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Original Article

Early and mid-term results of minimally invasive coronary artery bypass grafting



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ABSTRACT

Introduction: Minimally invasive coronary artery bypass grafting (MICABG) is a less invasive method of performing surgical revascularization. This technique coupled with use of off pump technique of surgical revascularization makes it truly less invasive. This method is highly effective even in high-risk patients. Results of this procedure are comparable to standard off pump technique and are better than percutaneous coronary intervention utilizing drug-eluting stent. We present an early and mid-term result of the use of this technique.

Method: We enrolled 33 patients for analysis operated between 2008 and 2012. Operation was performed utilizing off-pump technique of coronary artery bypass grafting through a minimal invasive incision. Left internal mammary artery graft was done for single vessel disease and radial artery was utilized for other grafts if required. Median follow up of 2.5 years (6 months–4 years) is available.

Results: Median age was 58.5 years (41–77) and all were male. Single vessel disease was present in 7, double vessel in 14 and triple vessel disease in 12 patients. All the patients had normal left ventricular size and function. There was no operative and 30-day mortality. Conversion to median sternotomy to complete the operation was done in 6.6% (2 out of 33 patients). One patient had acute myocardial infarction and there were no deaths during follow up.

Conclusion: MICABG is a safe and effective method of revascularization in low risk candidates for coronary artery bypass grafting.

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Along with the establishment of off-pump coronary artery bypass grafting (OPCAB),¹ the initial attempts were made of performing the operation through a small anterior thoracotomy on left chest.^{2,3} Off-pump coronary artery bypass (OPCAB) techniques that circumvent the need for cardiopulmonary bypass were initially greeted with enthusiasm. Later, lackluster data on the results of OPCAB led to this procedure falling out of favor among most surgeons. Improvements in results compared with those for on-pump Coronary Artery Bypass Grafting (CABG) were judged to be insufficient to justify the added technical complexity of OPCAB. Recently, however, the Da Vinci robot and small incision in chest has opened the door for a procedure that is both off-pump and sterna sparing.

The advantages of this approach are early recovery and possibility of early discharge after multivessel coronary artery bypass grafting. This procedure also proves beneficial in patients with high risk who may be exposed to higher mortality. In these patients performing inadequate revascularization using this technique produces similar results.⁴ However incomplete revascularization has been associated with increased cardiac death, myocardial infarction, revascularization and readmission reported in treatment of multivessel disease with drug eluting stents.⁵ Minimally invasive coronary artery bypass grafting (MICABG) can be accomplished using a small anterior thoracotomy of 6–8 cm or with the help of Robotic assistance using the same incision or with performing the complete operation through endoscopic approach using robot (Total Endoscopic Coronary Artery Bypass). This incision has proved to be more beneficial than a standard sternotomy in reducing the complications.⁶ MICABG approach is less technology intensive and cheaper to perform. Its comparison with an OPCAB technique reveals equitable results.⁷ Though, safety of the procedure and reproducibility are also the important considerations,⁸ this approach is feasible in active CABG program and is being currently pursued as an alternative to sternotomy CABG.

1. Method

Patients operated in the department of Cardiovascular and Thoracic surgery at Sanjay Gandhi Postgraduate Institute of Medical Sciences using MICABG were enrolled in the study. The patients enrolled were operated between August 2008 and August 2012. This is a retrospective analysis of cases. The permission from ethical committee of the institute was taken to extract the information from patient case records and hospital information system. The ethics committee waived the need for informed consent. Informed consent for MICABG was obtained from the patients before operation. They were also informed about the need of conversion to median sternotomy if required.

2. Anesthesia and patient position

Regular general anesthesia protocol is followed with double lumen endotracheal intubation. This is required to deflate the left lung while the surgery is performed to improve the exposure. The patient position is supine with 30° right lateral.



Fig. 1 – Incision and its retraction.

3. MICABG procedure

A 6–8 cm incision is placed in the anterior chest wall straddling the nipple on left side. Site of incision was slightly altered depending on the number of vessel to be grafted and the habitus of the patient. Incision is placed on the 5th intercostal space and the chest cavity entered through 4th or 5th space or sometimes using both the spaces to improve the exposure of all the vessels. The undercutting of the skin incision is required to prevent the rib fracture. To limit the size of incision narrow blade retractors with variable depth were used. To improve the vision further the retractor to lift the sternum was utilized.

Left internal mammary artery (LIMA) was harvested under direct vision and then radial artery (RA) was harvested from left arm whenever multivessel grafting was intended. LIMA to RA “Y” was prepared using 8-0 polypropylene suture. Retraction of small chest incision was performed using Thoratrak retractor (Medtronic Inc, Minneapolis, Min), Fig. 1 and LIMA exposure was enhanced by Fehling retractor (Fehling, Germany). Stabilization of heart was done using octopus NS and octopus NS nuvo (Medtronic Inc, Minneapolis, Min) and for lateral territory grafts Starfish NS (Medtronic Inc, USA) Fig. 2, was also utilized to avail adequate displacement of heart for better exposure. LIMA was used for grafting left anterior descending artery and RA was used for grafting other vessels.

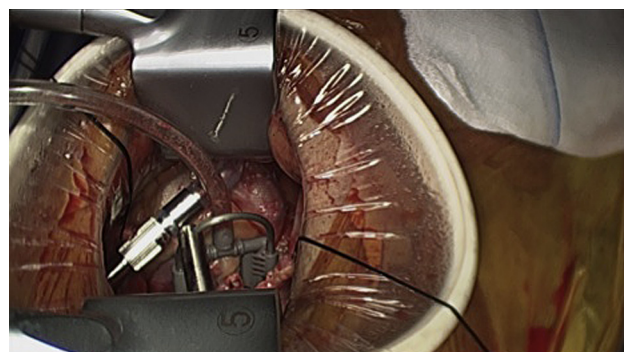


Fig. 2 – Grafting of lateral territory of heart.

Sequential anastomoses of RA were performed if more than two grafts were required. All the distal anastomoses were performed using 8-0 polypropylene suture. Initial 4 patients received saphenous vein graft, later all patients received radial artery. The operation was performed using off-pump technique.

4. Results

A total of 33 patients were operated in the department of cardiovascular and thoracic surgery of Sanjay Gandhi Post-graduate Institute of Medical Sciences, Lucknow. The median age of patients was 58.5 years (41–77) and all were male. There were 7 single vessel, 14 double vessel and 12 triple vessel disease patients. All the patients selected for the MIDCAB approach had normal ejection fraction (60%) with normal left ventricular size, end diastolic dimension (LVED) 46 mm (42–52) and end systolic dimension (LVES) 28 mm (17–39). Number of grafts proposed and performed is mentioned in Table 1. Conduits used in performing CABG are mentioned in Table 2. Postoperatively the LVEDD reduced significantly to 44 mm (34–49) $p = 0.02$ while LEVS and LV ejection fraction did not change significantly. Though statistically significant such a small change can be just a variation in measurement in light of already normal left ventricular function.

While performing MICABG 2 patients had pleural adhesions, 2 patients had intramyocardial left anterior descending artery and 3 patients developed atrial fibrillation during operation. There were 2 conversions to median sternotomy. One patient had no flow in the dissected LIMA due to dissection in the proximal part and other had bleeding from the LIMA–RA “Y” anastomosis. Left IMA was used as a free graft in proximally dissected IMA, while LIMA to radial artery bleeding was secured in the other patient. There was no 30-day mortality. None of the patients required reoperation for bleeding or other reason. The median hospital stay was 7 days (5–10) and intensive care unit stay was 26 h (20–48). Patients were ventilated for 10 h (6–12) and blood loss was a median of 330 ml (150–850). Twenty two patients did not require blood transfusion while 8 patients required a single unit of blood and three required 2 units of blood. Three patients required 4 units each of fresh frozen plasma while platelets were not transfused for any patient.

During follow up of median 2.5 years (6 months–4 years) 3 patients presented with angina class II and one with acute myocardial infarction 6 months following MIDCAB. Two

Table 1 – Number of grafts performed in patients and completeness of revascularization.

	n = 33 Median (minimum–maximum)
Number of grafts proposed (n)	2.5 (1–5)
Number of grafts performed (n)	2 (1–4)
Single graft	10
Two grafts	19
Three grafts	3
Four grafts	1

Table 2 – Conduits used in patients.

Conduits	n = 33
Left internal mammary artery	33
Saphenous vein graft	4
Radial artery	19

patients underwent coronary angiography. The patient developing acute myocardial infarction, had occluded LIMA–LAD anastomosis, he underwent a successful PTCA. One patient had angina due to appearance of new disease in one of the obtuse marginal artery, which underwent PTCA. Two patients had working LIMA–LAD grafts. Angina was considered to be arising from other coronary arteries not justifying invasive intervention and thus antianginal treatment was recommended.

5. Discussion

Multivessel CABG using total arterial revascularization is a safe procedure in low risk patients. Dissection of LIMA under direct vision from small incision is the first step in the procedure. It is safe and reproducible.⁹ Use of radial artery as a conduit helps in sparing the aortic manipulation in achieving the multivessel revascularization. It also helps in sparing the leg incision that helps in early mobilization. Though, the use of radial artery as a Y conduit on LIMA should be limited to coronary vessels with severe stenosis.¹⁰ Lemma performed a physiological study on LIMA and radial artery “Y” graft and has shown an increment in the LIMA and RA flow under situation of incremental exercise.¹¹ These facts make the choice and use of LIMA–RA “Y” safe and effective. In our experience MICABG procedure can also be performed safely with pleural adhesions. After deflation of left lung, a minimal amount of dissection of pleural adhesion helps in achieving adequate exposure. Intramyocardial LAD can also be dissected from the same incision. This procedure also ensures the adequate exposure to graft all the territories of coronary arteries. The patency rates of various anastomoses are comparable to OPCAB procedures.¹² Further, the outcomes of 7 years following MIDCAB are similar to standard CABG.¹³ Our study and initial experience has 10% incidence of angina and 3% incidence of acute myocardial infarction. These were comparable to other groups.^{14,15} Repeat revascularization was done in 6.6% patients over the median follow up period of median 2.5 years. Conversion to median sternotomy was performed in 6.6% cases, though all the operations were performed and completed using off-pump technique.¹⁶

MICABG has conclusively shown to have better result than PTCA to LAD with bare metal or even drug eluting stent.¹⁷ Further studies have proven the adequate and comparable result in mid term with this procedure. Though, it has been indicated that the procedure is more complex and should be performed by an experienced surgeon. MIDCAB and MICABG are similar procedures and sometimes used interchangeably. However MIDCAB utilizes a more anterior incision and thus is considered good for LAD grafting while MICABG uses a smaller and more lateral incision giving good exposure of all the vessels to be grafted.¹⁸

It has been established that minimizing the length of hospital stay or frequency of postoperative complications are among the highest-impact methods for reducing hospital costs.¹⁹ To analyze the influence of the surgical approach on total hospital costs, prospective analyses of 2 cohorts undergoing off-pump coronary revascularization by use of either a minithoracotomy or sternotomy were compared. The same surgeon performed all procedures, and the patient groups were matched for the number of coronary arteries revascularized and risk factors known to influence perioperative outcome.²⁰ Patients in the minithoracotomy group had shorter intubation times (4.8 ± 6.4 versus 12.2 ± 6.2 h, $p < 0.001$), intensive-care unit stay (21.9 ± 9.3 versus 50.6 ± 27.3 h, $p < 0.001$), total hospital stay (3.8 ± 1.5 versus 6.4 ± 2.2 days, $p < 0.001$), and lower blood transfusion requirements (0.2 ± 0.4 versus 1.4 ± 1.4 units, $p < 0.001$). Intraoperative assessment of flow is considered state-of-art facility today and strongly advocated by some groups.²¹ In the present study intraoperative graft assessment was not performed.

6. Conclusion

MICABG procedure is effective and safe in achieving multi vessel revascularization. The outcomes are comparable to conventional surgeries. Though the incomplete revascularization rates are higher with this procedure, MIDCAB remains an effective tool in achieving revascularization with complete occlusion of LAD, repeated in-stent stenosis and lesion not suitable for stenting for anatomical reasons.

Conflicts of interest

All authors have none to declare.

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