The Heart Surgery Forum #2007-1155
11 (2), 2008 [Epub April 2008]
doi: 10.1532/HSF98.20071155

Online address: http://cardenjennings.metapress.com

# Vettath's Technique of Long Mammary Patch Reconstruction of a Diffusely Diseased Left Anterior Descending Coronary Artery without Endarterectomy on the Beating Heart

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## ABSTRACT

Surgery for diffuse coronary artery disease requires coronary reconstruction with or without endarterectomy. Considering the immediate and late postoperative problems of coronary endarterectomy, many surgeons now prefer coronary reconstruction without endarterectomy. Patch reconstruction of the diseased coronary artery with either the internal mammary artery or another conduit is an attractive option. This article describes the technique of long mammary patch reconstruction of the left anterior descending coronary artery without endarterectomy as an off-pump procedure.

## INTRODUCTION

The off-pump coronary artery bypass grafting (OPCAB) technique of coronary revascularization has proven good results in the short and long terms. The main obstacle in performing coronary revascularization as an off-pump procedure is the technical challenge of maintaining hemodynamic stability during grafting [Buffolo 1990; Benetti 1991; van Dijk 2001; Angelini 2002; French 2004; Khan 2004; Lytle 2004; Puskas 2004]. Once the learning curve has been ascended, OPCAB becomes an effective tool in a surgeon's armamentarium for the surgical treatment of coronary artery disease (CAD) [Karmanokian 2000; Ricci 2000; Caputo 2001; Jenkins 2003; Puskas 2003].

Diffuse CAD is usually a surgically treated disease. Sometimes, such patients require a coronary endarterectomy (CE) and CAB grafting (CABG) for effective revascularization [Livesay 1986; Bezon 2006]. Performing a CE as an off-pump procedure is technically demanding; hence, many surgeons resort to cardiopulmonary bypass for coronary revascularization. As a consequence, the patient is exposed to the insults of cardiopulmonary bypass, as well as to the short- and long-term problems of CE [Minale 1989; Iran 2001; Marinelli 2002].

Given these facts, off-pump coronary reconstruction of the left anterior descending coronary artery (LAD) with the left internal mammary artery (LIMA) has gained popularity among surgeons. The technique for this procedure is well described [Barra 2000a, 2000b; Fukui 2005], but the procedure becomes most challenging if the coronary reconstruction exceeds 4 to 5 cm in length. The challenges confronting the surgeon include maintenance of hemodynamic stability through the anastomoses, obtaining a bloodless field for surgery, maintaining distal perfusion after the coronary arteriotomy, and construction of a good anastomosis between the LIMA and the LAD.

In this article, we describe the technique developed by one of the authors (M.P.V.) for long mammary patch reconstruction (MPR) of the LAD (exceeding 4 cm in length) on the beating heart.

## MATERIALS AND METHODS

Between July 2002 and April 2007, 1227 patients underwent CABG in this institution, and 972 of these operations were done as an off-pump procedure. MPR was required for 104 patients who had diffuse CAD, and 21 of these patients had anastomosis lengths of 4 cm or greater, which we describe as "long MPR" in this report.

### *Preoperative Evaluation*

If a CAD patient had diffuse disease involving the mid and distal LAD, with an identifiable LAD lumen distally (filling in an antegrade or retrograde manner according to the angiogram) and patent septal or diagonal branches originating from the diseased segment, we planned an MPR. Performing such an analysis in advance is important because it helps the surgical team to prepare for the procedure.

The final decision for an MPR is always made on the operating table after a consideration of the state of the diseased LAD, the quality of the LAD distally, and the presence of open diagonal or septal branches originating from the diseased segment.

*Received July 27, 2007; received in revised form November 28; accepted January 24, 2007.*

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***Procedure***

MPR is performed via a median sternotomy. Good exposure is necessary for successful completion of the procedure without hemodynamic compromise. The pleura is opened widely on both sides to allow for adequate cardiac dislocation. This positioning also allows pericardial retracting sutures to hold the heart up from the left side and move it into the surgeon's field.

The LIMA is harvested from its origin from the subclavian artery well into its branches for about 2 cm distally. Including the branches in the LIMA segment yields added length to the conduit for constructing a mammary patch without stretching the LIMA or putting tension on the anastomosis. It also allows dislocation of the heart for posterior, lateral, and inferior anastomoses. Semi-skeletonizing the IMA or splitting the thoracic fascia longitudinally yields additional length. In the process, any area of spasm on the LIMA can be visualized as well. A diluted papavarine solution is injected into the LIMA from the distal divided end. The LIMA is allowed to pulsate against the distal occlusion. The LIMA is dedicated to the LAD and is not shared with any other coronary artery.

Once the LIMA is harvested, the heart is lifted up into the surgical field by traction on retracting sutures and by placing wet sponges behind the heart. The LAD is inspected, and the anastomosis segment is planned. The LAD arteriotomy extends from just distal to the most proximal critical occlusion to the normal coronary lumen distally; hence, adequate stabilization of the entire planned segment is critical.

Arteriotomies longer than 4 to 5 cm require the use of 2 stabilizers, one facing the other. During arteriotomy, utmost care is necessary to avoid dissection or spiraling of the incision. The chances of both of these events are high in diffusely diseased and nearly totally occluded coronary arteries.

Once the arteriotomy is completed, distal coronary perfusion is ensured through the use of intracoronary shunts. Conventional intracoronary shunts (ClearView; Medtronic, Minneapolis, MN, USA) are inadequate for such long arteriotomies. M.P.V. has successfully modified the tips of conventional aortocoronary shunts (QuickFlow, Medtronic) into intracoronary shunts by using their distal ends to achieve distal coronary perfusion. These shunts are made of polymeric silicone (Silastic) and have an occluding doughnut at one end. This end is introduced into the distal end of the arteriotomy. If the predominant coronary flow is antegrade (which is rare), this end is introduced into the proximal end of the arteriotomy. The cut end of the shunt is inserted into the other end of arteriotomy (Figure 1). For smaller coronaries, we sometimes use the Ross shunt (intra-arterial shunt; Beating Heart, Sydney, Australia).

The shunt, being flexible, often "bowstrings" across the incision. It is tacked down to the coronary margin with a 7-0 polypropylene suture at the midpoint of the arteriotomy, and the suture is brought together with a Liga Clip (Ethicon Endo-Surgery, Guaynabo, Puerto Rico, USA), so that the anastomosis can be constructed without hindrance from the shunt. This tacking suture is removed once the midpoint is crossed during anastomosis.

A patch is fashioned by slitting the LIMA longitudinally so that the length of the opening matches the length of the LAD arteriotomy. The LIMA-to-LAD anastomosis is started at the heel, and 7-0 polypropylene suture is used to construct the anastomosis. The bites on the LIMA are taken to its edge, and bites on the coronary artery are taken to exclude all of the plaques from the neocoronary lumen. All of the bites are taken from the inside out in the coronary artery so as to fix the plaques. The openings of patent diagonal and septal branches are included into the neocoronary lumen. The reconstructed coronary artery is constituted by the native coronary artery in the posterior one third and by the LIMA in the anterior two thirds.

The suture passes through diseased and calcified coronaries during the anastomosis and hence rapidly loses its tensile strength. Therefore, M.P.V. uses a second suture beyond the midpoint of the anastomosis. Thus, the anastomosis is completed with 2 sutures, one on each side.

Once the suturing is about to be completed, the Silastic shunt is taken out of the LAD by means of a nerve hook passed between the sutures, which are kept loose. The LIMA is allowed to bleed across the anastomosis, and the suture is tightened by gentle traction until the bleeding from the anastomosis simply stops. Further hemostatic sutures are taken only when absolutely necessary. The authors prefer to wait until protamine is administered before suturing any bleeding anastomoses.

Any sizable diagonal arising from the diseased segment with a totally occluded ostium requires separate grafts. Hence, the surgeon should identify such totally occluded diagonals and ascertain their area of distribution for grafting.

Good anesthesia support is necessary for successful completion of MPR on the beating heart. Minimal handling of the heart and an attention to the finer details are a must during anastomosis. The visibility of the coronary edge can be enhanced by using a blower and intermittent saline washing.

If there is any hemodynamic instability, the heart is dropped down into the pericardium, and the packs are removed from behind the heart. Most often, the heart recovers, and anastomosis can then proceed. Gross hemodynamic compromise may necessitate placement of an intra-aortic balloon pump. Cardiopulmonary bypass is rarely, if ever, necessary.

## RESULTS

Twenty-one patients underwent long MPR of the LAD by means of the described technique. Of these patients, 20 (95%) were male, 15 (71%) had diabetes, 12 (57%) had hypertension, 18 (85%) had hyperlipidemia, and 10 (47%) were smokers preoperatively.

In 12 patients (57%), the use of long MPR was predicted on the basis of the criteria described prior to surgery.

There was no conversion to cardiopulmonary bypass, and no patient required placement of an intra-aortic balloon pump during or after anastomosis. No patients received anticoagulants or low molecular weight dextran in the postoperative period. All patients were given heparin (as prophylaxis for deep vein thrombosis) and aspirin/clopidogrel postoperatively.

There was one postoperative myocardial infarction in this subset of patients (based on enzyme criteria) [French 2004].

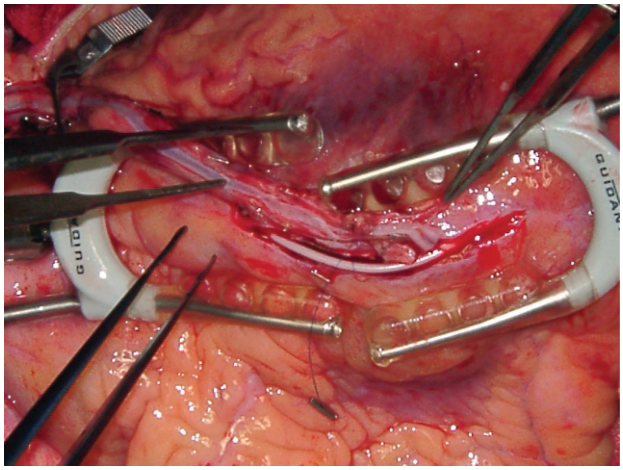

Figure 1. Long mammary patch reconstruction in progress with the double-stabilizer technique.

There was no mortality. The mean (±SD) mediastinal blood loss in the intensive care unit was 368 ± 134 mL, and mean blood/blood product usage was 2.6 ± 0.4 units. The mean postoperative stay in the intensive care unit was 3.2 ± 0.8 days, and the mean postoperative hospital stay was 7.8 ± 0.6 days (Table 1).

There has been no mortality in the postoperative follow-up (range, 6 months to 3 years), and all patients are in functional class I or II. Two patients agreed to undergo a coronary angiogram at 2 years postoperatively, and both anastomoses showed excellent patency.

## DISCUSSION

With the advent of percutaneous intervention and aggressive stenting, even for triple-vessel disease, surgeons are getting increasing numbers of CABG referrals for patients with diffusely diseased coronary arteries. CE had been the only option available for revascularization of these coronaries. Although CE accomplished the goal of revascularization, it always carried an increased morbidity and mortality compared with CABG alone, and the long-term results were poor. Hence, coronary artery reconstruction without endarterectomy came into vogue. Most often, the reconstruction extends for lengths of 5 to 10 cm.

Table 1. Characteristics of the Patients in the Study Group (n = 21)*

| | |
|---|---|
| Male/female sex, n | 20/1 |
| Diabetes, n | 15 (71%) |
| Hypertension, n | 12 (57%) |
| Dyslipidemia, n | 18 (85%) |
| Smoking history, n | 10 (47%) |
| Mean blood drainage in ICU, mL | 368 ± 134 |
| Blood/blood product use, units | 3.6 ± 0.4 |
| ICU stay, d | 3.2 ± 0.8 |
| Postoperative hospital stay, d | 7.8 ± 0.6 |
| Hospital mortality, n | 0 |

*Data are presented as the mean ± SD where appropriate. ICU indicates intensive care unit.

A long MPR is a surgical challenge as an off-pump procedure. A conscious effort from the entire surgical team is the most vital requirement for the successful completion of this procedure. The surgeon attempts to complete the procedure in the shortest possible time without compromising the quality of the anastomosis, while at the same time minimizing cardiac dislocation and maintaining flow to the distal myocardium with intracoronary shunts. The anesthesiologist is a key participant in the procedure. Therefore, the learning curve for acquiring the expertise necessary for successfully performing a long MPR involves the entire surgical team and not the surgeon alone.

Although the procedure seems demanding, the heart tolerates dislocation and handling much better than a heart with discrete coronary lesions, probably because it has been preconditioned by chronic ischemia.

The immediate and intermediate-term performance of patients who undergo this procedure is comparable with that of patients who undergo CABG alone. The increased operative mortality and morbidity, the use of cardiopulmonary bypass, and anticoagulation therapy in the postoperative period that are associated with CE have all been eliminated. Hence, the procedure will be a valuable tool for any surgeon dealing with diffuse CAD.

## CONCLUSION

Off-pump long MPR of the LAD is technically demanding but possible, with excellent results in the immediate and intermediate terms.

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