MICS CABG TECHNIQUE OVERVIEW

Minimally Invasive Cardiac Surgery Coronary Artery Bypass Graft Procedure
Medtronic is committed to the development of advanced technology to support MICS CABG with its multiple proven benefits for patients, surgeons, and hospitals.

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MICS CABG Instruments and Disposables

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This technique overview is based on the surgical techniques of:

Dr. Steven Hoff, Orlando, FL, U.S.
Dr. Joseph McGinn, Charlotte, NC, U.S.
Dr. Prem Rabindra, LaCrosse, WI, U.S.
Dr. Mahesh Ramchandani, Houston, TX, U.S.
Dr. Marc Ruel, Ottawa, Canada
What is a MICS CABG Procedure?

MICS CABG is a beating heart, multi-vessel CABG procedure in which the anastomoses are performed under direct vision through an anterolateral mini-thoracotomy. The internal mammary artery (IMA) harvest can be performed under direct vision, with video assistance, or robotically. Additionally, in order to achieve complete revascularization, a hybrid approach, or pump-assisted beating heart approach, can be employed.

Potential Benefits of MICS CABG:
- Improved satisfaction among patients
- Complete revascularization can be achieved through a small thoracotomy
- Surgeon differentiation
- Proven mid-term LIMA/LAD patency
- Comparable clinical outcomes to OPCAB

For the Patient:
- Shorter hospital stay
- Faster return to daily living
- Better cosmesis
- No sternotomy, no risk of a sternal wound infection

For the Hospital:
- Competitive differentiation
- Marketing opportunities
- Direct vision MICS CABG (Robots are not required for this procedure)

<table>
<thead>
<tr>
<th></th>
<th>MICS CABG</th>
<th>MIDCAB</th>
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<tbody>
<tr>
<td>Complete IMA Harvest²</td>
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</tr>
<tr>
<td>Access to Ascending Aorta for Proximal Attachment²</td>
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<tr>
<td>Multi-Vessel Revascularization²</td>
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<td>Lower Risk of Rib or Costochondral Injury²</td>
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<tr>
<td>Ability to Bypass Inferior &amp; Lateral Coronaries, ie, PDA, PL²</td>
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Product Risk Statement

Not all patients are candidates for beating heart procedures. Some patients require cardiopulmonary support during surgery.
1. **Patient Selection/Inclusion Criteria**
   - **Coronary Anatomy**
     - Left main coronary artery disease (CAD) with normal right coronary artery (RCA)
     - Triple vessel disease with medium to large posterior descending artery (PDA)
     - Complex proximal left sided lesions with or without large branch involvement
     - Previous unsuccessful stenting
   - **Comorbidities:** Includes patients who are at a high risk for problems with median sternotomy
     - Long-term steroid use
     - Severe chronic obstructive pulmonary disease (COPD)
     - Advanced age
     - Need for other major operative procedure
     - Severe deconditioning
     - Patients with arthritic or orthopedic problems
     - Patients who want the procedure, are active, and seek out less invasive surgery options

2. **Contraindications**
   - **Contraindications**
     - Emergency cases
     - Patients with hemodynamic instability
   - **Potential Contraindications:**
     - Previous CABG surgery
     - Morbid obesity
     - Patients with postero-lateral branch disease
     - Ejection Fraction < 20%
     - Patients with peripheral vascular disease (PVD)
     - Moderate to severe aortic insufficiency

3. **Patient Positioning**
   - Position patients in a 15° to 30° right lateral decubitus position (supine), with the right arm extended to allow harvest of the radial artery, if applicable.
   - Place a roll longitudinally between the left scapula and spine.
   - Drape the patient to allow access to the left groin and right thigh/leg for femoral cannulation (if needed) and saphenous vein harvest, respectively.
   - Slightly drape the left elbow from the patient’s side to expose the patient’s left lateral thoracic wall.
   - The patient’s iliac crest (top of the hip bone) should be near the flex break in the table, and the patient is placed in a slightly reversed Trendelenburg position.

4. **Anesthesia**
   - Single-lung ventilation is required in off-pump MICS CABG procedures.
   - If pump assistance is used, both lungs can be deflated. However, note that deflating both lungs moves the heart away from the surgeon.
   - Perform intubation with either a double or single lumen oral endotracheal tube and a left bronchial blocker to deflate the left lung. The single lumen oral endotracheal tube and bronchial blocker are placed under fiber optic guidance.

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**TIP**

If CPB is necessary and the surgeon is considering using the right subclavian artery for arterial cannulation, the arterial line should be placed in the left radial artery or the femoral artery.
4. **Anesthesia (continued)**

- Place one external defibrillator pad high over the left scapula and one inferior to the right breast extending medially to the nipple line.
- Vasopressors, such as phenylephrine and norepinephrine, and vasodilators, such as nicardipine and nitroglycerine, should be available to control blood pressure during proximal anastomosis.
- A standard IV drip setup that includes: nitroglycerine, phenylephrine, norepineprine, vasopressin, insulin, and nicardipine is recommended.
- An airway cart with a fiber optic bronchoscope is recommended for placement of a bronchial blocker.
- Lines are routine and include an arterial line and PA catheter. If peripheral access is limited, at least a 16-gauge IV should be placed. A triple lumen catheter is placed along with the PAC – “double stick”.
- After intubation, place a bronchial blocker into the left mainstem bronchus with fiber optic guidance. Place the proximal end of the balloon approximately 1-cm to 2-cm below the carina.

**TIP**

Look beyond the blocker to be sure it is not pushing on a secondary carina. This decreases the chance of trauma to the bronchial mucosa that may result in excessive bleeding after heparinization.

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5. **Thoracotomy/Incisions**

*The “window incision” refers to the skin incision and the intercostal incision together.*

- The window incision is a 5-cm to 7-cm intercostal incision in the 4th ICS.
  - Male patients: Over the 4th intercostal space (ICS)
  - Female patients: Inframammary
  - In some patients, this could be the 5th ICS, depending on the location of the apex of the heart.
  - 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.
6. Access Portals

- Two access incisions are recommended in multi-vessel MICS CABG procedures
  - An access incision at the 6th ICS
  - An access incision below the xiphoid process

The incisions should be just large enough to allow the shaft of the Octopus™ Nuvo tissue stabilizer or Starfish™ NS heart positioner to enter the space. No trocars are needed for the portals.

7. Left Internal Mammary Artery (LIMA) Harvesting

- Place a large Kelly clamp with a sponge in the 6th ICS to assist with harvesting the LIMA. Use the sponge to push away tissue for better IMA visualization.
- Insert the MICS retractor system into the 4th ICS; then hook the MICS retractor system to the Rultract™ to facilitate the LIMA harvest.
- In order to prevent damage to the LIMA, make sure the superior portion of the retractor is placed and maintained in the lateral aspect of the incision.
- Care should be taken not to fracture a rib.
  - The MICS retractor system should be cranked slowly, which allows tissue and bone to acclimate to the change in position to minimize the potential for rib fracture and pain.
- The LIMA harvest is started at the 3rd ICS using direct vision through the window incision.
- Use an extended electrocautery instrument, endoscopic forceps, suction, endoscopic clip applier, and small clips for the harvest.
- The harvest is completed up to the subclavian vein and down past the left 5th ICS.
- Take care to identify and avoid the phrenic nerve.
- During the LIMA harvest, flexing the table may facilitate access to the superior portion of the LIMA.
- The pedicle of the LIMA is anchored with silk ties to maintain the proper orientation.
- Intravenous heparin is given prior to LIMA division.

TIP Hybrid Note

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.

- If the patient is not currently taking antiplatelets, give aspirin and a loading dose of 300-mg of clopidogrel 30 minutes prior to the CABG procedure.
- Utilize routine heparinization during the MICS CABG part of the hybrid procedure.
- Unless bleeding is a concern, do not reverse the heparin and proceed to completion arteriography and then percutaneous revascularization.
- Generally, do NOT reverse protamine upon completion of percutaneous revascularization.
- If bleeding is a concern, a half-reversal dose of protamine may be administered at the clinician's discretion.
- Administer 300-mg of clopidogrel in ICU.
- Give 75-mg clopidogrel daily post-op.

†Anticoagulation protocol utilized by Dr. Steven Hoff

Figure 2. LIMA harvest

TIP

An Army Navy placed at the inferior portion of the window incision retracted by an assistant or attached to the Rultract™ may increase visibility when harvesting the distal IMA.
8. Pump-Assisted Beating Heart Bypass

- Left groin cannulation is performed with the following cannulae: Bio-Medicus™ NextGen arterial cannula; Bio-Medicus™ NextGen venous cannula.
- A reduced prime pump with vacuum-assist setup is preferred.
- Pump flow rate at 2-3 liters/minute should be sufficient to support circulation.
- A Perclose™ A-T (auto-tie) Suture-Mediated Closure (SMC) device may be used to close femoral artery cannulation site.

Figure 3. Pump-assist approach

9. Aorta Preparation for Proximal Anastomosis

- 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 (Figure 4).
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.
5. Place the Octopus™ Nuvo 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 1½-inch penrose drain behind the aorta to pull the aorta closer to the window incision.
7. After the blood pressure drops to 90 to 100 systolic, the proximal anastamoses can be performed with a proximal connector or hand-sewn anastomoses.
   - A side-biting clamp can be placed on the ascending aorta to facilitate up to 3 hand-sewn anastomoses.

Figure 4. Aorta preparation

**TIP** Considerations for Pump Assistance

Preparing the groin for cannulation at the beginning of the procedure is recommended for the following circumstances:
- Cardiomyopathies
- Difficult inferior and lateral vessels, i.e., PL and OM2
- Aortic Insufficiency
- Surgeons in the early phase of MICS experience
- If positioning of the heart causes hypotension that is not responsive to position changes and vasoactive medications, the surgeon can try to reposition the heart to allow for better hemodynamics. If all of these maneuvers fail, it may be necessary to perform the distal anastomoses with pump-assistance.
- Consider axillary arterial cannulation when femoral cannulation is a poor option, i.e., iliac disease (PVD).
1. Place the MICS retractor with #1 or #2 blades in the window incision.
2. To expose the ascending aorta, the pericardium is opened anteriorly and retracted inferolaterally toward the thoracotomy by using several traction sutures.
3. Position the MICS retractor in a cephalomedial direction with the Rultract™ skyhook.
4. A 6-mm incision is made in the left 7th ICS to allow introduction of an Octopus™ Nuvo tissue stabilizer.
5. Position the Octopus Nuvo tissue stabilizer over the pulmonary artery trunk or right ventricular outflow tract, to gently depress it in a left postero-inferior direction.
6. Pack an open gauze against the right lateral aspect of the aorta, anterior to the SVC.
7. Place a Kay-Lambert side-biting clamp on the ascending aorta, and up to 3 hand-sewn proximal anastomoses can be performed by using 6-0 polypropylene sutures, under direct vision.

10. Anastomoses (Distal)
   - Open the pericardium down to the diaphragm and then toward the right pleura.
   - Heart positioning is accomplished using the Starfish™ NS heart positioner placed through the subxiphoid portal.
   - Cases involving the left anterior descending artery (LAD), Diagonal, 1st obtuse marginal (OM), 2nd OM, or ramus intermedius, require the Starfish NS heart positioner to be placed through the subxiphoid portal.

**TIP** Anesthesia Considerations for the McGinn Proximal Technique
   - Bring the systolic blood pressure down to 90 to 100-mmHg. This makes the aorta more supple, making it easier to pass the tape around the vessel without damaging it.
   - Occasionally the surgeon will ask to check the superior vena cava (SVC) with the TEE during placement of the umbilical tape around the aorta. This is to be sure the SVC is not occluded by the strap.
   - It is extremely important to keep the SBP low to keep the side-biting clamp from slipping off, and to prevent damage to the aorta i.e., aortic dissection.
   - Keep control of the SBP by giving more anesthetics and by using boluses of nicardipine along with an infusion, if necessary.

**TIP** Anesthesia Considerations for the Ruel Proximal Technique
   - Minimalize distention of the heart by decreased fluid administration; this keeps the patient dry and assists avoiding overfilling with CVP kept below 14-mmHg. A concern with this technique is patients with decreased renal function.
   - Single-lung ventilation with left lung down (bronchial blocker or double-lumen endotracheal tube) during the proximal anastomosis
   - During ascending aorta isolation, the following maneuvers are taken:
     - Increased tidal volume
     - Decreased inspiratory/expiratory ratio
     - Increased Peep

   Be aware that these maneuvers can result in decreased $O_2$ saturation and shunting.

   Note: Check RV pressure when completing proximal anastomosis to ensure the RCA has not been clamped.
10. Anastomoses (Distal) (continued)

- Divide the rectus fascia just prior to the Starfish™ NS heart positioner insertion.
- A red rubber catheter is placed through the subxiphoid portal and pulled out through the window.
- Attach the red rubber catheter to the Starfish NS heart positioner shaft.
- Pull the tip of the shaft through the window and attach the Starfish NS heart positioner head onto the shaft.
- Next, attach the head of the Starfish NS heart positioner to the obtuse marginal side of the apex of the heart, and apply suction.
- Overall Positioning Guidelines
  - Diagonal and ramus intermedius: Neutral position of the Starfish NS heart positioner
  - LAD Position: Clockwise rotation of the Starfish NS heart positioner
  - OM: Counterclockwise rotation of the Starfish NS heart positioner, while moving the heart medially
  - PDA: Rotate and move the heart toward the patient’s left shoulder with the Starfish NS heart positioner

**TIP** Optimal Stabilization
In order to keep the heart midline for optimal stabilization, during a left circumflex anastomosis, use bilateral, low-tidal ventilation. Alternatively, use lap pads to pack the left lung and achieve the same result.

**TIP** Anesthesia Considerations for Distal Anastomosis
Prior to the distal anastomosis, patients can be given a loading dose of Milrinone (50-μg/kg) over approximately 20 minutes; even if the cardiac index is adequate. This technique has the effect of decreasing the cardiac size, allowing the smaller heart to be more easily positioned in the confined space of the closed chest. It also has the effect of shifting the heart's Frank-Starling curve upward, allowing for better hemodynamics in the face of decreased preload secondary to the positioning of the heart for distal anastomoses.

**TIP** Re-inflate the left lung under direct vision to prevent avulsion of the LIMA-LAD with the expanding lung tissue.

11. Chest Tube and Drains

- A chest drain can be placed through each of the portals that have already been created for the Starfish NS heart positioner and Octopus Nuvo tissue stabilizer.
12. Post-Op Pain Relief With a Pain Pump

- After protamine administration, 2 soaker catheters can be placed:
  - One subpleural
  - One subcutaneous
- Catheters remain in place per pain pump instructions.
- Administer Marcaine™* in a .25% dosage level.

13. Interdisciplinary Post-Op Guide

- Extubation is usually achieved 2 to 6 hours after surgery.
- Pain management: Pain pump
- Start patients on daily enteric-coated 325-mg aspirin on the day of the operation.
- Resume clopidogrel, 75-mg, in patients with coronary stents.
- Unless contraindicated, resume antihypertensive medications on the first post-operative day.
- Patients undergoing MICS CABG with a radial artery graft are prescribed dihydropyridine calcium channel blockers for 6 months.
- Post-op Day 1
  - Patient ambulating and all drains out
  - Evaluate discharge needs and prepare for discharge
  - Transfer to telemetry
  - Bedside exercise, ambulate with assistance
- Post-op Day 2 and Beyond
  - Ambulate with minimal or no assistance
  - Evaluate for discharge
  - Ad-lib activities
  - Visiting nurse referral
- At Home
  - No physical restrictions
  - Remove pain pump as instructed

These are recommendations based on optimal patient recovery.

TIP
All patients are treated with medical therapy as with conventional CABG via sternotomy, including aspirin, beta-blockers, ace inhibitors, and statin therapy.
# MICS CABG Instruments and Disposables

1. ThoraTrak™ MICS Retractor System  &  12. 14-inch Chest Tube Passer w/ Lock
2. Octopus™ Nuvo Tissue Stabilizer  &  13. Tangential Occlusion Clamp - 34-mm w/ DeBakey Atraumatic Jaws, Slightly Curved
3. Starfish™ NS Heart Positioner  &  14. DeBakey Aorta Clamp - Full Curved DeBakey Atraumatic Jaws, Curved Shanks, Stainless Steel, 10.5-inch
5. Rultract™ with Skyhook Retractor  &  16. 16 Fr and 18 Fr Red Rubber Catheter
6. Optional Rotating Extender Bar with Cross Square (Rultract™)  &  17. Extended Bovie Blade
11. Minimally Invasive DeBakey Forceps

Notes: Medtronic products are listed in **bold**. The authors of this technique guide typically use the instruments listed here, in addition to essential instruments necessary to perform surgery.

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**Medtronic**

710 Medtronic Parkway
Minneapolis, MN 55432-5604
USA
Tel: (763) 514-4000
Fax: (763) 514-4879
Toll-free: (800) 328-2518

**LifeLine**
CardioVascular Technical Support
Tel: (877) 526-7890
Tel: (763) 526-7890
Fax: (763) 526-7888
rs.cstechsupport@medtronic.com

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