How to perform distal anastomosis using a robotic platform: totally endoscopic coronary artery bypass

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Clinical vignette

A 79-year-old male patient with a past medical history significant for non-ST-segment elevation myocardial infarction (NSTEMI) experienced worsening dyspnea on exertion and chest pain. A stress nuclear test showed ischemia in the apical area with coronary angiogram revealing an occlusion of the left anterior descending artery (LAD). He was referred for minimally invasive placement of a left internal mammary artery (LIMA) bypass to the LAD. Preoperative workup for robotic totally endoscopic coronary artery bypass (TECAB) grafting revealed a forced vital capacity (FVC) of 82% of the predicted value and a forced expiratory volume of 92% of the predicted value. A computed tomography (CT) angiogram of chest, abdomen and pelvis demonstrated only mild atherosclerotic plaques on the aorto-iliac level and the ascending aortic diameter was less than 35 mm. He was therefore regarded as a good candidate for TECAB using peripheral heart lung machine cannulation and use of endoaortic balloon occlusion for cardioplegia.

Surgical technique

Preparation

The patient received general anesthesia and a bronchial blocker for left lung isolation was placed. Two radial artery pressure lines were used to monitor the position of the aortic endoballoon. The patient was positioned with the left chest 30 degrees elevated.

Exposition

The da Vinci Xi system (Intuitive, Sunnyvale, CA, USA) was used to perform the procedure. Ports were placed in the left third, fifth and seventh intercostal spaces and, the robot was docked.

Operation

With robotic camera view 30 degrees up, the LIMA was harvested in skeletonized technique using a robotic cautery level of 2. The vessel after harvesting was clipped distally and detached from the thoracic wall.

Femoral cannulation was carried out in parallel to LIMA harvesting. A. distal leg perfusion line was installed into the ipsilateral superficial femoral artery. A 25-F venous cannula was brought up into the right atrium and superior vena cava under transesophageal echo (TEE) guidance. A 23-F Edwards Intraclude (Edwards, Irvine, CA, USA) cannula was inserted into the left femoral artery. The endoaortic occlusion balloon was brought up through the cannula into the ascending aorta. The catheter was connected to the cardioplegia and aortic root vent lines and to balloon and aortic root pressure measurements.

An 8 mm assistance port was brought in parasternally and a 12 mm subcostal port was inserted and docked to the 4th arm of the da Vinci system. With a robotic camera view 30 degrees down the pericardial fat-pad was taken down and the pericardium was opened in L-shaped fashion.

Cardiopulmonary bypass (CPB) was started. The aortic endoballoon was inflated, 6 mg of adenosine were injected into the aortic root, and 1,200 mL of del Nido cardioplegia were given.

The LAD was then exposed and incised using robotic Pott's scissors. The LIMA was occluded with an endo-bulldog, incised distally, and checked for adequate free-flow. A robotic long-tip forceps was inserted through the subcostal port and used to optimize the exposure of the LAD.

Robotic black diamond micro-forceps were used to carry out the anastomosis with a 7 cm 7/0 Pronova suture (Somerville, Ethicon, NJ, USA). The first stitch was placed inside out on the LAD close to the anastomotic toe on the anastomotic back wall. The needle was parked in the apical epicardium. Using the other needle, the back wall was sutured using all forehand stitches going inside out on the graft and outside in on the target vessel. Care was taken to pull frequently on the two suture ends in order to avoid sling formation on the back wall. The suture was then carried around the heel of the anastomosis and the needle was parked in the cranial epicardium. The other suture end was then used to continue the anastomosis. Stitches were placed outside in on the graft and inside out on the target vessel going around the toe and along the anterior wall of the anastomosis. Care was again taken to correct suture slings by intermittently pulling on the suture with the needle. After inspection of the back wall and heel with correction of lose slings, the needles were taken off and the suture was tied of using robotic instrument ties. A pre-emptive repair stitch was placed on the back wall.

The endoaortic occlusion balloon was deflated and the heart started beating in sinus rhythm. During reperfusion, graft flow measurements were carried out which showed a transit time flow of 25 mL/min and a pulsatility index of 2.5. The patient was weaned from CPB and decannulated. Protamine was given and an inspection of the chest cavity followed. The robot was undocked. A chest tube was inserted through the camera port hole and the ports and inguinal wound were closed in layers.

Comments

Clinical results

Concerning results, we refer readers to papers which the first author has published (1-3).

Advantages

The main advantage of a totally endoscopic approach to coronary artery bypass grafting (CABG) is that the procedure is carried out only through robotic ports. The robotic device allows complex intrathoracic maneuvers, and all components of bypass grafting can be performed in a closed chest. Endoscopic suturing is ergonomically very appealing, and the robotic camera provides insights into suturing that are not available with standard loupe magnification in open CABG. The cardioplegia version of TECAB also lets the surgeon take full advantage of completely tremor free work as the robot filters out the latter.

Caveats

TECAB with use of the endoballoon for induction of cardioplegia requires additional training and it is highly recommended acquire the skills for endoballoon use in procedures other than TECAB. As the EndoWrist^{TM} stabilizer (Intuitive Surgical, Sunnyvale, CA, USA) for beating heart TECAB is currently unavailable, the procedure described herein is one of the few ways to perform robotic TECAB. Proper patient selection for TECAB is extremely important and endoscopic suturing needs to be practiced intensely in simulation models before it can be carried out clinically.

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Footnote

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

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