Totally endoscopic sequential arterial coronary artery bypass grafting on the beating heart

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A 50-year-old man was referred to the Department of Thoracic and Cardiovascular Surgery at the Johann Wolfgang-Goethe University (Frankfurt, Germany) with angina on exertion. An evaluation revealed critical stenosis involving the proximal portion of the left anterior descending artery and the first diagonal branch. The patient underwent successful sequential grafting of the left internal mammary artery to the left anterior descending artery and the diagonal branch using a totally endoscopic coronary artery bypass grafting technique on the beating heart with a new version of the da Vinci Surgical System (Intuitive Surgical, USA). To the authors' knowledge, this is the first report in literature to describe sequential arterial off-pump grafting of two anterior wall target vessels using a totally endoscopic technique on the beating heart.

Key Words: *Beating heart; Sequential grafting; Totally endoscopic coronary artery bypass*

The introduction of computer-enhanced instrumentation systems into cardiac surgery in the late 1990s enabled surgeons to perform coronary artery bypass graft, mitral valve repair and atrial septal defect closure procedures in a closed-chest fashion (1). The totally endoscopic coronary artery bypass (TECAB) technique is still evolving, and needs further procedural and technical refinements. The present report describes sequential arterial bypass grafting of the left anterior descending artery (LAD) and the first diagonal branch (D1) with the TECAB technique on the beating heart.

CASE PRESENTATION

A 50-year-old man was referred to the Department of Thoracic and Cardiovascular Surgery at the Johann Wolfgang-Goethe University (Frankfurt, Germany) with angina on exertion (Canadian Cardiovascular Society angina class II) and signs of ischemia on the anterolateral wall. A coronary angiogram revealed critical proximal stenosis of the LAD (90%) and the D1 (70%) (Figure 1). Due to the complexity of the LAD lesion, percutaneous coronary intervention was not possible, and the patient was referred for minimally invasive surgical revascularization.

The patient underwent TECAB on the beating heart by using the da Vinci S Surgical System (Intuitive Surgical, USA) at the university. The anesthesia and operative technique for TECAB were similar to a previously reported technique (1). In brief, the stereoscope was placed in the fifth intercostal space in the anterior axillary line. Two robot trocars were placed

Pontage coronarien séquentiel entièrement réalisé par endoscopie sur cœur battant

Un homme de 50 ans est adressé au département de chirurgie thoracique et cardiovasculaire de l'Hôpital Universitaire Johann-Wolfgang-Goethe (Frankfurt, Allemagne) pour angine d'effort. À l'examen, on note une sténose très prononcée de la portion proximale de la descendante antérieure et de la première branche diagonale. Le patient a subi avec succès une greffe séquentielle de l'artère mammaire gauche interne sur la descendante antérieure et la diagonale, au moyen d'une technique de pontage coronarien entièrement endoscopique sur cœur battant, réalisée avec une version récente du *da Vinci Surgical System* (Intuitive Surgical, États-Unis). À la connaissance de l'auteur, il s'agit du premier article publié qui décrit le pontage artériel séquentiel de deux vaisseaux ciblés de la paroi antérieure, réalisé sans circulation extracorporelle, au moyen d'une technique entièrement endoscopique sur cœur battant.

Figure 1 Preoperative angiogram showing the lesion (arrow) located at the bifurcation point of the left anterior descending artery and the first diagonal branch

under direct vision in the third and seventh intercostal spaces in the midaxillary line. After endoscopic dissection of the left internal mammary artery (LIMA) and incision of the pericardium, the target vessels were identified. The endoscopic stabilizer (Intuitive Surgical, USA) was placed in the left subcostal

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Figure 2) Schematic drawing of the port sites for the totally endoscopic off-pump bypass surgery (author KA's own drawing). 1 Third intercostal space (ICS) for the right robot arm; 2 Fifth ICS for stereoendoscope; 3 Seventh ICS for the left robot arm; 4 Subxyphoid region for the endoscopic stabilizer (Intuitive Surgical, USA); 5 Left subcostal region for the endoscopic stabilizer

region, approximately 6 cm lateral to the xyphoid, for immobilization of the target site (Figure 2). After placement of the silastic loops on the diagonal branch, a longitudinal 6 mm arteriotomy was performed. A 1.5 mm intracoronary shunt (Guidant Corporation, USA) was inserted through the arteriotomy. The LIMA to D1 anastomosis was sutured in a side-to-side fashion by a running 7/0 polypropylene suture (Fumalen Coro Gold, Fumedica Medizintechnik GmbH, Germany). A 6 mm longitudinal arteriotomy was then performed on the LAD target segment, and a 1.5 mm intracoronary shunt was placed. The LIMA to LAD anastomosis was sutured in an end-to-side fashion by a running 7/0 polypropylene suture. No ST segment alteration or relevant arrhythmia occurred on electrocardiogram during the procedure. The duration of the total operation and the LAD and D1 anastomoses were 5.1 h, 22 min and 25 min, respectively. Two chest tubes were inserted; one each through the camera port and the left arm incision.

The patient was extubated 5 h postoperatively; the total chest tube drainage was 300 mL. Control angiography on the third postoperative day showed a patent LIMA graft with good perfusion of the LAD and D1 (Figure 3).

DISCUSSION

One of the ultimate goals of TECAB is to avoid a cardiopulmonary bypass (CPB). The experience gathered from TECAB on the arrested heart is expected to become a milestone for more complex procedures such as off-pump or multivessel TECAB (1). Despite the first TECAB on the beating heart being reported in 2001, the number of these procedures has not approached to the desired level and CPB still remains a prerequisite for TECAB (2).

We have previously described (3) the first sequential anastomoses to the LAD and D1 using the TECAB technique on the arrested heart. In the present case, the LIMA graft was sequentially anastomosed to the LAD and D1 using a totally endoscopic off-pump technique. In the literature, Mohr et al (4) reported two successful, single-vessel beating heart TECAB procedures of eight intended cases. Kappert et al (5) reported 29 successful beating heart TECAB procedures. To date, we have performed 16 successful single-vessel beating heart TECAB procedures (1,2). The rate of conversion to another minimally invasive or standard approach is still approximately

Figure 3) Control angiogram of the sequential left internal mammary artery (LIMA) anastomoses to the left anterior descending artery (LAD) and the first diagonal branch (D1) bypass performed by the totally endoscopic off-pump bypass surgery technique

30%. The main obstacle in TECAB on the beating heart is the stabilization of the target site and the resulting difficulty in suturing the anastomosis on the beating heart (3,5).

In the new version of the da Vinci Surgical System, a third instrument arm is added to the slave unit; this accommodates the new version of the endoscopic stabilizer, which has evolved into a da Vinci-controlled robotic instrument. The lateral placement of the endostabilizer port gave two major advantages. First, it facilitated endoscopic access to the antero-lateral territory of the heart. Second, collision between the left instrument arm and the stabilizer was minimized.

Technical improvements of the da Vinci system over the past years facilitated the TECAB procedure. However, construction of a 'hand-sewn anastomosis' with the da Vinci system is a demanding task in TECAB. New technological achievements such as semiautomatic or automatic anastomotic devices may facilitate graft to coronary anastomosis.

In conclusion, although beating-heart TECAB is shown to be a feasible approach for single- or double-vessel revascularization, it is still a surgically challenging procedure and needs further procedural refinement. Integration of robotic technology into a particular revascularization policy such as coronary artery bypass graft with a limited incision or percutaneous coronary intervention seems to be the mid-term future of robotic coronary revascularization.

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