportional-hazards regression model).

Parameters	*Pr> Chi-Square*	*Risk Ratio*	*95% Hazard Ratio Limits*	
Age	0.0067	1.124	1.033	1.223
Cancer	0.0006	17.63	3.459	89.874
CRF	0.0302	5.164	1.17	22.793

CRF: chronic renal failure

Table 5. Repeated revascularization at long-term.

Patient	Month	Angiographic lesions	Treatment	Target vessels
P.T.	2	LIMA-LAD anastomotic site (occlusion)	CABG	LAD
M.M.	7	LIMA-LAD anastomotic site (stenosis)	CABG	LAD
B.C.	19	LAD (new lesion)	PTCA	LAD
P.F.	19	Cx, RCA (new lesions)	PTCA	Cx, RCA
G.B.	20	Cx (progression of known subcritical lesion)	PTCA	Cx
P.C.	25	RCA (progression of known subcritical lesion)	PTCA	RCA
E.W.	30	LIMA (string sign), Cx, RCA (new lesions)	CABG	LAD, Cx, RCA
C.S.	32	LIMA-LAD anastomotic site (stenosis), RCA (new lesion)	CABG	LAD, RCA
G.A.	61	Cx (new lesion)	PTCA	Cx
C.P.	101	LIMA-LAD anastomotic site (stenosis),	PTCA	LAD
C.O.	110	Cx (new lesion)	PTCA	Cx
C.F.	155	Diagonal (new lesion)	PTCA	Diagonal
B.S.	219	LIMA-LAD anastomotic site (stenosis), RCA (new lesion), Cx (new lesion)	PTCA	LAD, RCA, Cx
C.R.	Unknown	RCA (new lesion)	PTCA	RCA

LIMA=Left Internal Mammary Artery; LAD=Left Anterior Descending coronary artery; Cx=Circumflex coronary artery; RCA=Right Coronary Artery; PTCA=Percutaneous Transluminal Coronary Angioplasty; CABG = Coronary Artery Bypass Graft.

Table 6

Determinants of total revascularization (Cox proportional-hazards regression model) at long-term.

Parameters	*Pr> Chi-Square*	*Risk Ratio*	*95% Hazard Ratio Limits*	
Age	0,068	0,948	0,9	1,044
EF<50%	0,0001	12,8	3,5	47
Female sex	0,005	4,7	1,6	14

EF: ejection fraction

Determinants of LAD revascularization at long-term.

Parameters	*Pr> Chi-Square*	*Risk Ratio*	*95% Hazard Ratio Limits*	
EF<50%	0,0015	9,6	2,39	38,8

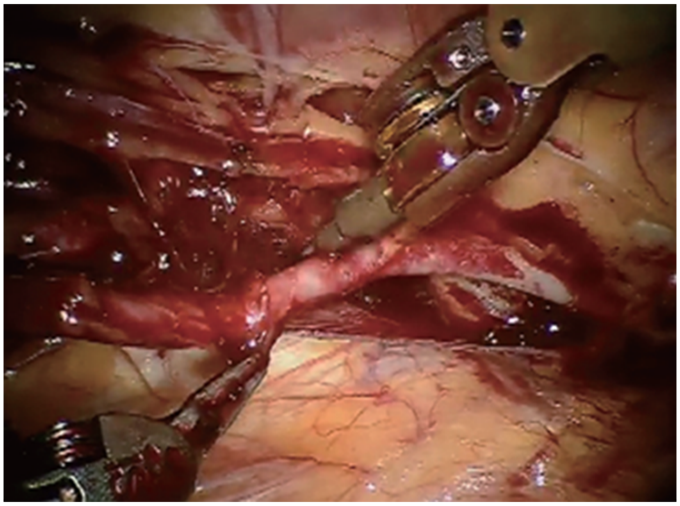
List of figures:

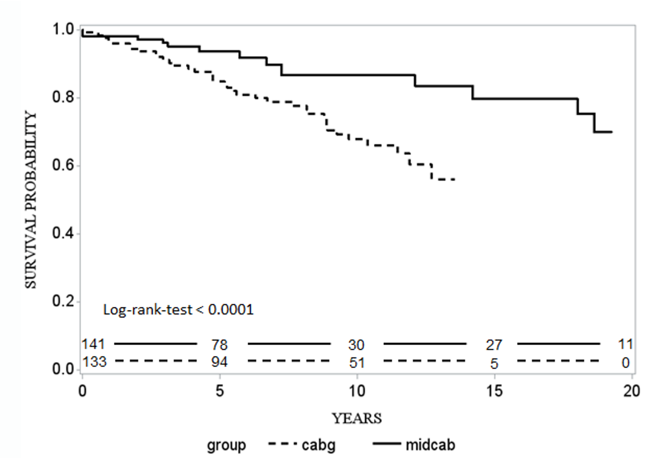
Figure 1: LIMA harvesting

Figure 2: All-cause mortality Kaplan-Meier curve

Figure 3: Cardiac mortality Kaplan-Meier curve

Figure 4: MACCE Kaplan-Meier curve

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10
15
20
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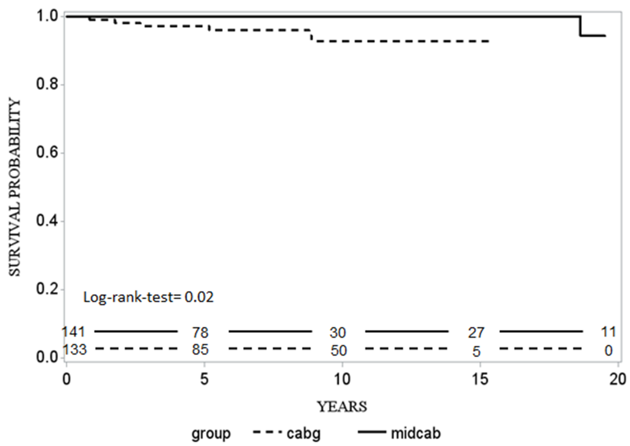
cabg
midcab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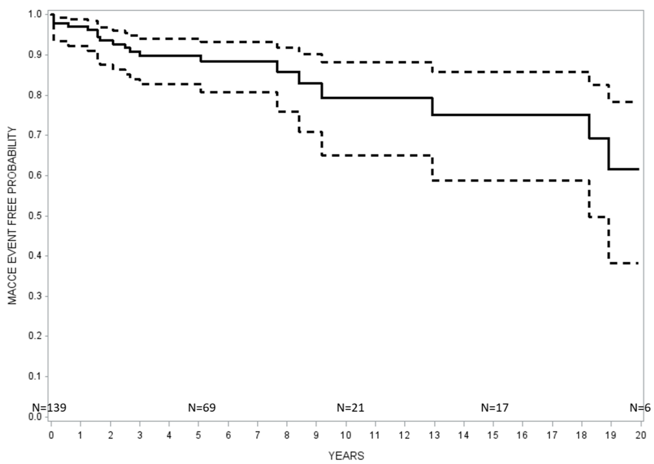
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0.6
0.5
0.4
0.3
0.2
0.1
0.0
N=139
N=69
N=21
N=17
N=6
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
YEARS