

Minimally Invasive Coronary Artery Bypass Surgery



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Ever since May 1967 when Favoloro and Effler began performing reversed saphenous vein graft at the Cleveland clinic (1) there have been fast moving advances in the field of coronary artery bypass surgery. In early 90's, the concept of less tissue disruption, shortened patient recovery and cost effective delivery of myocardial revascularisation was introduced as minimally invasive coronary bypass surgery.

The definition of minimally invasive surgery is still unclear but presently 81% of surgeons believed that absence of use of cardiopulmonary bypass was the defining factor whereas the other group (19%) thought that size of the incision was more important component (2).

However, the ultimate goal is to provide complete multiconduit revascularisation with minimal invasion while maximizing the safety and minimizing the risk and recovery time for patients requiring Coronary Artery Bypass Surgery (CABG) (3). The reduction of systemic inflammatory response subsequent to avoidance of Cardio-pulmonary Bypass (CPB) and use of small surgical access can lead to a reduction of in hospital morbidity and mortality (4).

Currently used minimal invasive techniques are :

1. Coronary bypass surgery performed via complete sternotomy without the use of cardiopulmonary bypass.
2. Minimally invasive CABG performed via small incision on beating heart.
3. Port access surgery using small incision on cardiopulmonary bypass and endovascular instrumentation.

Off pump sternotomy coronary bypass

Buffalo (5) and Bennetti (6) have come out with large series of myocardial revascularisation without cardiopulmonary bypass. The performance of revascularisation via complete sternotomy without CPB is a reconfiguration of accepted surgical techniques, through a small skin incision with adequate tissue mobilisation, a complete sternotomy, multi vessel procedure could be accomplished using stabilisation devices (7). This allows more accurate surgery on the beating heart. *Octopus* is the stabilisation device which has revolutionised this procedure. With its suction cups it allows adherence to and retraction of heart into the operative field with less packing and manipulation of the ventricle thereby minimizing hemodynamic compromise (8).

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Biggest advantage of off pump CABG with sternotomy is that it obviates the need of CPB thus expanding its indications to patients having contraindication to standard technique or with significant co-morbid factors such as renal, CNS or pulmonary disease (9). Moreover, it is cost effective also. Disadvantage being technically demanding and approach to posterior wall becomes difficult.

Minimally invasive off pump approaches

LAST operation meaning left anterior small thoracotomy is modified by Calafiore and Subramanian (10). Through a small anterior left thoracotomy incision, left internal mammary artery is harvested via a video thoracoscope and coronary revascularisation is accomplished. Technical performance is enhanced by the use of pressure plate stabilizers (11). These devices are designed to be placed through small incisions. Subsequently a variety of approaches to minimally invasive beating heart surgery have been developed. These include right anterior small thoracotomy for bypass grafting on right coronary artery, an abdominal approach for utilisation of the gastro-epiploic vessel in bypassing the posterior descending branch of distal right coronary artery. Hybrid procedures, combination of MIDCAB with coronary angioplasty especially in re-do coronary surgery. Whereas dense adhesions with mediastinum may be avoided.

Port access technique

The development of endovascular technology has allowed CABG and replacement to be completed via small incisions using cardiopulmonary bypass accomplished through endovascular technology using femorofemoral bypass. Endovascular CPB system consisted of a Y-shaped femoral arterial return canula. A femoral venous canula for drainage

of right atrium, an endopulmonary vent catheter and an endo aortic balloon occlusion catheter-endoaortic clamp (12).

Advantages of port access technique is that because of use of CPB, all coronary arteries can be reached for revascularisation without any hemodynamic compromise.

Technology advances

Minimally invasive CABG is technology dependant and fast moving advances occur rapidly. Areas of technology allowing advancements are :

Vessel Stabilisation devices have already been discussed, they include Octopus device in off pump sternotomy, CABG, and pressure plate device in LAST Midcab operation.

Control of blood flow in lumen of vessel to be bypassed is to be maintained so as to prevent distal ischemia. Intra-coronary shunts have been developed to maintain intraluminal blood flow yet they keep the field dry to allow for suture placement (13). These shunts are usually bulb tipped, longitudinal devices and are inserted into the lumen of the vessel when anastomosis is nearly completed and the shunt is removed.

Visual equipment that can produce three dimensional view of the intra-thoracic cavity and the heart to allow precise construction of anastomosis have been developed which allow brilliant light to be placed inside the thoracic cavity and three dimensional view can be seen either on a TV set or in mounted head set camera (14).

Specialised instrumentation for anastomotic construction. These include sutures, staples and biological glue (14). Robotic system will allow steady suture placement via robotic arms as well as

voice activated camera placement and surgical assistance.

Comment : Invasive coronary surgery continues to evolve. The pace is rapid, hence techniques as well as equipment becomes out-modelled fast. The procedure described for minimally invasive surgery currently belongs in the armamentarium of modern cardiovascular surgeons and enables the creation of 'Designer' myocardial revascularisation.

As Dr. Denton A Cooley noted "We must tailor the operation to the patient and not the patients to operation" (15). With the developing expertise, cardiovascular surgery will be able to better conform to this ideal.

References

1. Favoloro RG. Saphenous vein graft in the surgical treatment of coronary artery disease. Operative Technique. *J Thorac Cardiovasc Surg* 1969 ; 58 : 178.
2. Shennib H, Mack MJ, Lee AGL. A survey on minimally invasive coronary artery bypass grafting. *Ann Thorac Surg* 1997 ; 64 : 110-15.
3. Arom KV, Emery RW, Nicolff DM. Minimally invasive direct CABG-Experimental and clinical experience. *Ann Thorac Surg* 1997 ; 63 : 548-52.
4. Butler J, Rocker GM, Westly S. Inflammatory response to cardiopulmonary bypass. *Ann thorac Surg* 1993 ; 55 : 552-59.
5. Buffolo E, Andrade JCS, Succi *et. al.* Direct myocardial revascularisation without CPB. *J Thorac Cardiovasc Surg* 1985 ; 33 : 26-29.
6. Benneti FJ, Naselli G, Wood M. Direct Mycoradial revascularisation without extra-corporeal circulation. *Chest* 1991 ; 100 : 312-16.
7. Emery RW, Aromk KV, Lillehei TJ. Suture techniques of MIDCAB surgery. In : Techniques for minimally invasive bypass surgery (MIDCAB) Emery RW, Arom KV, Fonger JD *et. al.* (eds) Hanely and Belfus, Philadelphia 1997 ; 87-93.
8. Grundeman PF, Borst C, Herwardden V. Hemodynamic changes during displacement of beating heart by Utrech Octopus method. *Ann Thorac Surg* 1997 ; 63 : 885-935.
9. Tashio T, Todo K, Haruta Y *et. al.* CABG without CPB for high risk patients. *Cardio Vasc Surg* 1996 ; 4 : 207-11.
10. Subramanian VA, Sani G, Benneti FJ. Minimally invasive CABG. *Circulation* 1995 ; 92 : 645.
11. Pagni S, Paquish NK, Senior DG. Anastomotic complication in minimally invasive coronary bypass surgery. *Ann Thorac Surg* 1997 ; 63 : 564-67.
12. Fann JI, Pompli MF, Stevens JH. Port access operation with cardioplegic arrest. *Ann Thorac Surg* 1997 ; 63 : 535-39.
13. Rivetti LA, Gandra SMA. Initial experience using an intraluminal shunt during revascularisation of the beating heart. *Ann Thorac Surg* 1997 ; 63 : 1742-47.
14. Werker PMN, Kon M. Review of facilitated approaches to vascular anastomosis surgery. *Ann Thorac Surg* 1997 ; 63 : 5122-27.
15. Westaby S. Invited commentary of Ott *et al.* *Ann Thorac Surg* 1997 ; 64 : 478-81.

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