Masters of Cardiothoracic Surgery

Different styles in trocar placement in robotic-assisted beating heart coronary artery bypass grafting

Michiel Algoet[1], Husam H. Balkhy[2], Dries Dewulf[1], Wouter Oosterlinck[1]

[1]Department of Cardiovascular Sciences, Research Unit of Cardiac Surgery, KU Leuven, Leuven, Belgium; [2]Division of Cardiac Surgery, Department of Surgery, University of Chicago Medicine, Chicago, IL, USA

Correspondence to: Dr. Michiel Algoet, MD. Department of Cardiovascular Sciences, Research Unit of Cardiac Surgery, KU Leuven, Herestraat 49, 3000 Leuven, Belgium. Email: michiel.algoet@kuleuven.be.

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Introduction

Since the mid-nineties, minimally invasive direct coronary artery bypass grafting (MIDCAB) has evolved and, thanks to technological development of robotically assisted beating heart coronary surgery known as robot-assisted MIDCAB (RA-MIDCAB) and totally endoscopic coronary artery bypass (TECAB), the procedure has become even less invasive. Here we describe trocar placement for both techniques. Both techniques can be used for single or multiple vessel bypass using single or bilateral internal thoracic arteries as an *in-situ* graft. The presented techniques are used in an off-pump strategy.

Clinical vignette

The first case is a sixty-three-year-old male with a history of pacemaker implantation. Because of shortness of breath, he underwent coronary angiography. A significant stenosis of the right coronary artery was diagnosed which was treated by a drug eluted stent. Second, a significant stenosis on the bifurcation of the left anterior descending (LAD) artery and first diagonal branch was observed. The indication for RA-MIDCAB was set.

The second case is a sixty-eight-year-old male with stable angina. He underwent coronary angiography revealing an ostial stenosis of the LAD (70–90%) and proximal stenosis of the circumflex artery (50–70%). Cardiovascular risk factors are a body mass index (BMI) of 28.1 kg/m^2, history of smoking, arterial hypertension, hypercholesterolemia. He was scheduled for a TECAB.

Surgical technique

Preparation

Pre-operative evaluation

A chest X-ray (and/or computed tomography scan) should be available for pre-operative assessment of the thoracic cavity. Anatomical references or landmarks should be marked before incision: sternal midline, intercostal space (ICS) 2-3-4, xiphoid process and the lower rib.

Anaesthesia

For both techniques, RA-MIDCAB and TECAB, we advise to administer intrathecal morphine to reduce post-operative pain and facilitate an enhanced recovery after cardiac surgery. Endotracheal intubation should be performed by a double lumen tube or endotracheal tube and bronchus blocker to allow single lung ventilation.

Patient positioning

The patient is installed in dorsal decubitus, the left side of the body is aligned with the table's edge such that the left shoulder overhangs slightly and the left arm can be placed underneath the back. The operation table is slightly tilted towards the right. This positioning lessens impeded manipulations of the superior thoracic robotic arm.

Trocar placement

RA-MIDCAB

Three trocars are needed for a RA-MIDCAB approach. The standard approach is placement in ICS 2, 4 and 6. The

first trocar is the video trocar and is usually placed in the fourth ICS. Before placement of the first trocar a Verres needle is placed in the fourth ICS just lateral of the nipple. The pleural cavity is insufflated to a pressure of 6 mmHg before the trocar is placed at the site of the Verres needle. The next trocar is placed in the second ICS on the anterior axillary line. The last trocar is placed in the sixth ICS on the mid axillary line. At the end of the robotic procedure, a mini-thoracotomy is performed at the fourth ICS.

TECAB

When performing a TECAB procedure, four trocar and one working (assistant) port is needed. Insufflation of the pleural cavity using the Verres needle is performed first in the fourth ICS. The first three trocar are placed on the anterior axillary line in ICS 2, 4 and 6. The fourth trocar is usually placed lateral to the xiphoid process (left internal mammary-LAD) or subcostal between the mid clavicular line and midsternal line (posterolateral wall revascularization, e.g., obtuse marginal branches) depending on the coronary target that needs to be treated. At the end of the robotic harvesting phase, one additional working port is placed in the left ICS 2 parasternal.

Important notes during trocar placement

Keep hemodynamics in mind during every step of trocar placement, creating a pneumothorax can cause severe hypotension. Communication with the anesthesiologic team is key during robotic surgery. Put the pressure below 6 mmHg to start and flow low to allow adaptation with minimal repercussions. If you have difficulties insufflating the pleural space, place your Verres needle at a different trocar site and repeat the insufflation or directly use the blunt introduction of the trocar. During TECAB, it can be useful to use an Airseal® (CONMED, Largo, FL, USA) to maintain a stable intrapleural pressure even when advancing sutures or snaring devices.

Comments

Clinical results

Since the first report (1) of robotic-assisted coronary artery bypass grafting at the turn of the millennium, several teams have adopted this technique. Many variants have been proposed, but RA-MIDCAB and TECAB have stood ground for the longest time and are described best in the literature. Both techniques have shown equivalent cardiovascular outcomes compared to open coronary revascularization with the additional advantages of shorter intensive care stay, shorter total hospital stay, less blood transfusion and faster revalidation (2,3). Nonetheless, TECAB allows more flexibility inside the chest and allows the surgeon to use all the robotic advantages for the most delicate work in the procedure: the anastomosis.

Advantages

Since the chest remains closed by avoiding sternotomy, much-feared sternal dehiscence and infection are no longer a consideration (4,5). While generally minimizing surgical trauma, it also hastens the patient's recovery and therefore, has a positive impact on the patient's early return to work or normal daily activities (3).

Caveats

As there is a general desire for many minimally invasive cardiac surgeons to perform TECAB, there are some technical caveats. The supply of the Endowrist stabilizer (Intuitive Surgical, Sunnyvale, CA, USA) has been stopped for several years, the absence of this stabilizer including the support of the robotic surgery industry has made it difficult to perform totally endoscopic cardiac surgery. On top of that, European legislation has ordered a medical device regulation in which many devices, including those from robotic cardiac surgery is considered as class III. This up-classification has led towards a more complex application process which also withholds the breakthrough of robotic cardiac surgery in Europe.

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Footnote

Conflicts of Interest: H.H.B. and W.O. are proctors for Intuitive Surgical. The other authors have no conflicts of interest to declare.

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