Masters of Cardiothoracic Surgery

# Robotic totally endoscopic beating-heart unroofing of a left anterior descending artery myocardial bridge

**Sarah Nisivaco, Hiroto Kitahara, Husam H. Balkhy**

Department of Cardiothoracic Surgery, University of Chicago Medicine, Chicago, IL, USA

*Correspondence to:* Husam H. Balkhy, MD. Department Cardiothoracic Surgery, University of Chicago Medicine, 5841 S. Maryland Ave. E-500, Chicago, IL 60637, USA. Email: hbalkhy@bsd.uchicago.edu.

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## Clinical vignette

A 46-year-old male presented to an outside hospital (OSH) with severe, recurrent chest pain (CP). His medical history included hyperlipidemia, asthma, and sleep apnea (no surgical history, non-smoker). He was diagnosed with a non-ST-elevation myocardial infarction (NSTEMI), with angiography revealing a myocardial bridge (MB) of his proximal/mid left anterior descending artery (LAD). Medical treatment was initiated, but despite maximum medical therapy his CP remained severe. Further testing confirmed a diagnosis of MB, including angiography with intravascular ultrasound and provocative testing (confirming hemodynamic significance of his LAD-MB). He had a normal ejection fraction (60–65%) and no valvular disease. He was recommended surgical unroofing via sternotomy, but came to our institution seeking a sternal-sparing option. All imaging/workup was reviewed, and he was deemed suitable for robotic-assisted unroofing of his LAD-MB.

## Surgical techniques

We perform MB unroofing off-pump using the DaVinci Si robot with the EndoWrist™ stabilizer (Intuitive, Sunnyvale, CA, USA). A left bronchial blocker is used for left lung isolation. Patients are placed supine with a left shoulder bump. Ports are placed in the left 2$^{nd}$, 4$^{th}$, and 6$^{th}$ intercostal spaces (ICS)—identical to our totally-endoscopic coronary bypass (TECAB) ports (1). A 12-mm subcostal port is placed for the 4$^{th}$ robotic arm and the EndoWrist Stabilizer™ and a 2$^{nd}$ anterior ICS 8 mm AirSeal working port (SurgiQuest, Orange, CT, USA). A posterior pericardiotomy is made (helping to minimize the risk of pericarditis, in addition to a prophylactic steroid taper), then the anterior pericardium is opened along the length of the LAD. The LAD is identified where it is an epicardial vessel (usually towards the distal third) and the stabilizer is positioned. The LAD is followed proximally, carefully dividing the myocardial bridging fibers using bipolar electrocautery (used initially to avoid ventricular arrhythmias—low settings used, 10 W, and increased as needed to control bleeding from epicardial veins). After the bridging muscle is rendered electrically inactive, we switch to monopolar electrocautery or Potts scissors if needed to divide the muscle. This continues proximally along the LAD until the anterior arterial wall is fully exposed. It is important to fully visualize and 'stay on' the LAD anterior wall during the dissection in order to not move off of it and to avoid entering the right ventricle (RV). Care is taken to identify small epicardial coronary veins which may run near/cross over the LAD. When encountered, meticulous hemostasis is achieved using bipolar electrocautery or metal clips. Given the procedure is performed off-pump, systemic heparin is avoided which helps with hemostasis. The robotic EndoWrist™ stabilizer, controlled by the console surgeon, is vital to the procedure and its position is adjusted continuously to maintain adequate exposure of the LAD deep in the myocardium. Upon completion the extra-pericardial fat is closed loosely to cover the anterior surface of the heart.

## Comments

MB occurs when a coronary artery, most commonly the LAD, has an intramyocardial course. For symptomatic patients the primary treatment is medical. In those who

 

fail medical therapy, surgical unroofing can be offered to relieve symptoms. The main surgical approach is unroofing/myotomy, which involves division of the muscle fibers that comprise the MB overlying the LAD.

We have performed totally endoscopic robotic beating-heart MB unroofing in 34 patients who failed medical therapy. Mean age was 48±8 years, and 56% were female. One patient had prior septal myectomy via sternotomy. All patients had evidence of hemodynamically significant MB on pre-operative left heart catheterization with provocative testing. Mean procedure time was 140±69 minutes. There were no conversions. Mean MB length was 4.5±1.4 cm and mean depth 1.6±0.9 cm. Mean intensive care and hospital length of stay (LOS) were 0.97±0.58, and 1.74±1.0 days, respectively. There were no mortalities, strokes, or return for bleeding.

Surgical unroofing is safe, with several reports showing no perioperative mortality or major morbidity, and effective with longer-term reduction of symptoms (2-4). The rare reports of minimally-invasive approaches to MB unroofing demonstrate good results (1,5).

We believe that the robotic endoscopic off-pump approach for MB unroofing is beneficial because patients experience known benefits, including short LOS, less blood transfusions, no sternal wound infections, and swift recovery (1). When performed via this approach, surgical unroofing can be offered to patients with a confirmed diagnosis of hemodynamically significant MB and can be easier to justify than unroofing via sternotomy, even if the procedure is not guaranteed to provide full symptomatic relief in this challenging diagnosis.

Another significant benefit of the robotic-endoscopic approach is enhanced visualization. In our experience, this—coupled with an off-pump/no heparin strategy—decreases the incidence of complications. One of the primary concerns in MB unroofing is RV perforation, a reason most are performed on-pump/arrest-heart. We believe that the course of the intramyocardial LAD, MB muscle fibers, and bridging veins are highly visible in a robotic approach. In this series there were no RV perforations. Additionally, an advantage of the totally-endoscopic approach over mini-thoracotomy is achieving greater completeness of the myotomy, as longer/multiple LAD segments (or large diagonal branches) can be visualized along the entire course and fully unroofed.

The importance of the robotic epicardial stabilizer in any robotic-assisted off-pump surgery cannot be overstated. It is fully controlled by the surgeon at the console. It spreads gradually and smoothly, allowing for frequent adjustments to achieve perfect exposure, and can spread the deep epicardial fat to expose the overlying muscle fibers, rendering a deep target more superficial without need for additional retraction.

Limitations of this approach include the necessity for an experienced robotic surgeon and team. MB has a low prevalence and surgical treatment is relatively rare. As with all new robotic procedures, we recommend mastering the principal techniques (e.g., off-pump surgery) prior to transitioning to a robotic-assisted endoscopic approach. Once competency is obtained, this procedure can be performed with excellent results and benefit to patients. We perform this procedure with the aid of the EndoWrist stabilizer, an instrument only available on the Si robot. We hope that renewed interest in robotic cardiac surgery will re-engage industry support to make this important device available on current robotic systems.

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## Footnote

*Conflicts of Interest:* The authors have no conflicts of interest to declare.



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