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Video Article / *Video Makalesi*

Minimally invasive total arterial off-pump coronary revascularization: A reproducible technique

Minimal invaziv total arteriyel off-pump koroner revaskülarizasyon: Tekrarlanabilir bir teknik

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It has been over five decades since the first coronary artery bypass grafting (CABG) of a left internal thoracic artery (LITA) to the left anterior descending (LAD) artery was described by Kolesov in 1964.[1,2] The use of the saphenous vein and radial artery as conduits and the feasibility of multiple coronary bypass grafts was described soon thereafter.[3,4] While CABG is accepted as recommended therapy for multi-vessel disease requiring revascularization, the standard approach toward this goal has been through a full sternotomy. While being the most practiced and easily reproducible, this approach maybe associated with significant morbidity in both short- and long-term.

Alternative approaches to avoid a sternotomy have been described in the past (i.e., minimally invasive direct coronary artery bypass), but have limitations either due to limited applicability, incompleteness of revascularization, or the freedom to use a choice of conduits.[5,6] Minimally invasive cardiac surgery (MICS) CABG which was first described by McGinn et al.[7] in 2006 is useful to overcome these limitations and has evolved over the last decade into an operation which can be performed routinely with a few specialized instruments. This article describes our technique of a multi- vessel MICS CABG using all arterial conduits.

SURGICAL TECHNIQUE (Video)

Patients considered as ideal candidates for conventional CABG are also suitable for a MICS CABG. While the indications for both procedures are the same, certain contraindications are specific to MICS CABG. Absolute contraindications include hemodynamic instability requiring emergency surgery, severe kyphosis or scoliosis, and mesocardia or dextrocardia complicating access to the heart from a left thoracotomy. Relative contraindications include dilated cardiomyopathy where the left ventricular end-diastolic diameter is greater than 6.5 cm or a cardio-thoracic ratio greater than 6.5, low ejection fraction (<30%), significant left subclavian artery stenosis, significant peripheral vascular disease precluding groin cannulation if required, redo surgeries or previous thoracic surgery on the left, and pulmonary disease significant enough to prevent a single lung ventilation. The use of cardiopulmonary bypass (CPB) may be helpful to overcome a few of these contraindications.

Intubation with selective left lung isolation is achieved with a double-lumen endotracheal tube (ETT) or a single-lumen ETT with a bronchial blocker. We prefer using a pulmonary artery catheter in all patients

Video. Video showing minimally invasive total arterial off-pump coronary revascularization.

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for monitoring. Transesophageal echocardiography is used to monitor and guide the position of peripheral cannulas, if CPB support is required. The left femoral pulse at the groin is marked for quick access, if necessary. A venous catheter is placed in the right femoral vein for percutaneous cannulation. The patient is positioned supine with a small roll or gel bag below the left chest to provide a better access to the interspaces. The radial artery is harvested endoscopically, if required as a conduit.

A 5 to 7-cm (2 to 3-inch) curvilinear chest incision is placed two finger breadths below the left areola in males and below the mammary crease in females. The incision corresponds to the mid-clavicular line and is placed more lateral than medial. The intercostal site of entry corresponds to the cardiac apex and is usually the fifth intercostal space in most patients. This is particularly important for easy access to the distal right coronary artery (RCA) or its branches or the posteriorly located obtuse marginals, if required. The use of a soft tissue retractor aids exposure. A Fehling retractor system (Fehling Instruments GmbH & Co. KG Karlstein am Main, Germany) is used both for rib spreading and mammary harvesting. The L-shaped blade used for LITA exposure is retracted just enough to lie flat against the chest wall. Excessive retraction can cause rib fracture and should be avoided. The rib lift provided by this retractor increases the space within the chest cavity allowing for easier manipulation of the heart. The LITA is harvested under direct vision in a skeletonized manner. Either a conventional cautery with a long tip (110 mm) or a Harmonic scalpel (Ultrasonic; Ethicon, Hamburg, Germany) with a long probe can be used, although our preference is the Harmonic scalpel. If the right internal thoracic artery (RITA) is planned as a conduit, it must be, then, harvested prior to LITA harvesting. The pericardium is opened in an inverted T-fashion starting at the apex, extending toward the aorta and, then, along the diaphragmatic attachment both medially and laterally. Two pericardial stay sutures are placed. The first at the lower end of the pericardiotomy near the apex and the second on the pericardial reflection above the superior vena cava. This second stay suture is brought out through a stab incision along the left sternal border. Traction on this stay allows a better access to the aorta, if side clamping of proximal is required. The Octopus Nuvostabiliser (Medtronic, Mineapolis MN, USA) is inserted through a stab incision in the sixth or seventh interspace and positioned at the site where the LAD artery anastomosis is planned. The LITA-to-LAD anastomosis is constructed in the usual fashion. The limbs of the Octopus Nuvo is, then, repositioned proximally over the course of the LITA at the site where the Y is to be constructed. This technique allows for a stable LITA, while a Y is constructed. The LITA can be further stabilized with a fine suture fixing it to the epicardium between the limbs of the stabilizer. A Starfish NS heart positioner (Medtronic, Mineapolis MN, USA) is introduced through a subxiphoid stab incision, positioned over the lateral aspect of the cardiac apex before applying suction. Retraction of the Starfish medially should allow easy access to the obtuse marginals. Similarly, retraction laterally and toward the left shoulder should allow for easy access to the distal RCA and its branches. With identification of each vessel to be revascularized, the Octopus is positioned to stabilize the site of anastomosis. As many anastomoses as required can be constructed in this manner, depending on the length of the arterial conduit and the size of the heart. Principles applicable to the arterial conduits and sequential anastomosis in open surgery are similarly applied here. Once revascularization is complete, the lower part of the pericardium over the apex is closed. One or two chest drains are placed in the anterior mediastinum and the left pleural cavity. The thoracotomy is closed in layers and rib approximation is not required.

In conclusion, several short- and long-term studies have shown that the benefits of surgical revascularization accrue with time, particularly in relation to improved survival, lower rates of major cardiovascular events, and repeated revascularization, compared to percutaneous coronary intervention (PCI). Although conventional CABG is an excellent therapy for multi-vessel disease requiring revascularization, poor public perception and acceptability, helming from its invasive as well as morbid nature make this therapy less used. Total arterial revascularization using both internal thoracic arteries or the radial artery have been shown to have better outcomes.[8] Despite the evidence, total arterial revascularization is performed in less than 20% of CABG cases worldwide and the most common reason is sternal wound breakdown.[9] Total arterial, anaortic, off-pump has been advocated as an optimal operative strategy for coronary revascularization and its only drawback is the sternotomy. A total arterial MICS CABG performed on the beating heart as described above overcomes all the drawbacks of a conventional CABG and can be performed routinely. A few studies published have shown excellent outcomes with MICS CABG in the short term.[10,11] Based on our own experience with this technique in over 1,500 coronary revascularization procedures in the last five years, the results seem to be encouraging and the technique is the primary procedure for 70% of patients referred for revascularization.

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