MICS CABG

TECHNIQUE OVERVIEW:
Minimally Invasive CABG (MICS CABG) Procedure
Medtronic is committed to the development of advanced technology to support MICS CABG with its multiple proven benefits for patients, surgeons, and hospitals.

Caution: Federal law (USA) restricts this device to sale by or on the order of a physician. For a listing of indications, contraindications, precautions and warnings, please refer to the Instructions for Use.
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This technique overview is based on a compilation of the surgical techniques of:  
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Dr. Marc Ruel, University of Ottawa Heart Institute; Ottawa, Canada  
Dr. Mahesh Ramchandani, Methodist Hospital; Houston, Texas  
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Anesthesia techniques:  
Dr. Scott Sadel, Staten Island University Hospital; Staten Island, New York  
Dr. Ben Sohmer, University of Ottawa Heart Institute; 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 and referring physicians\(^1\)
» Complete revascularization can be achieved through a small thoracotomy
» Surgeon differentiation

For the Patient:
» Shorter hospital stay\(^2\)
» Faster return to daily living\(^2\)
» Better cosmesis
» No sternotomy, no risk of a sternal wound infection

For the Hospital:
» Competitive differentiation
» Marketing opportunities
» Direct vision MICS CABG: Lower cost per procedure than robotic cases

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<tr>
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<th>MICS CABG</th>
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<td>Ability to Bypass Inferior &amp; Lateral Coronaries, i.e., PDA, PL</td>
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PRODUCT RISK STATEMENT
Not all patients are candidates for beating heart procedures. Some patients require cardiopulmonary support during surgery.
Key Procedural Steps (with general recommendations)

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.

**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.

4. Anesthesia (continued)

» Single-Lung Ventilation:
  - Deliver approximately 10 cc/kg of tidal volume prior to and during single-lung ventilation. The tidal volume may need to be decreased with single-lung ventilation because a large tidal volume causes shifting of the mediastinum, which may cause the MICS retractor to slip.
  - Keep the O₂ saturation greater than 90%. If the saturation begins to decrease:
    - Add CPAP of 5 cm H₂O to the deflated lung. This can be performed through the bronchial blocker by inserting a 7 ETT connector into the barrel of a 3 cc syringe. Insert the syringe tip into the lumen of the bronchial blocker. Attach the 7 ETT connector to a CPAP circuit.
    - CPAP can be increased, but if it is increased too much it will cause the lung to inflate and obscure the surgeon’s view.

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

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.

Fig. 1 MICS CABG incisions
6. Access Portals

» Two access incisions are recommend in multi-vessel MICS CABG procedures
- An access incision at the 6th intercostal space
- An access incision below the xyphoid 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 intercostal space 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 intercostal space incision; 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 intercostal space 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 intercostal space.

» 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

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.
- 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.
- 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 dose of protamine can be considered.
- Administer 300 mg of clopidogrel in ICU.
- Give 75 mg clopidogrel daily post-op.

*Anticoagulation protocol utilized at Vanderbilt Heart Institute

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® arterial cannula; Bio-medicus® 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

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 (Fig. 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 subxyphoid 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 90-100 systolic, the proximal anastomoses can be performed by using u-Clip® anastomotic devices, 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.

TIP Considerations for pump assistance

Preparation of 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).
9. Aorta Preparation for Proximal Anastomosis (continued)

» Ruel Proximal Technique
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 intercostal space to allow introduction of an Octopus® Nuvo tissue stabilizer.
5. Position the Octopus® Nuvo 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 superior vena cava.
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 subxyphoid 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 subxyphoid portal.
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 subxyphoid 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**

For lateral coronary vessels, place the patient in the Trendelenberg position and rotate the patient away from the surgeon to better expose the left lateral wall of the heart.

- Once the heart is positioned and visible through the window, place the Octopus® Nuvo Tissue Stabilizer through the 6th intercostal space incision and stabilize the vessel using suction.
- Once the artery is stabilized, the artery is occluded and bypass is created using routine forceps, coronary scissors, and coronary needle holders.

**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.

**Helpful hint**

- All distal anastomoses can be created using the U-Clip® Anastomotic Device or standard suturing techniques.

**TIP**

Anesthesia Considerations for Distal Anastomosis

Staten Island technique: Prior to the distal anastomosis, patients can be given a loading dose of Milrinone (50μg/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 subpleura
     - 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 2-6 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.

TIP

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

These are recommendations based on optimal patient recovery.

How do I begin?
Medtronic offers peer-to-peer education for surgeons interested in learning how to do a MICS CABG procedure. Please contact your CardioVascular sales representative for more information.
## MICS CABG Instruments and Disposables

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<tr>
<td>1. ThoraTrak® MICS Retractor System</td>
<td>12. Minimally Invasive Debakey Forceps</td>
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<tr>
<td>2. Octopus® Nuvo Stabilizer</td>
<td>13. 14&quot; Chest Tube Passer w/ Lock</td>
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<tr>
<td>3. Starfish® NS Positioner</td>
<td>14. Tangential Occlusion Clamp - 34 mm w/ Debakey Atraumatic Jaws, Slightly Curved</td>
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<tr>
<td>4. U-CLIP® Anastomotic Device</td>
<td>15. Debakey Aorta Clamp - Full Curved Debakey Atraumatic Jaws, Curved Shanks, Stainless Steel, 10.5 inch</td>
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<tr>
<td>5. Mounting System for Octopus® Nuvo and Starfish® NS</td>
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<tr>
<td>7. Optional Rotating Extender Bar with Cross Square (Rultract®)</td>
<td>17. 16 and 18 Fr Red Rubber Catheter</td>
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<td>22. Standard Off-Pump CABG tray</td>
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* Medtronic products in **bold.**

** The instruments/disposables listed are in addition to essential instruments necessary to perform surgery. Refer to MICS CABG instrumentation list for complete details.

*** Cannula sizing should be determined by the surgeon.

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**References:**


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