

Minimally Invasive Coronary Artery Bypass Graft Surgery: Personal Perspective

Mohd Zamrin Dimon

Faculty of Medicine, Universiti Teknologi MARA, Selangor, Malaysia

Conventionally, Coronary Artery Bypass Grafting (CABG) is done via performing a midline sternotomy, which will lead to full exposure of the heart and coronary artery vessels. However, this usually leads to a prolonged recovery period and other related complications. Minimally Invasive Cardiac Surgery for Coronary Artery Bypass Graft (MICS CABG) is a novel surgical technique, pioneered by McGinn, which aims to reduce the invasiveness of conventional CABG, while maintaining the practicality and durability of surgical coronary revascularization¹. Mastering the off-pump coronary artery bypass technique is important prior to embarking on this procedure, as this is where the most benefit lies for the patient. However, placing the patient on cardiopulmonary bypass or on pump technique during MICS CABG is not a contraindication.

The right instrumentation during the MICS CABG is one of the main factors for a successful outcome. Some investment is required especially for the rib spreader retractor, which functions to improve the surgeon's view during Left Internal Mammary Artery (LIMA) takedown from left side of the patient. Another important instrument is a special arm extension for stabilization of the retractor (Octopus® Nuvo Tissue Stabilizer) during proximal anastomosis of the coronary arteries. The use of minimally invasive and long micro surgical instrument is another tool that facilitate the success of the procedure.

The other factors to ensure success of the procedure is the selection criteria. MICS CABG should be limited to few suitable patients. The important selection criteria include non-dilated heart, apex of the

heart not extending beyond the 5th intercostal space (ICS) on chest radiograph, good ejection fraction (EF) of more than 45%, absence of diffuse disease especially of the left coronary artery, absence of aortic calcification and proximal stenosis of more than 70% at the Left Circumflex Artery (LCA) and Posterior Descending Artery (PDA). Preoperative investigations and management are similar to the conventional sternotomy approach.

Imaging techniques have evolved over time to improve surgical outcomes. Kikuchi et al² advocated all patients to have preoperative computed tomography (CT) scan of the thorax and heart to determine the accurate position of the apex and other critical information especially aortic calcification and any thoracic wall anomaly. However, my personal practice is to reserve this to patients with advanced age of more than 70 years old, with suspicious peripheral artery disease or features of aortic calcification on chest radiograph. Confirmation of the conditions above would serve as contraindications for MISC CABG in these patients. Another important aspect of preoperative evaluation is the suitability of femoral-femoral cannulation for cardiopulmonary bypass in the event for a need to convert the off-pump to the on-pump procedure.

Technically, in MICS CABG, the coronaries will be approach through a small opening at either the 4th or 5th ICS, depending on the location of the apex of the heart. One of the techniques described by Massimo Lemma et al³, is through the 4th ICS, and this is one of the selection criteria for the procedure. The patient is in a supine position and tilted towards the right, with the



left chest slanted at 35-40 degrees angle, propped up by an inflated blood pressure cuff or folded linen (Figure 1). The right femoral area is exposed for the access of bypass cannulation, if necessary. Once the incision is made, the pericardial fat is removed extensively, exposing the right pleura, diaphragm and supra aortic vein superiorly. This has to be performed with skill and accuracy to detail, requiring time and precision.



Figure 1 Position of patient and plan incision wound during MICS CABG

As the surgery is performed from the left side of the patient, significant adjustment and orientation need to be mastered by the surgeon and practiced pre-operatively, i.e. in wet or dry laboratories including the use of cadaver, porcine or simulator. This is particularly important for the Left Internal Mammary Artery (LIMA) takedown, proximal aortic anastomosis, orientation of the graft layout and the distal anastomosis from the different surgeon's angle and position. New surgeons are required to observe adequate number of MISC CABG and subsequently find a good mentor familiar with the procedure prior to embarking on an MISC CABG

program. My personal technical challenge is on the proximal aortic anastomosis and we recently restricted this procedure for the very tight coronary stenosis of more than 70%. We resorted to non-aortic touch technique popularized by Kim KB et al⁴, by grafting vein to LIMA through Y-anastomosis.

The sequence of the anastomoses are as follows: Y-anastomosis of the vein to LIMA, followed by LIMA to Left Anterior Descending (LAD) artery then sequential vein to LCA territories followed by PDA vessels. The Octopus® Nuvo Tissue Stabilizer stabilizes the heart for the purpose of distal anastomosis (Figure 2). A few deep pericardial sutures allow the assistant surgeon to elevate the heart and improve coronary exposure and position of the heart during the anastomosis. On a few occasions the use of apical positioner ® will facilitate the vision of the surgeon during surgery. This is the reason for the adequate prerequisite of off-pump experience prior to embarking on MICS CABG, particularly significant as the whole procedure is done through a small surgical opening.



Figure 2 Direct coronary anastomosis through small wound at left intercostal space

Anaesthesia and other intra-operative management is similar to the conventional off-pump coronary bypass. However, it is easier to maneuver the position of the heart from the left side of the patient, which subsequently results in easier manipulation the haemodynamic parameters during the off-pump period. Furthermore, the coronaries are immediately below the incision of the surgical wound that facilitates the coronary anastomosis.

The beauty of this procedure is the speedy post-operative recovery period. Most of the patients are extubated a few hours after the operation, experience significantly short stay in the intensive care unit (ICU) and overall hospital admission. However, a challenging postoperative complication is intense thoracic pain. This is mainly due to the broken intercostal cartilage, which occurred during retraction of the intercostal bones and easily identified intraoperatively. Post-operatively, most patients are adequately controlled with percutaneous continuous anesthesia (PCA) with morphine or fentanyl and are comfortable upon discharge.

In conclusion, based on personal experience and convincing results of this procedure, I believe that it is promising despite a steep learning curve. However, appropriate patient selection is pivotal to ensure its success. It can be done off-pump or with the assistance of cardiopulmonary bypass through femoral-femoral cannulation. The major benefits include shorter ICU and hospital stay, minimal post-operative wound

complications and ability to return to daily activities quickly. Further studies and long-term outcomes comparing MICS CABG to the conventional CABG are needed. The off-pump technique is an important surgical technique to master prior to the start of the program, which will benefit future surgeons. Avoiding sternotomy is the future of CABG surgery.

REFERENCES

1. McGinn Jr JT, Usman S, Lapierre H, Pothula VR, Mesana TG, Ruel M. Minimally invasive coronary artery bypass grafting: dual-center experience in 450 consecutive patients. *Circulation*. 2009; 120(11_suppl_1): S78-84.
2. Kikuchi K, Une D, Endo Y, Matsuyama T, Fukada Y, Kurata A. Minimally invasive coronary artery bypass grafting using bilateral in situ internal thoracic arteries. *The Annals of Thoracic Surgery*. 2015; 100(3): 1082-4.
3. Lemma M, Atanasiou T, Contino M. Minimally invasive cardiac surgery-coronary artery bypass graft. *Multimed Man Cardiothorac Surg*. 2013; mmt007. doi: 10.1093/mmcts/mmt007. PMID: 24413006.
4. Kim KB, Choi JW, Oh SJ, Hwang HY, Kim JS, Choi JS, Lim C. Twenty-year experience with off-pump coronary artery bypass grafting and early postoperative angiography. *The Annals of thoracic surgery*. 2020; 109(4): 1112-9.