

# Minimally Invasive Direct Coronary Artery Bypass

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## ABSTRACT

**Background:** Minimally invasive cardiac surgery is a new and promising approach to the treatment of coronary artery disease allowing surgery to be performed through smaller incisions with lesser morbidity.

**Methodology:** From November 1995 to February 1997, ten minimally invasive direct coronary artery bypass (MIDCAB) grafts were performed. The left internal mammary artery was used to bypass the left anterior descending coronary artery (LAD) through a limited left anterior thoracotomy.

**Patients:** There were seven males and three females and their ages ranged from 42 to 72 years (mean = 60 years). Two patients had prior interventional procedures. Cardiopulmonary bypass was used in the first two patients. Two patients were converted to conventional surgery early in the series.

**Results:** There was no mortality nor major morbidity. Mean post-operative hospital stay was seven days. To date, three patients have had post-operative angiography confirming the patency of the left internal mammary artery to LAD anastomosis.

**Conclusion:** Early results of the MIDCAB procedure are encouraging. However, the definitive place of such procedures awaits longer term follow-up.

**Keywords:** cardiothoracic surgery-minimally invasive; coronary artery bypass; Thoracotomy; Internal mammary coronary artery anastomosis; cardiopulmonary bypass

## INTRODUCTION

Minimally invasive techniques have been developed recently for the treatment of coronary artery disease (CAD). They encompass the benefits of internal mammary artery grafting as a long lasting intervention for CAD and also offset the invasiveness of conventional coronary artery bypass grafting (CABG)<sup>(1,2)</sup>. Surgery performed through smaller incisions aims at reducing post-operation morbidity and complications of the procedure, thus promoting earlier hospital discharge. We report here ten cases of minimally invasive direct coronary artery bypass (MIDCAB) performed at our institution from November 1995 to February 1997.

## MATERIALS AND METHODS

Ten patients underwent MIDCAB at our institution. There were 7 males and 3 females. Their ages ranged from 42 to 72 years with a mean age of 60 years. All the cases had single vessel coronary disease with 8 having subtotal and 2 having total occlusion of the left anterior descending coronary artery (LAD). Exercise treadmill test was performed and found to be positive for ischemia in all but one of the cases who had osteoarthritis of both knees. However a dobutamine stress echocardiography study for that patient was positive for ischemia in the left anterior descending artery territory.

One patient underwent prior percutaneous transluminal coronary angioplasty (PTCA) and another underwent prior PTCA and stenting before the MIDCAB operation. The indication for surgery was restenosis following PTCA in these patients and also the patients' preference for surgery. In all the other patients, the lesions were unsuitable for PTCA.

## Surgical technique

The left internal mammary artery (LIMA) was used to bypass the LAD through a limited left anterior thoracotomy in all the cases. In the first three patients, double lumen endotracheal intubation was used to facilitate thoracoscopic LIMA harvest. The patients were placed in a 30° right lateral decubitus position. A standard 10 mm – 0° right thoracoscope was passed through a trocar placed in the fourth intercostal space in the posterior axillary line. Additional ports were placed in the third and fifth intercostal spaces for introduction of an endoscopic grasping instrument and scissors with electrocautery. An additional port was placed in the sixth intercostal space for introduction of a fan used to retract the lung. The LIMA was then harvested as a pedicle with video imaging and standard surgical technique with control of side branches by cautery and endoscopic clips. Subsequently, the internal mammary artery harvests were performed by direct vision through a limited left anterior small thoracotomy (LAST) incision as it was found to be unnecessary to use the thoracoscope.

A limited anterior incision was made over the fourth intercostal space and the cartilage portion of the fourth rib was resected. The LIMA was then

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visualised and harvested to the first and second intercostal space under direct vision. Distally, the LIMA was mobilised as far as possible. A vertical incision was made in the pericardium and stay sutures were placed to draw the heart anteriorly and medially for fuller visualisation of the LAD. Snare sutures of 5-0 polypropylene were placed proximally and distally from the target area. On the LAD to be bypassed, the vessel was looped for occlusion at the time of anastomosis and the heart rate was slowed down by the administration of esmolol. The mobilised LIMA was divided distally and the end of the mammary artery was brought through the incision for grafting. The anastomosis between LIMA and LAD was performed using 1 layer of continuous 7-0 polypropylene suture. Use of an assistant to stabilise the motion of the heart and constant irrigation, blowing with a CO<sub>2</sub> gas source or suction to clear the coronary artery facilitated the anastomosis. Upon satisfactory completion of the anastomosis, the esmolol infusion was discontinued and the pericardium was partially closed with care not to kink the LIMA. A small drain was placed inside the pericardium. Pleura and prepectoral fascia were closed to prevent lung herniation. The skin incision was closed with subcuticular 4-0 Dexon.

Cardiopulmonary bypass (CPB) with femoral artery-femoral vein bypass was used in the first two patients. Conversion to conventional surgery was required in another two patients. In one of the patients early in the series, we were unable to achieve single lung ventilation and thus abandoned the procedure. However, we now mobilise all mammary arteries through thoracotomy. We believe that thoracotomy was required for proper mobilisation of the LIMA at that time. In the other patient, poor flow of blood in the internal mammary artery necessitated a median sternotomy and a saphenous vein was used to bypass the LAD. All surgical procedures were performed under standard cardiac operation anaesthetic technique.

## RESULTS

The intra-operative course was generally straight forward and uneventful. Mean duration of the operation was four hours. The patients have been followed up for a period of 1 to 14 months (mean = 7 months). The results of the post-operative electrocardiograms and the hemodynamic recordings of cardiac function were satisfactory in all cases with no evidence of myocardial infarction. Seven patients had vascular scans taken post-operatively. Visualisation of the graft was technically difficult in one of the post-operative vascular scans taken. The other six scans taken confirmed the patency of the LIMA to LAD anastomosis. Three patients had post-operative angiogram confirming patency of the LIMA to LAD anastomosis. None of the patients had a recurrence of angina. There was no mortality nor major morbidity. No complications occurred post-operation. Mean ICU stay was three days and mean post-operative hospital stay was seven days.

## DISCUSSION

At present, patients with CAD are revascularised with either CABG or PTCA. Surgical treatment via CABG may be the better option in many patients with multi-vessel disease but coronary angioplasty is the most widely applied procedure for treatment of single-vessel disease. Although mortality is less than 1%, restenosis rates may be as high as 40%–60% within six months of the angioplasty procedure<sup>(2)</sup>. Restenosis after the PTCA procedure remains a significant limitation to the long-term benefit of the procedure<sup>(3)</sup>. However, with the advent of coronary stents, restenosis may be significantly lowered. Although LIMA to LAD grafts yield excellent long-term results, morbidity exists from the use of CPB associated with conventional CABG<sup>(2,4)</sup>. Recent efforts have been focused on less invasive surgical techniques that can significantly reduce the pain, recovery period, patient morbidity and mortality rates, and the cost of open surgical procedures without a sacrifice in efficacy<sup>(1,5)</sup>. This has led to the advent and acceptance of MIDCAB.

A patient with isolated LAD and/or RCA lesion, in whom PTCA was not advisable due to a complex stenosis or a complete occlusion, is a good candidate for this procedure. A patient with a proximal LAD and/or RCA lesion who can be treated with an interventional catheter procedure, and a patient with multi-vessel disease with a prohibitively high predicted mortality and morbidity with CPB is also indicated for this type of approach<sup>(1,6)</sup>.

Minimally invasive direct coronary artery bypass is performed on a beating heart, hence avoiding the adverse effects of cardiopulmonary bypass. Myocardial revascularisation without extra-corporeal support is not a new concept and it was initially discussed in 1967 by Kolessov<sup>(7)</sup>. Ankeney<sup>(8)</sup> reported to the Society of Thoracic Surgeons in 1972, a study of 143 patients who underwent CABG without CPB. Subsequently it has also been described by Pfister<sup>(4)</sup>, Benetti<sup>(9)</sup> and Fanning<sup>(10)</sup> and their colleagues. Their experiences demonstrated the feasibility of direct coronary artery bypass without extra-corporeal circulation. Most cardiac surgeons however, favour CPB in heart surgery due to the relative ease of working on an arrested heart<sup>(4)</sup> and also because the intermediate and long term results of MIDCAB involving a LIMA to LAD anastomosis is uncertain. Subramanian<sup>(11)</sup> et al reported their experience in 96 patients who had mini-anterior thoracotomy. There was no early mortality and two late non-cardiac related deaths.

Schaff<sup>(12)</sup> et al reviewed their experience with 29 patients who had undergone MIDCAB at the Mayo Clinic. Twenty-six of them had immediate graft angiography taken, of which, four had unsatisfactory anastomoses due to kinks and one had a limited dissection of the internal mammary artery. The percentage of patients who had re-operation is considered high, at 19.2%.

As reported by Westaby<sup>(13)</sup> et al, a principal difficulty of MIDCAB concerns the accuracy and quality of the anastomosis following the operation on a beating heart. If this problem cannot be solved,

then graft patency will be disappointing and the method will fall into disrepute. Even with cardioplegic arrest, these anastomoses can still be very taxing. The procedure has also been restricted to bypass procedures performed on the anterior surface of the heart. Although it is possible to bypass multiple vessels, most of the procedures to date have been done on single vessels. Moreover this procedure is not applicable to valve replacement procedures, which require the heart to be arrested<sup>(14)</sup>.

Our experience shows that the early results of MIDCAB are encouraging. However, the definitive place of such procedures must await a larger experience and a longer term follow-up globally.

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