Case report - Coronary
Bilateral MIDCAB for triple vessel coronary disease

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Abstract
Minimally invasive direct coronary artery bypass grafting utilising an anterior mini-thoracotomy has traditionally been limited to surgical revascularisation for single or double vessel coronary disease. The widespread use of percutaneous coronary intervention has further limited the use of this technique. Minimally invasive direct coronary artery bypass grafting offers the advantage of avoiding a sternotomy, in patients with a higher risk of sternal wound dehiscence and infection. We have used bilateral anterior mini-thoracotomy in conjunction with bilateral internal mammary and radial artery conduits, allowing an aortic no-touch technique, on the off-pump heart in two patients.

Keywords: Minimally invasive surgery CABG

1. Introduction
Minimally invasive direct coronary artery bypass grafting (MIDCAB) utilises an anterior mini-thoracotomy to surgically re-vascularise the heart. Kettering et al. [1], in a review of 16 articles, noted early mortality for MIDCAB ranged from 0 to 4.9% and late mortality (after > 30 days) ranged from 0.3 to 12.6%. Non-fatal myocardial infarction ranged between 0 and 3.1%. Intra- and postoperative complications (wound infections, re-operation for management of bleeding, arrhythmias, stroke, etc.) occurred in 1.6 to 40%. The conversion rate to sternotomy/cardio pulmonary bypass ranged between 0 and 6.2%. Re-interventions (surgical revision or percutaneous transluminal coronary angioplasty) due to graft failure were necessary in up to 8.9% of patients.

MIDCAB is traditionally limited to the left anterior descending coronary artery or its diagonal branches, on the anterior surface of the heart, when the coronary disease is not suitable for percutaneous coronary intervention. Although MIDCAB offers advantages such as the avoidance of sternotomy and cardiopulmonary bypass, it is limited by difficulty in gaining access to the lateral and posterior surfaces of the beating heart. In an attempt to expand the benefits of MIDCAB to patients with multivessel disease, hybrid myocardial revascularisation has been used, combining surgery of the LAD territory with percutaneous coronary intervention (PCI) for lesions on the lateral and posterior surface of the heart. Unfortunately this hybrid method can only be used selectively, when the coronary disease on the lateral and posterior surface of the heart is amenable to PCI.

Thus innovative surgical approaches are necessary to extend the benefits of MIDCAB to patients having triple vessel coronary disease not suitable for PCI. In a report on two patients, we describe how the utilisation of stabilisation devices used in off-pump coronary surgery may help achieve this objective.

2. Materials and methods
Permission was obtained from the hospital’s media officer and the patients, to obtain digital images of the procedure. The patients were counselled preoperatively and written consent obtained. Patients were under general anaesthesia with a double lumen endotracheal tube for ventilation, with external defibrillation pads in place.

2.1. Harvesting of internal mammary arteries
The patients were positioned in a semi-lateral position with a 30° tilt away from the side of harvest, with single contra-lateral lung ventilation, for internal mammary artery (IMA) harvesting. Harvesting of the IMAs was performed through anterior mini-thoracotomies, video-assisted by a thoracoscope placed at the lateral angle of the incision. A 5-cm incision was performed for the Right IMA (RIMA), which was harvested through its entire length. The patient was heparinised to maintain an ACT of 300 units during the remainder of the operation. Next, a 6-cm left anterior mini-thoracotomy was made and the Left IMA (LIMA) was harvested through its entire length, using right lung ventilation. The RIMA was passed anterior to the pericardium into the left hemithorax.

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2.2. Performance of coronary anastomoses

Epicardial stabilisation for distal coronary anastomoses was achieved using a Medtronic Octopus® 4 stabiliser (Medtronic Inc, Minneapolis, USA). Intracoronary shunts were not used during the distal anastomoses. Systolic arterial pressures were maintained at a minimum of 70 mmHg during distal anastomoses utilising venous volume regulation, rate control, inotropes or vasoconstrictors. Normothermia was maintained by using warm intravenous fluids, a heating mattress and a humidified airway; in addition to maintaining a warm operating theatre. Cell saver suction was used and a perfusionist with primed bypass circuit was available for all OPCAB cases.

With right lung ventilation the pericardium was opened anterior to the left phrenic nerve. The anterior edge of the pericardium was lifted upwards and medially, using stay sutures. The posterior edge of the pericardium was retracted outwards using stay sutures on surgical clips. The RIMA was anastomosed to the left anterior descending coronary artery. In the first patient, the LIMA was then anastomosed to the first obtuse marginal having lifted the posterior edge of the pericardium upwards and outwards using stay sutures that were now fixed onto the drapes with surgical clips. This allowed dextro-rotation of the heart exposing the circumflex territory. The left radial artery was next anastomosed to the posterior descending coronary artery, utilising the stabiliser to both lift and rotate the inferior cardiac surface towards the left thoracotomy thereby improving access. Finally, the proximal end of the left radial artery was anastomosed to the LIMA as a ‘Y’ graft. This approach was modified to facilitate performance of the procedure in the second patient. After anastomosis of the RIMA to the left anterior descending coronary artery, the proximal end of the radial artery was anastomosed to the LIMA as a ‘Y’ graft. Subsequently, the LIMA was anastomosed to the distal circumflex coronary artery and finally the distal left radial artery was anastomosed to the posterior descending coronary artery.

Protamine was used for reversal of heparin. A single chest drain was placed in each hemithorax and the chest wall was closed in layers.

3. Results

3.1. In-hospital

Both patients were male; aged 76 and 65 years, respectively. The operative times were 240 and 245 min. There were no ECG changes and no dysrrythmias postoperatively. A chest infection occurred in the second patient and responded promptly to antibiotics. There were no neurological complications, wound infections or renal failure post operatively. Both patients were discharged on post-operative day five. Fig. 1 shows the three grafts as seen through the left anterior thoracotomy (a) and the appearance of the surgical scars on day five in the first patient (b).

3.2. Post-discharge

Both patients were reviewed at 6 weeks and 3 months postoperatively with no recurrence of cardiac symptoms, allowing a full return to their daily functions. Exercise tolerance testing was performed for both patients at 3 months postoperatively and no inducible symptoms or electrocardiographic changes were present.

4. Discussion

Traditional MIDCAB has been restricted by two technical factors that have prevented it from being easily used for triple vessel coronary disease. The first factor is the difficulty in reaching the lateral and posterior surfaces of the beating heart, through the traditional left anterior mini-thoracotomy. This did not pose a great challenge as flexible epicardial stabilisation devices are now freely available with the advances that have taken place in off-pump cardiac surgery. The second factor is the difficulty in gaining access to the aorta, to perform top-end anastomo-

Fig. 1. (a) Left anterior mini-thoracotomy incision showing the three anastomoses of: the RIMA to the left anterior descending coronary artery; the LIMA to the obtuse marginal coronary artery; and the radial artery coming from the LIMA to the posterior descending coronary artery. (b) Appearance of the right and left anterior mini-thoracotomy incisions prior to discharge home on day 5 in the first patient.
ses for multiple coronary grafts. This was circumvented by combining bilateral IMAs with a radial artery ‘Y’ graft off the LIMA, avoiding the need for proximal anastomosis of conduit to the aorta. Previous studies by both Endo et al. [2] and Calafiore et al. [3] have shown good angiographic patency of BIMAs over time.

Advantages of the procedure include the elimination of the risk of sternal infection and dehiscence, whilst allowing the use of BIMA conduits. This provides a survival advantage over single IMAs as shown by Lytle et al. [4], potentially extending even for patients who are diabetic [5], and hence likely to be at greater risk of infective complications associated with sternotomy. In a retrospective review of over 30,000 patients Tang et al. found the in-hospital mortality rate was 6.9% for deep sternal infections, compared to 2.8% for patients without such infection [6] illustrating the impact on survival. Bilateral MIDCAB is also a useful alternative in patients with triple vessel disease having a tracheostomy or oesophagostomy in whom a median sternotomy is best avoided as a median sternotomy may jeopardise the stoma, risk mediastinal or sternal infection, and potentially compromise future tracheal or oesophageal operations [7–9]. Both Sato et al. [7] and Smedira et al. [8] describe the use of bilateral thoracotomy combined with distal median sternotomy to re-vascularise the heart in these situations. Furthermore, due to the complete avoidance of aortic contact, the risk of stroke is potentially decreased [10]. In addition to the above, the scar is obscured by the sub-mammary folds, providing an aesthetically pleasing result.

Limitations of the technique arise in patients with significantly impaired lung function, as they may not tolerate the periods of single lung ventilation that are required. Furthermore, patients who have had previous pleural diseases such as effusions and empyema may have pleural adhesions that prevent access through anterior mini-thoracotomy. There also exists the problem of pain that may result from subluxation of costo-chondral joints or fracture of ribs, restricting respiratory movements. Furthermore, emergent conversion may be difficult.

We hope to use thoracoscopic or robotic harvesting of the RIMA in future patients, as this will eliminate the need for the right thoracotomy. In addition new thoracoscopic suction devices are available and could be used to further facilitate grafting of the PDA. Subramanian et al. [11] recently described the use of an anterior thoracotomy or transabdominal approach in performing robotic harvesting of conduit with port access stabilisation and cardiac positioning for coronary bypass, further illustrating minimal access techniques that are evolving.

In conclusion, this preliminary presentation illustrates that MIDCAB can be extended to the surgical revascularisation of multivessel coronary disease, when performed with resources already available in off-pump surgery. It is important that the techniques are further tested in a larger series and the results evaluated.

References