Journal of Cardiovascular Disease Research

ISSN: 0975-3583,0976-2833 VOL09, ISSUE 03, 2018

Postoperative results of minimally invasive direct coronary artery bypass thoracotomy versus off-pump coronary artery bypass sternotomy

Abdullah Osama*[1], Kerellos Max[1], Mohammad Abdelrahman Hussein[2]

[1]Cardiothoracic Surgery Department, Faculty of Medicine, Fayoum University, Egypt

[2]Cardiothoracic Surgery Department, Faculty of Medicine, Cairo University, Egypt

*Corresponding author: Abdullah Osama, Email: amo11@fayoum.edu.eg

ABSTRACT

Background: Off-pump coronary artery bypass (OPCAB) is considered an important method for coronary surgery as it avoids many drawbacks to CPB e.g.: incidence of strokes, renal impairment, post-operative coagulopathy and bleeding especially with prolonged bypass times. this approach could be beneficial in reducing some of these drawbacks. Along with the evolution of off-pump techniques, we could perform these operations with minimally invasive direct coronary artery bypass (MIDCAB) through thoracotomy incisions adding the benefit of avoiding median sternotomy to the proposed benefits of off-pump. **Objectives:** to compare the early outcomes following OPCAB- sternotomy with MIDCAB- thoracotomy. **Methods:** between October, 2017 and April, 2018 thirty patients with single vessel (LAD) disease indicated for CABG divided into 15 patients underwent OPCAB- sternotomy and 15 patients underwent MIDCAB- thoracotomy. **Results:** MIDCAB had mean mechanical ventilation time of 4.93 (±3.058), blood transfusion was needed in 2 patients which was significantly different from OPCAB population. **Conclusion:** MIDCAB yielded shorter mechanical ventilation times and lower rate of blood transfusion, comparable results as regards the ICU, hospital stay and infection rate.

Keywords: Coronary artery bypass surgery, Off-pump surgery, Minimally invasive coronary surgery.

INTRODUCTION

One of the most significant surgical operations in the annals of medicine is coronary artery bypass grafting (CABG). No other procedure has perhaps extended more lives, reduced more symptoms, or been the subject of more extensive research. It has been the adult cardiac surgery technique that Patients with coronary artery disease continue to benefit from CABG since it is the most reliable method of revascularization (CAD). Off-pump coronary artery bypass is regarded as an innovative technique in the field of coronary surgery as research on the cardiopulmonary bypass machine has advanced. It has proven that CPB has numerous drawbacks, including a high incidence of stroke, renal issues, post-operative coagulation defects, and bleeding, especially with prolonged bypass times [1]. It is thought that performing these operations off-pump could help to mitigate several of these disadvantages. We not only could perform CABG with the off-pump benefits, but we could also perform these surgeries with minimal access thoracotomy incisions. This aims at taking the benefits of avoiding sternotomy and CPB complications [2].

The aim of the present study was to compare the early outcomes following OPCAB-sternotomy with MIDCAB- thoracotomy.

MATERIALS AND METHODS

This is a multi-center prospective non-randomized comparative study conducted between October, 2017 and April, 2018 on 30 patients with single vessel (LAD) coronary disease indicated for surgery after applying inclusion and exclusion criteria and divided into two groups first group underwent OPCAB (n=15) and the second one underwent MIDCAB (n=15).

Inclusion criteria:

All patients undergoing coronary bypass surgery for LIMA/LAD through conventional sternotomy (OPCAB) and thoracotomy (MIDCAB).

Exclusion criteria:

Patients with EF less than 50%, re-do cardiac surgery, patients with unstable angina, complicated coronary anatomy, combined procedures and obese patients.

Study groups:

The selected patients are divided into two groups: **(see Figure. 1)**

Group (A): n=15 patients underwent (MIDCAB) through left anterolateral thoracotomy incision.

ISSN: 0975-3583,0976-2833 VOL09, ISSUE 03, 2018

Group (B): n=15 patients underwent (OPCAB) through conventional median sternotomy incision.

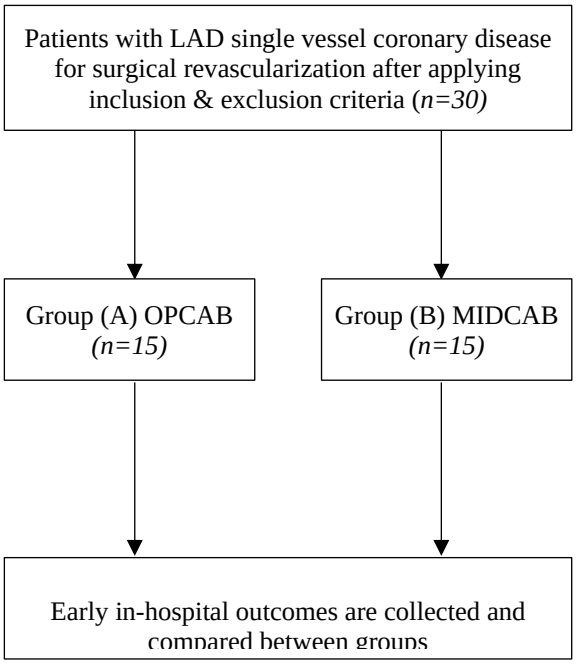

Figure 1: Flow chart for our study design

Preoperative assessment:

Risk factors in both groups were identified according to EURO SCORE and were compared with each other to make sure that both groups are comparable. These factors included age (>65 years), preoperative co-morbidities with Diabetes Mellitus, systemic hypertension, COPD, liver cell failure, renal impairment (determined by serum creatinine >1.2), impaired left ventricular function (determined by Ejection fraction ≤ 50) and re-do cardiac surgery as well as any neurological dysfunction. This is in addition to previous myocardial infarction and renal dialysis.

Operative technique:

Patients were taken to the operation room, placed under general anesthesia and intubated with a double-lumen tube (only in group B). Standard monitoring includes 5-lead electrocardiogram (ECG), arterial blood pressure, central venous pressure, nasopharyngeal temperature and peripheral oxygen saturation and then:

For group (A):

The patients were placed in a supine position with the operative site (left side) slightly elevated up to 30^{o}. After a small antero-lateral thoracotomy (about 6 cm in length) in the fourth inter-costal space and with single lung ventilation of the right side, the skeletonized left internal thoracic artery (LITA) was harvested under direct vision**.** Heparin (150 U/kg) was administered for systemic anticoagulation. Local coronary artery occlusion was achieved by widely placing a 4-0 prolene felt-pledgeted suture proximal to the site of anastomosis.

Distal anastomosis was performed on the beating heart by exposing and fixing the target anastomotic site with the MICS retractor **"ThoraTrak MICS Retractor System | Medtronic MICS," (Figure)** and the suction coronary stabilizer **(ACROBAT-i Stabilizer, Maquet)** mounted on it.

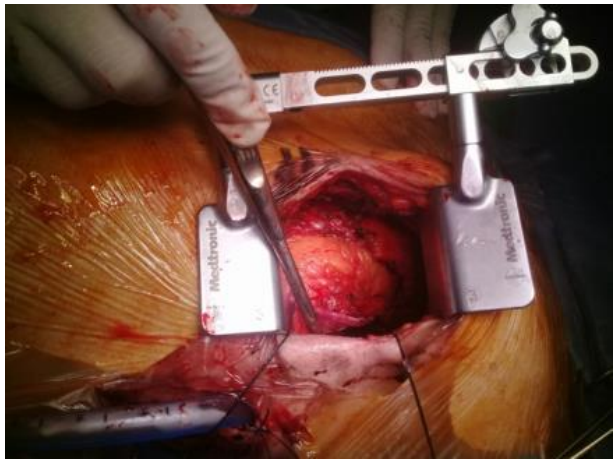

Figure (2): The MIDCAB incision and MICS retractor (from our work)

For group (B):

After median sternotomy and harvesting of skeletonized LIMA, Heparin (150 U/kg) was administered for systemic anticoagulation then LIMA to LAD anastomosis was achieved off-pump without CPB after temporary occluding and stabilizing LAD.

Intraoperative data that were collected including number of conversions to CPB in both groups and conversion to full sternotomy in MIDCAB group. Post-operative data were collected including duration of ICU stay and post-operative hospital stay, rate of wound infection in each group and need for re-opening for bleeding.

Statistical analysis:

Data were statistically described in terms of mean & standard deviation (±SD), median and range, or frequencies (number of cases) and percentages when appropriate. Comparison of the means of the 2 study groups was done using the independent t-test. Non parametric variables was compared using mann-whitney test when comparing the 2 groups. Chi- square test was used to analyze categorical variables. For all statistical

ISSN: 0975-3583,0976-2833 VOL09, ISSUE 03, 2018

tests done, the level of significance was fixed at the 5% level. A p-value > 0.05 indicated no significant difference. A probability value < 0.05 indicated significant difference. The smaller the p-value Obtained, the more significant was the difference. Data were collected arranged and coded using Microsoft Excel 2013 then data analysis was performed using computer program SPSS version 21 all in MS Windows 7.

RESULTS

There were 12 males (89%) and 3 females (20%) in each group. 6 patients (40%) had age above 65 years old in MIDCAB group. whereas 5 (33.33%) patients had the same age in the OPCAB group. Other co-morbidities were enlisted in **table 1**. All of these variables had statistically insignificantly difference between both groups.

Table 1: The preoperative variables and risk factors. Data are expressed as %

Prepoperative variables	MIDCAB (n=15)	Conventional OPCAB (n= 15)	P value
Gender			
• **Male**	12 (80.00%)	12 (80.00%)	1.000
• **Female**	3 (20.00%)	3 (20.00%)	1.000
Age>65years	6 (40.00%) (mean 73.6)	5 (33.33%) (mean 71.5)	1.000
Preoperative morbidities			
Diabetes Mellitus	6 (40.00%)	7 (46.67%)	1.000
Systemic Hypertension	12 (80.00%)	13 (86.67%)	1.000
Hyperlipidemia	11 (73.33%)	10 (66.67%)	1.000
COPD	2 (13.33%)	3 (20.00%)	1.000
Renal impairment (Cr.>1.2)	1 (6.67%)	0 (0.00%)	1.000
Previous MI	3 (20.00%)	2 (13.33%)	1.000

Early outcomes of OPCAB- sternotomy versus MIDCAB- thoracotomy:

- **Hours of mechanical ventilation**

On comparing the two groups we found that there is a significant difference of mean post-operative mechanical ventilation times between the two groups in MIDCAB group 4.93 hours compared with OPCAB group 8.13 hours with P value of 0.011.

ISSN: 0975-3583,0976-2833 VOL09, ISSUE 03, 2018

Table. 1: post operative hours of mechanical ventilation. Data is expressed as the total mean (±SD) and % of cases every 4 hours

Hours of mechanical ventilation	% MIDCAB (n=15)	% OPCAB (n=15)	P value
Mean hours	4.93 (±3.058)	8.13 (±3.357)	0.011*
0-3 hours	3 (20.00%)	1 (6.67%)	0.291
4-7 hours	10 (66.67%)	6 (40.00%)	0.150
8-11 hours	2 (13.33%)	4 (26.67%)	0.369
12-15 hours	0.00%	4 (26.67%)	0.035*

- **Hours of stay in the ICU**

Our results are not parametrically distributed hence we used median (IQR) it's found that there is no significant difference between the two study groups.

Table 2: Hours of stay in ICU. Data is expressed as median (IQR) for total ICU hours and % of clustered hours of ICU stay

	MIDCAB (n=15)	OPCAB (n=15)	P-value
median hours	23 (20-32)	24 (24-30)	0.345
5-14 hours	2 (13.33%)	0.00%	0.15
15-24 hours	6 (40.00%)	8 (53.33%)	0.472
25-34 hours	4 (26.67%)	5 (33.33%)	0.696
35-44 hours	1 (6.67%)	0.00%	0.317
45-54 hours	2 (13.33%)	0.00%	0.15
55-64 hours	-	-	
65-74 hours	0.00%	2 (13.33%)	0.15

- **Need for blood transfusion**

We found statistically significant difference concerning the need for blood transfusion intra and post-operative, with p-value was 0.008 when we applied the chi-squared test also. Data are summarized in the following table and chart.

ISSN: 0975-3583,0976-2833 VOL09, ISSUE 03, 2018

Table 3: The need for blood transfusion in the two groups. Data are expressed as %.

	Blood transfusion		
	No	**Yes**	**p-value**
MIDCAB	13 (86.66%)	2 (13.33%)	0.00*
OPCAB	6 (40.00%)	9 (60.00%)	0.28
p-value	0.01*	0.01*	

- **Re-operation for bleeding**

In our study, there is no recorded cases with post-operative bleeding requiring re-operation. So results were comparable concerning reoperation for bleeding.

- **Wound infection (sternotomy vs. thoracotomy)**

Results are comparable in the two groups concerning wound infection (p-value = 1.00).

Table 4: Wound infection rate in both groups. Data are expressed as %.

	Wound infection		
	No	**Yes**	**p-value**
MIDCAB	14 (93.33%)	1 (6.67%)	0.00*
OPCAB	13 (86.67%)	2 (13.33%)	0.00*
p-value	1.00	0.99	

- **Hospital stay (days)**

Hospital admission days as well as post-operative hospital stay were collected and data was found to be comparable in the two study groups.

Table 5: Total and post-operative hospital days of admission in both groups. Data are expressed as mean and ±SD.

	MIDCAB (n=15)	OPCAB (n=15)	P-value
Total hospital stay	7.67(±1.676)	8.40 (±2.131)	0.304
Post-operative hospital stay	5.87 (±1.407)	6.87 (±2.134)	0.141

- **Rate of conversion to sternotomy or CPB and in-hospital mortality**

In our sample, there is no mortality or conversions to CBP or sternotomy (for MIDCAB) recorded in the two groups.

ISSN: 0975-3583,0976-2833 VOL09, ISSUE 03, 2018

DISCUSSION

Vasilii Kolesov reported performing the first minimally invasive bypass grafting of the LAD with the LITA through a left anterior thoracotomy [3]. After OPCAB gained popularity, the MIDCAB approach followed suit and highlighted its minimal access strategy. **Ben-Gal et al.** [1] stated that The MIDCAB approach combines a good event-free survival following surgical revascularization of the LAD with the possibility of a shorter recovery. This may be because several programmes have expressed concerns about their early experiences in the period before the widespread use of more modern stabilizers [4]**.**

In a meta-analysis of 3,304 cases of MIDCAB surgery and 3,060 cases of off-pump surgery through a sternotomy [4]**.** In the 1990s, it was established that stabilizing devices considerably decreased the rate of stenosis. According to a more recent study by **Tekin & Arslan** [5] off-pump coronary surgery has increased in popularity due to improved stabilizing devices being made accessible and an increase in experience. For the MIDCAB operation, the same authors created customized, suction-based stabilizers (HT-KD, China). The stabilizer pods for target vessel stabilization were created to make deep, tiny incision manipulations easier. Additionally, the stabilizer could be attached to a minimally invasive retractor's arm. This should increase the appeal of the minimally invasive approach.

In the study of **ElTawil et al.** [6] which was performed on 62 MIDCAB patients and 730 OPCAB patients with single vessel LAD disease, they stated that with the widespread acceptance of MIDCAB as the preferred method of surgical revascularization for isolated coronary artery disease of the anterior wall, it's not wise to open the whole sternum of a patient especially who carries surgical risks to perform single vessel anastomosis (LIMA-to-LAD) and adding to his risks sternotomy complications. Of the 62 MIDCAB patients there were only two conversions (3.2%) to full sternotomy (ie. Success rate of 96.8% of this approach). This is nearly comparable to our results concerning conversions to sternotomy in our study (zero conversions of 15 MIDCABs).

No statistically significant difference in the groups was found in our study in terms of mortality in the early post-operative period. This is comparable with the results of **ElTawil et al.** [6] which was 1.4% in MIDCAB and 5% in OPCAB groups. Another study conducted by **Birla et al.** [7] on 74 MIDCABs and 78 OPCABs resulted in the no mortality in both groups this also supports our results.

Holzhey et al. [8] reported on 1,347 MIDCAB procedures 7 years of follow-up, demonstrating a freedom of major adverse events and angina of 89.5% after 5 years and 83.3% after 7 years.1 Their Kaplan–Meier analysis revealed a five-year survival rate of 91.9% (95% confidence interval [CI]: 90.1–93.8%) and a seven-year survival rate of 89.4% (95% CI: 86.7–92.1%).

In terms of operative time, postoperative morbidity, postoperative course and in-hospital mortality **ElTawil et al.** [6] demonstrated superior results for MIDCAB concerning the need for blood transfusion (5.6% of MIDCABs and 10% of OPCABs) and postoperative hospital stay (mean 11.2 days in MIDCABs and 13.5 days in OPCABs), which signifies an early return to work and regular life, which is consistent with the minimally invasive goals, and is consistent with the same strategy used in our series. Even other early outcome parameters mentioned were found to be comparable with that of OPCAB.

Regarding post-operative period of mechanical ventilation, our results are comparable to results of the study of **Rogers et al.** [9] that was performed on 91 MIDCABs with median = 4 hours VS 93 OPCABs with median = 5.35 hours for mechanical ventilation with p-value of 0.017.

Concerning post-operative ICU hours of stay, again our results are comparable to **Rogers et al.** [9] which has median = 22.4 hours for MIDCABs VS median = 23 hours for OPCABs with insignificant difference between the two study groups (p-value = 0.91) [9].

Regarding the total hospital and post-operative days of hospital stay, **Pande et al.** [10] recorded a mean of 7 day admission for MIDCAB [10], while **Poston et al.** [11] reported 4.80 mean days for MIDCAB post-operative stay VS mean days of 12.24 in OPCAB group with p-value of 0.001 reflecting statistically significant difference in reducing hospital stay.

It has been proven that reducing the duration of mechanical ventilation, ICU admission, hospital stay, or incidence of post-operative complications, which were all described above, is one of the most effective ways to lower overall hospital costs [11].

The number of wound infections in the MIDCAB group (three superficial, one requiring

ISSN: 0975-3583,0976-2833 VOL09, ISSUE 03, 2018

debridement) was concerning as this exceeds our current rate of wound infections after a midline sternotomy although the difference was not statistically significant.

A study of 1,400 MIDCABs at the Cleveland Clinic found that the total wound infection rate was 2.9% and the risk of deep infections was 1.9%, but that there was no appreciable difference between them and open heart surgery [12]. In another 165 MIDCAB cases, another study found that 15 patients (9.1%) had wound complications, including 2 (1.8%) incisional hernias, 4 (2.4%) superficial dehiscences, 3 (1.8%) wound infections, 3 (1.8%) chronic pain syndromes, and 2 (1.2%) seromas [13].

LIMITATIONS

The major limitation found during the study was the limited number of candidates with single vessel (LAD) coronary artery disease and indicated for CABG as well as these technically demanding surgical techniques requiring well-trained and expert surgeons.

CONCLUSION

MIDCAB is one of the various coronary surgical revascularization approaches which is safe and effective. It has the benefit of avoiding sternotomy and CPB. It is a gentle method of effectively revascularizing the most significant coronary vessel with the best possible graft, the LIMA to LAD through a small thoracotomy incision. With MIDCAB, superior early post-operative outcomes could be achieved over off-pump sternotomy (OPCAB) in terms of decreased hours of mechanical ventilation, decreased blood loss and subsequently fewer blood transfusions required, and fewer wound complications. It gives comparable results concerning hours of ICU stay, re-operation for bleeding, post-operative hospital stay and in-hospital mortality.

Financial support and sponsorship: Nil.

Conflict of interest: Nil.

REFERENCES

[1] Y. Ben-Gal et al., “Revascularization of left anterior descending artery with drug-eluting stents: comparison with minimally invasive direct coronary artery bypass surgery.,” Ann. Thorac. Surg., vol. 82, no. 6, pp. 2067–71, Dec. 2006, doi: 10.1016/j.athoracsur.2006.06.041.

[2] M. Ruel, D. Une, J. Bonatti, and J. T. McGinn, “Minimally invasive coronary artery bypass grafting: Is it time for the robot?,” Current Opinion in Cardiology, vol. 28, no. 6. pp. 639–645, 2013. doi: 10.1097/HCO.0b013e3283653fd1.

[3] V. Kolessov, “Mammary artery–coronary artery anastomosis as method of treatment for angina pectoris,” J Thorac Cardiovasc Surg, vol. 54, pp. 535–544, 1967.

[4] R. D. L. Stanbridge and L. K. Hadjinikolaou, “Technical adjuncts in beating heart surgery: Comparison of MIDCAB to off-pump sternotomy: A meta-analysis,” Eur. J. Cardio-thoracic Surg., vol. 16, no. SUPPL. 2, pp. 24–33, 1999, doi: 10.1016/S1010-7940(99)00265-1.

[5] A. İ. Tekin and Ü. Arslan, “Perioperative outcomes in minimally invasive direct coronary artery bypass versus off-pump coronary artery bypass with sternotomy,” Videosurgery Other Miniinvasive Tech., vol. 3, no. 3, pp. 285–290, Sep. 2015, doi: 10.5114/wiitm.2017.67679.

[6] T. ElTawil, A. N. Khallaf, and A. S. Fouad, “MIDCAB versus conventional CABG peri-operative results of single vessel anastomosis (LIMA–LAD) – retrospective comparative study of Egyptian 10-year experience,” Jun. 2011.

[7] R. Birla, P. Patel, G. Aresu, and G. Asimakopoulos, “Minimally invasive direct coronary artery bypass versus off-pump coronary surgery through sternotomy,” Ann. R. Coll. Surg. Engl., vol. 95, no. 7, pp. 481–485, Oct. 2013, doi: 10.1308/003588413X13629960047119.

[8] M. Holzhey, D et al., “Seven-Year Follow-up After Minimally Invasive Direct Coronary Artery Bypass: Experience With More Than 1300 Patients,” Ann. Thorac. Surg., vol. 83, no. 1, pp. 108–114, 2007, [Online]. Available: http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=emed8&NEWS=N&AN=2006614637

[9] C. A. Rogers et al., “An open randomized controlled trial of median sternotomy versus anterolateral left thoracotomy on morbidity and health care resource use in patients having off-pump coronary artery bypass surgery: The Sternotomy Versus Thoracotomy (STET) trial,” J. Thorac. Cardiovasc. Surg., vol. 146, no. 2, p. 306–316.e9, Dec. 2013, doi: 10.1016/j.jtcvs.2012.04.020.

[10] S. Pande et al., “Early and mid-term results of

ISSN: 0975-3583,0976-2833 VOL09, ISSUE 03, 2018

minimally invasive coronary artery bypass grafting.," Indian Heart J., vol. 66, no. 2, pp. 193–196, 2014, doi: 10.1016/j.ihj.2014.02.010.

[11] R. S. Poston et al., "Comparison of Economic and Patient Outcomes With Minimally Invasive Versus Traditional Off-Pump Coronary Artery Bypass Grafting Techniques," Trans. ... Meet. Am. Surg. Assoc., vol. 126, no. 4, pp. 281–289, Oct. 2008, doi: 10.1097/SLA.0b013e31818a15b5.

[12] S. M. Gordon, "New surgical techniques and surgical site infections," Emerg.Infect.Dis., vol. 7, no. 1080–6040 (Print), pp. 217–219, 2001, [Online]. Available: c:%5CKarsten%5CPDFs%5CInfektiologie-PDFs%5CInfekt-2001%5CGordon-New surgical techniques and surgical site infections.pdf

[13] P. C. Ng, A. N. Chua, M. S. Swanson, T. C. Koutlas, W. R. J. Chitwood, and J. R. Elbeery, "Anterior thoracotomy wound complications in minimally invasive direct coronary artery bypass.," Ann. Thorac. Surg., vol. 69, no. 5, pp. 1331–1338, 2000, [Online]. Available: http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=med4&NEWS=N&AN=10881801