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# Multiple Coronary Artery Bypass Via Mini Left Thoracotomy With Conventional Aortic Occlusion

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## ABSTRACT

**Background:** Complete myocardial revascularization can be achieved through a mini left anterior thoracotomy. Our approach (West Coast Technique) takes advantage of the Port-Access™ (Heartport®, Redwood City, CA) concept while utilizing conventional instrumentation.

**Methods:** Thirty-eight patients underwent multiple coronary artery bypass grafting (CABG). Aortic occlusion was performed using a transthoracic clamp, and all anastomoses were performed under a single cross-clamp.

**Results:** There were no deaths and no neurologic deficits. There was one perioperative myocardial infarction (MI), and one re-exploration for bleeding. Ten patients (26%) required blood transfusions, and five patients (13%) developed atrial fibrillation. The average number of grafts per patient was 2.9, and average hospital stay was 5.2 days.

**Conclusion:** Multiple CABG can be accomplished safely through a minithoracotomy, which eliminates the need for endoaortic occlusion.

## INTRODUCTION

During the past four years, a number of techniques have been developed to perform multiple coronary artery bypass operations that meet the definition of minimally invasive procedures. Although surgeons have usually preferred to perform coronary artery bypass grafting (CABG) through a median sternotomy without extracorporeal circulation, patients are frequently more concerned with cosmetic effect, comfort, and the faster rehabilitation that results from avoidance of the sternal split. Until recently, only the Port Access™ (Heartport®, Redwood City, CA) technique provided an option that allowed us to accomplish a multiple CABG through intercostal access [Groh 1998].

The clinical objections to Port Access™ have been partially resolved by the development of the Endodirect™ (Heartport®, Redwood City, CA) approach that allows for cannulation of the ascending aorta [Glower 1999]. Yet, other aspects of the technique continue to make the procedure demanding on the surgical team. The anesthesiologist has to place two radial arterial lines to monitor innominate artery patency, a retrograde coronary sinus catheter, and a double lumen endotracheal tube. The perfusionist needs to control perfusion pressures more closely to avoid displacement of the Endoaortic clamp. Occasionally, when the central lumen of the Endoaortic™ clamp is against the wall of the aorta, cardioplegia delivery can be compromised and, in turn, aortic root venting becomes ineffective.

With the Port Access™ technique, the surgeon is faced with limited access, a wet coronary field, and an Endoaortic™ clamp that occasionally migrates. Construction of the proximal anastomosis requires a partial occlusion clamp placed through the wound, further decreasing the operating space. The presence of the latter not only limits surgical access but causes the anterior wall of the aorta to collapse increasing the technical challenge in constructing the proximal anastomosis. In addition, partial occlusion offsets the conceptual benefit of endoluminal occlusion. Our technique addresses these problems and incorporates the principles of traditional CABG with the small left anterior thoracotomy approach.

## MATERIALS AND METHODS

Thirty-eight patients were operated upon between January and December 1999. These patients were selected on the basis of body habitus, avoiding obese patients who might

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present an access problem. We chose patients with ejection fractions greater than 40%, without aortic insufficiency, and with good-quality coronary targets. There were 30 males (79%) and 8 females (21%). The average age was 65.1 years (range of 48-81). Twenty-three patients (60%) presented with unstable angina, nine (24%) with stable angina, four (11%) with acute myocardial infarction, and two (5%) in heart failure. Seven patients (10%) had diabetes, ten (26%) had a history of previous myocardial infarction, thirteen (34%) were smokers, and eight (21%) had left main coronary artery lesions. The number of grafts per patient was 2.9, with twelve patients having a double bypass, seventeen having a triple bypass, and nine having a quadruple bypass. All patients had the left internal thoracic artery grafted to the left anterior descending coronary artery. The cross-clamp times varied between 42 and 116 minutes, with a mean of 65 minutes. The average time of extracorporeal circulation was 103 minutes (range of 70-167). All anastomoses were performed under a single cross-clamp.

***Surgical Technique***

*Incision:* Access was obtained through the fourth intercostal space. In males this occasionally coincides with the nipple and the skin incision is made just below it for aesthetic purposes. In females the incision is always made under the breast. No ribs are resected. Upon entering the left chest cavity, the lung is collapsed using the previously placed double lumen endotracheal tube. The Limavator (Genzyme Surgical Products, Tucker, GA) retractor is inserted and the ribs slightly separated. Before the retractor is opened further, we divide the intercostal muscles as posteriorly as possible to reduce the chance of fracturing the ribs. It is at this point that the Rultract (Rultract-Pemco Inc., Cleveland, OH) component of the system should be attached to the Limavator and lift initiated. Prior to proceeding, we infiltrate the chest wall at two intercostal levels above and below the incision with a long-lasting local anesthetic. We repeat this maneuver before closing the chest. This not only helps with pain control but also assists in achieving early extubation.

*Internal Thoracic Artery (ITA) Dissection:* The ITA is easily identified along the chest wall, and dissection is accomplished in a manner similar to the technique used with a median sternotomy. We use a conventional cautery with an extended tip at low power. The ITA is dissected throughout its whole length since this exposure provides excellent direct visualization from the innominate vein to the diaphragm. No thoracoscopic assistance is used, but a headlight is mandatory.

*Cardiac Exposure:* The pericardium is opened medially with the purpose of creating a cradle effect. This avoids major displacement of the heart into the left chest at the conclusion of the procedure. Pericardial suspension sutures are placed and brought through the chest wall using a #12 angiocath and a crochet hook. The sutures not only retract the pericardium but also lift the right side of the mediastinum and facilitate exposure of the right side of the heart and the aorta.

*Arterial Cannulation:* Central aortic cannulation is desirable to avoid retrograde perfusion. Elevation of the chest wall facilitates placement of the purse-string sutures and insertion of the cannula. We prefer to cannulate the arch as opposed to the distal ascending aorta, particularly in patients with a prominent pulmonary artery. Distal aortic cannulation allows more room for clamping and performance of the proximal anastomosis. Recently the Toronto group showed that distal cannulation of the aorta reduces the incidence of cerebral microembolization [Borger 1999]. The cannula of choice is the 7.0 Sarns softflow (3M Healthcare, Ann Arbor, MI) because it has multiple openings. This configuration reduces the concern of cannula positioning. The ring on the cannula is removed. Two pledgeted sutures are placed at the chosen site of cannulation. An umbilical tape is passed through the cannula opening and the tails of the tape are passed through a stab wound at the level of the second intercostal space into the chest. Traction on the umbilical tape with simultaneous guidance of the cannula delivers the cannula into the chest. To facilitate deployment of the cannula into the aorta, a Javid clamp is used to control the cannula approximately three-quarters of an inch from its tip. This maneuver provides the needed stabilization to penetrate the aorta with ease. An aortotomy is made with a #15 blade and the cannula is introduced. The markers on the cannula are used to judge the depth of insertion. The cannula is tied in place and the slack pulled outside of the chest.

*Venous Cannulation:* Drainage is obtained by femoral venous cannulation. We generally prefer to cut-down on the femoral vein with a small transverse incision in the groin. A purse-string of 5-0 polypropylene suture is placed in the vein and secured with a tourniquet. Cannulation is accomplished without applying clamps to the femoral vein. We have not encountered problems with deep venous thrombosis and we attribute this to the "no touch" technique we employ. A small stab wound is used within the purse-string and a #28 DLP (Medtronic, Inc. Minneapolis, MN) three-stage cannula is advanced over a wire under strict transesophageal echocardiographic control. Position of this cannula is critical and when properly placed, just below the junction of the superior vena cava and the atrium, drainage is consistently satisfactory. Cardiopulmonary bypass (CPB) is initiated and flows stabilize. The 5-0 suture is used to secure the femoral vein following decannulation.

*Aortic Clamping:* A Scanlan-Chitwood (Scanlan International, Inc., St. Paul, MN) clamp is used to occlude the aorta. The clamp is brought into the chest through a separate stab wound at the level of the third intercostal space under direct vision. The smaller of the two clamps available is large enough for most patients. Cardioplegia is delivered antegrade through a 12- or 14-gauge angiocath that also serves as an aortic root vent.

*Construction of the Anastomoses:* All proximal and distal anastomoses are constructed under a single cross-clamp. All distal coronary vessels are readily accessible by entering the chest through the fourth intercostal space. The use of a

single cross-clamp not only is in line with evidence of reduction in the risk of stroke [Aranki 1994] but also facilitates sewing the proximals on the aorta. A single cross-clamp allows for a flaccid vented aorta, making the construction of the proximal anastomosis easier than working with a partial occlusion clamp in the wound.

*Arterial Decannulation:* Once cardiopulmonary bypass (CPB) has been discontinued, we recommend the separation of the arterial line from the arterial cannula and transfer to the venous cannula prior to decannulation. This simple maneuver provides the opportunity to transfuse rapidly through the venous line in the event of bleeding during aortic decannulation. The previous placement of two purse-string sutures makes aortic decannulation safer. The assistant controls the cannulation site by cinching one of the sutures with a tourniquet after the surgeon removes the cannula. Both purse strings are tied as usual. This maneuver is easier when performed with the left lung collapsed.

## RESULTS

There were no deaths. Major complications included one perioperative myocardial infarction, and one re-exploration for bleeding. Two patients required intubation for more than 48 hours. There were no neurologic deficits, and only ten patients (26%) required blood products. Five patients (13%) developed atrial fibrillation, one of which required a prolongation of hospital stay.

## CONCLUSION

At a time when major changes are taking place in the performance of coronary artery bypass grafting, surgeons are facing the dilemma of offering patients an operation with or without CPB, and with or without a sternotomy. The patients' perception of minimally invasive surgery is that in which the surgical trauma is minimized. The West Coast Technique allows for the performance of multiple coronary bypasses applying the principles of classical coronary surgery and utilizing conventional instrumentation. Some modifications have been introduced to the classical techniques in order to accommodate operating with limited access.

## REFERENCES


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## REVIEW AND COMMENTARY

***1. Editorial Board Member MB134 writes:***

This is an incremental step forward, for which sound reasoning and adverse case experience from prior techniques is openly discussed. There are very clear explanations of methods, such that a reader can implement these recommendations. Reasons for each portion of the operative technique are well stated and match the experience others have had with minimally invasive techniques.

The one weakness is theoretical. The whole operation is designed to avoid a sternotomy. There appears to be no other discrete advantage over conventional surgery. Thus, selection of patients is dependent on the patients' expectations and desires for a less invasive approach. The authors do not discuss rib fractures, costochondral dislocations, lung hernias, or post-thoracotomy pain as a consequence of their approach, but all of these have been drawbacks for MIDCABs and mini-valves using a lateral intercostal approach. Thus, it appears to come down to a matter of personal and patient philosophy whether this operation should be favored over conventional sternotomy, or even trans-sternal OPCAB.

One additional equipment change could be used. The aorta can be cannulated with Seldinger style cannulas such as the RMI Fem-Flex 2. The purse string can be smaller, as the aorta is dilated to accept the device. This reduces the initial cut and the bleeding effects of aortic cannulation. The cannula can be directed downward into the descending artery. I agree that this is a safer position with reduced neurologic side effects.

***Authors' Response by Alex Zapolanski, MD:***

In the early stages of the MIDCAB or "West Coast Technique" procedures, we did cause rib fractures and occasionally costochondral dislocations. We rarely have these problems today because we control rib separation with the use of the Limavator. Post-thoracotomy pain remains a problem in the first 24 to 48 hours in some patients. We have considered using the RMI Fem-Flex 2 cannula.

The rigidity of the obturator limits the angle of penetration through the skin. In addition, the multiple holes in the 7.0 Sarns cannula have provided us with less resistance, and the position of the cannula in relationship to the wall of the aorta is irrelevant since the cannula has so many openings.

***2. Editorial Board Member SC389 writes:***

I would like to know the average number of grafts per patient that were done on the sternotomy patients.

***Authors' Response by Alex Zapolanski, MD:***

The average number of grafts for sternotomy patients was 3.6. It is clear that the cases we selected for this tech-

nique required fewer grafts, particularly as we were developing the operation. I must point out that a number of patients had four bypasses.

***3. Editorial Board Member TL41 writes:***

It would be better if the paper were to be subtitled to indicate its limited scope, e.g., "A new approach to multiple coronary artery grafting." In the absence of diagrams or other illustrations, the description of the technique is rather opaque and relies excessively on proprietary names.

***Authors' Response by Alex Zapolanski, MD:***

I apologize for the lack of diagrams, but I will provide the film of the procedure as it was presented at the CTT in Ft. Lauderdale. The use of proprietary names was meant to facilitate the reproduction of the technique by other colleagues. I have no personal benefit from the promotion of any of the equipment.

***4. Editorial Board Member NM341 writes:***

Forty percent seems high for the cut-off between low and normal EF. The definition used for "urgent" seems unclear. Grouping patients with acute hemodynamic compromise together with patients with left main artery disease raises difficulties with calculating risk-adjusted mortality. Another weakness is that the group of patients is too heterogeneous and poorly defined.

***Authors' Response by Alex Zapolanski, MD:***

The majority of the patients whom we chose were intentionally low risk, which is advisable for any new technique.