

Subject Area: Cardiology

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Recommended Citation

Zaye, Ahmed; Mohamed, Mohamed M.; El Banna, Tamer; and Sadek, Yasser A. (2021) "Minimal invasive cardiac surgery coronary artery bypass grafting and hybrid revascularization: Early experience and potential indications," *Journal of Medicine in Scientific Research*: Vol. 4: Iss. 2, Article 8.
DOI: https://doi.org/10.4103/jmisr.jmisr_118_20

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Minimal invasive cardiac surgery coronary artery bypass grafting and hybrid revascularization: Early experience and potential indications

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Abstract

Background

There is increasing interest and patient demand for minimally invasive cardiac surgery.

Aim

We aimed to assess the safety and potential indications of minimally invasive coronary artery bypass grafting (CABG) and possibilities of such techniques and debating it will become the standard procedure.

Patients and methods

From February 2015 till February 2020, 83 cases underwent CABG via right submammary incision, and of them, 18 cases underwent hybrid technique.

Results

The procedure was successfully performed in all. Conversion rate to full sternotomy was 0%. Hospital mortality was seen in two (2.4%) patients. Re-exploration for bleeding was done in 0 (0%) patients. Superficial wound infection was seen in five (6%) patients, and deep wound infection was seen in one (1.2%) patient. Graft failure occurred in one patient who needed redo-operation after 6 months postoperatively, and one patient needed to lengthen the left internal mammary artery with composite vein graft.

Conclusions

Minimally invasive direct coronary artery bypass is a safe procedure for patients requiring left internal mammary artery to left anterior descending, as for hybrid CABG, clear indications are still to be revised.

Keywords: Coronary artery bypass grafting, cardiac surgery, minimal invasive cardiac surgery

INTRODUCTION

Regarding coronary artery bypass grafting (CABG), often interventional treatment with percutaneous coronary intervention (PCI) appears risky or impossible owing to complex lesions, close relationship with the main stem, or other coronary arteries or total occlusion of the target vessel [1]. In other patients, repeated interventions at the left anterior descending (LAD) remained without longstanding success. Besides its original intention for revascularization of the LAD, minimally invasive direct coronary artery bypass (MIDCAB) can be a useful part of hybrid procedures in patients with multivessel disease, where a major coronary surgery procedure

would not be well tolerated [2]. Although multivessel disease is a predictor of elevated mortality after CABG, the MIDCAB procedure can be performed as a standalone procedure with acceptable results in midterm morbidity and mortality, even though formally incomplete revascularization may remain [3]. Several studies and our own experience proved that in selected patients with main stem stenosis or multivessel disease,

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Submitted: 29-Nov-2020 Revised: 14-Dec-2020 Accepted: 06-Jan-2021 Published: 19-May-2021

How to cite this article: El Banna T, Mohamed MM, Zayed A, Sadek YA. Minimal invasive cardiac surgery coronary artery bypass grafting and hybrid revascularization: Early experience and potential indications. J Med Sci Res 2021;4:155-8.

Access this article online

Quick Response Code:



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DOI:
10.4103/jmsr.jmsr_118_20

MIDCAB can be safely performed. Complete revascularization can be achieved by a hybrid approach with accompanying PCI [4,5]. Interestingly, a significant part of the planned PCI has not been performed as the MIDCAB resulted in ongoing freedom from angina. This is particular true in multivessel disease where the LAD is the dominating vessel. As a rare indication, two children aged 12 and 13 years who had undergone a switch operation as babies for transposition of the greater arteries, and later, they developed significant stenoses of the LAD and were successfully treated by MIDCAB with an uneventful postoperative course and restored coronary circulation. Recently, MIDCAB can be performed in octogenarians with satisfying midterm results. Especially, these patients benefit from the marginal surgical trauma, less anesthesia, and short ventilation duration and intensive care unit stay [6]. A small subgroup of patients received MIDCAB who experienced severe bleeding complications owing to dual antiplatelet medication after PCI with drug-eluting stents.

Aim

We aimed to assess the safety and potential indications of minimally invasive CABG and possibilities of such techniques and debating it will become the standard procedure.

PATIENTS AND METHODS

From February 12, 2013 till February 12, 2020, 83 cases underwent CABG via right sub mammary incision, and of them, 18 cases underwent hybrid technique (Figs. 1 and 2).

Numbers	Male	Female	Mean age	Operation	Pathology
83	70	13	58	LIMA to LAD (53) Hybrid LIMA to LAD and PCI to right coronary artery (10) Hybrid LIMA to LAD and PCI to OM (8) LIMA to LAD and radial to OM and diagonal (8) LIMA to LAD and SVG to OM and diagonal (4)	IHD (13) Instent restenosis (40) CTO LAD (28) IHD with coronary ectasia (1) Left Main (1)

What is a minimal invasive cardiac surgery coronary artery bypass grafting procedure?

Minimal invasive cardiac surgery (MICS) CABG is a beating heart, multivessel CABG procedure in which the

anastomoses are performed under direct vision through an anterolateral mini thoracotomy. The internal mammary artery harvest can be performed under direct vision, with video assistance, or robotically. Additionally, to achieve complete revascularization, a hybrid approach, or pump-assisted beating heart approach, can be employed [7,8].

Potential benefits of MICS CABG are as follows [7]:

- (1) Improved satisfaction among patients and referring physicians.
- (2) Complete revascularization can be achieved through a small thoracotomy.
- (3) Surgeon differentiation for the patient.
- (4) Shorter hospital stay.
- (5) Faster return to daily living.
- (6) Better cosmetic.
- (7) No sternotomy, and no risk of a sternal wound infection.
- (8) For the hospital, competitive differentiation and marketing opportunities.

Direct vision MICS CABG has lower cost per procedure than robotic.

Potential indications [7,8]

- (1) Patient selection/inclusion criteria were as follows:
 - (a) Coronary anatomy: left main coronary artery disease with normal right coronary artery, triple vessel disease with medium to large posterior descending artery, complex proximal left sided lesions with or without large branch involvement, and previous unsuccessful stenting.
 - (b) Comorbidities: include patients who are at a high risk for problems with median sternotomy, long-term steroid use, severe chronic obstructive pulmonary disease, advanced age, need for other major operative procedure, and patients with arthritic or orthopedic problems.
 - (c) Patients who want the procedure are active and seek out less invasive surgery options.
 - (d) Morbid obesity.
 - (e) Ejection fraction less than 30%.
- (2) Contraindications were as follows:
 - (a) Emergency cases.
 - (b) Patients with hemodynamic instability.
- (i) Potential contraindications, such as previous CABG surgery.

Patient positioning [7,8]

- (1) Patients were positioned in a 15°–30° right lateral decubitus position (supine), with the left arm extended to allow harvest of the radial artery and room for assistant.
- (2) The patient was draped to allow access to the left groin and right thigh/leg for femoral cannulation (if needed) and saphenous vein harvest.

Anesthesia [7,8]

- (1) Single-lung ventilation is required in off-pump MICS CABG procedures.

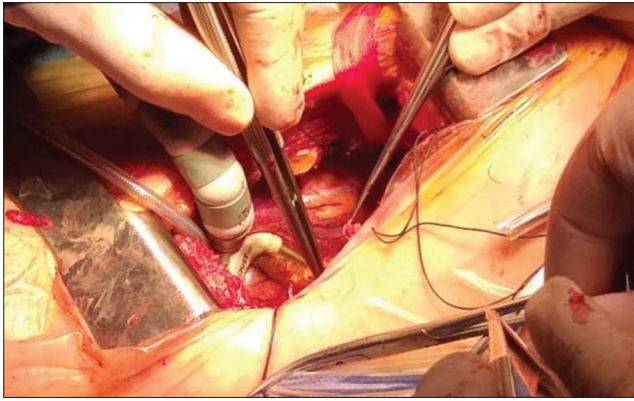


Figure 1: Minimal invasive CABG showing distal anastomosis to OM1. CABG, coronary artery bypass grafting; OM, obtuse marginal.

- (2) If pump assistance is used, both lungs can be deflated. However, note that deflating both lungs moves the heart away from the surgeon.
- (3) Place one external defibrillator pad high over the left scapula and one inferior to the right breast extending medially to the nipple line.

Operation steps

- (1) Male patients: operation was done over the fourth intercostal space.
- (2) Female patients: operation was done over inframammary region:
 - (a) The medial two-thirds of the window incision is medial to the anterior axillary line. Divide the intercostal muscles laterally to reduce the risk of rib fracture, then divide them medially to avoid damage to the left internal mammary artery (LIMA). While making the window incision, deflate the left lung. A soft tissue retractor can be placed in the window incision to maximize access.
- (3) The LIMA harvest is started at the third intercostal space using direct vision through the window incision.
- (4) Use an extended electrocautery instrument, endoscopic forceps, suction, endoscopic clip applier, and small clips for the harvest.
- (5) The harvest is completed up to the subclavian vein and down past the left fifth intercostal space.
- (6) Take care to identify and avoid the phrenic nerve.
- (7) During the LIMA harvest, flexing the table may facilitate access to the superior portion of the LIMA.
- (8) The pedicle of the LIMA is anchored with silk ties to maintain the proper orientation.

Hybrid note [7,8]

Anticoagulation protocol in patients undergoing simultaneous hybrid coronary revascularization: anticoagulation should be modified for hybrid coronary revascularization procedures to reduce the risk of perioperative bleeding and maximize platelet inhibition.

- (1) Give aspirin and a loading dose of 300 mg of clopidogrel 30 min before the CABG procedure.



Figure 2: Minimal invasive CABG skin wound 15 days after patient discharge. CABG, coronary artery bypass grafting.

- (2) Utilize routine heparinization during the MICS CABG part of the hybrid procedure.
- (3) Do not reverse the heparin and proceed to completion arteriography and then percutaneous revascularization.
- (4) Generally, do not reverse heparin upon completion of percutaneous revascularization.
- (5) If bleeding is a concern, a half dose of protamine can be considered.
- (6) Administer 300 mg of clopidogrel in ICU.

Give 75 mg clopidogrel daily postoperatively.

Pump-assisted beating heart bypass [7,8]

- (1) Left groin cannulation is performed.
- (2) A reduced prime pump with vacuum-assist setup is preferred.
- (3) Pump flow rate at 2-3 l/min should be sufficient to support circulation.

Aorta preparation for proximal anastomosis [7,8]

McGinn proximal technique

- (1) After placing the #1 or #2 MICS retractor blades in the window incision, angle the retractor superiorly and use the Rultract to pull the retractor cephalad to gain better access to the ascending aorta.
- (2) Remove thymus tissue over the aorta and pulmonary artery.
- (3) Open the pericardium anterior to the pulmonary outflow track and extend cephalad to the innominate (brachiocephalic) vein.
- (4) Place pericardial retraction stitches on the right side of the pericardium, and bring the stitches out through separate parasternal stab wounds; these stitches enable you to roll the aorta toward the window incision personally I use the same window incision not separate wounds.
- (5) Place the Octopus Tissue Stabilizer through the subxiphoid incision to depress the pulmonary artery and expose the ascending aorta.
- (6) Dissect around the aorta and place vaginal packing or a

nylon tape behind the aorta to pull the aorta closer to the window incision.

- (7) After the blood pressure drops to 90–100 systolic, the proximal anastomoses can be performed by. A side-biting clamp can be placed on the ascending aorta to facilitate up to three hand-sewn anastomoses.

Anastomoses (distal) [7,8]

- (1) Open the pericardium down to the diaphragm and then toward the right pleura.
- (2) Cases involving the LAD, diagonal, first obtuse marginal (OM), second OM, or ramus intermedius, require the heart positioner to be placed through the subxiphoid portal. However, if performing on heart lung machine, using progressive pericardial stitches will aid in coronary exposure.
- (3) Overall positioning guidelines were as follows:
 - (a) Diagonal and ramus intermedius: neutral position.
 - (b) LAD position: clockwise rotation.
 - (c) OM: counterclockwise rotation, while moving the heart medially.
 - (d) Posterior descending artery: rotate and move the heart toward the patient's left shoulder.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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