10 Plus-Years Follow-Up after Patch Angioplasty of the Left Main Coronary Artery

J. Ernesto Molina, M.D., Ph.D.¹

ABSTRACT

In ostial or proximal left main coronary artery (LMCA) obstruction, re-establishment of normal antegrade flow via the main trunk may be preferable to distal bypass grafting. The objective of this study was to assess the effectiveness of patch plasty of the left main (LM) trunk of the coronary artery for more than 10 years. Direct widening of the LMCA was recommended to patients with ostial, proximal, or midpoint stenosis of the main trunk. Group I of 16 patients had isolated LM obstruction with no distal disease, and Group II of 15 patients had, in addition, right coronary obstruction. The mean age was 60.9 years (age group, 47 to 83 years). Nineteen patients underwent this operation through an anterior transverse aortotomy. No endarterectomies were performed. In Group II, in addition, a single saphenous vein bypass graft was placed in the right coronary artery. There were no operative deaths. Follow-up period extends from 10 to 18 years (mean 11.2). Eight patients had angiography from 3 to 9 years after surgery and all show adequate LM trunk caliber. Noncardiac deaths occurred in five patients (26.3%) at 2 months, and 1, 4, 6, and 7 years after surgery. Two women with isolated ostial stenosis diagnosed as a spasm have not shown progression of coronary disease 7 to 9 years after the operation. Widening of the LMCA should be considered in selective cases, only when ostial, proximal, or midportion stenosis of the main vessel exist, even if a right coronary bypass graft is required.

KEYWORDS: Angioplasty, coronary artery, cardiac catheterization, left main coronary artery disease, coronary intervention, saphenous vein, vessel repair

Significant stenosis of the left main (LM) coronary vessel represents a highly threatening condition that requires prompt intervention to prevent certain death. Most commonly, the presence of LM obstruction is associated with more distal peripheral coronary vascular disease, but in a small percentage of cases, it presents as an isolated condition. Usually, this problem is treated by urgent coronary bypass surgery implanting arterial or vein grafts in the distal vessels, namely the left anterior descending (LAD) coronary artery and circumflex systems. However, in cases where the distal vessels are not involved or mildly involved, the re-establishment of a

normal antegrade flow via the main trunk should be preferable over placement of distal bypass grafts that provide retrograde circulation to a very large area of myocardium.

Throughout the years there have been isolated reports of operating directly on the left main coronary artery (LMCA) by creating a patch using either saphenous veins pericardium or even arterial patches to solve this obstruction. In previous reports, the follow-up periods have extended from a few months to slightly over 3 years. In 1983, Hitchcock et al reported that nine patients were operated using a posterior aortotomy

¹Division of Cardiothoracic Surgery, Department of Surgery, University of Minnesota, Medical School, Minneapolis, MN.

Address for correspondence and reprint requests: J. Ernesto Molina, M.D., Ph.D., 420 Delaware Street S.E., MMC 207, Minneapolis, MN 55455 (e-mail: molin001@umn.edu).

Int J Angiol 2011;20:143–148. Copyright © 2011 by Thieme

Medical Publishers, Inc., 333 Seventh Avenue, New York, NY 10001, USA. Tel: +1(212) 584-4662.

Published online: July 5, 2011.

DOI: <http://dx.doi.org/10.1055/s-0031-1283217>.

ISSN 1061-1711.

incision.¹ In Effler et al's report back in 1965,² a more anterior approach was implemented. Endarterectomy was also proposed of the segment involved. Dion et al³ reported performing these surgical angioplasties in 22 patients using posterior and anterior aortotomy approach. They found that the anterior approach was preferable, giving better exposure. Their follow-up period extended only up to 24 months. The angiography performed in 14 patients showed excellent results in 13. Horii (Horii T, personal communication, 1998) also reported 10 patients operated in this manner with excellent mid-term 2-year follow-up results. The report by Jönsson⁴ had a follow-up with a mean of 45 months also with good results. In the most recent review article by Chikwe⁵ in 2010, the only article quoted is the report by Dion reporting a patency rate at 75 months of 87% with an early technical failure rate of 10%, which had not been reported in other studies. The study by Raanani⁶ showed no early mortality, but the follow-up period extended to only 55 months. Nevertheless, the transesophageal echo done on these patients showed all of them having a normal flow pattern and normal caliber of the LM trunk. Therefore, the method of direct approach of the LMCA in cases with ostial or proximal obstruction and no calcification seems to offer a good alternative to the most common practice of implanting bypass grafts to the distal vessels which provides only retrograde flow to a large mass of myocardial tissue.^{7,8}

This direct patching technique seems to be even more properly indicated in cases with LM coronary spasm, which we have seen in young people, particularly women who experience the type of so-called Prinzmetal angina with perfectly normal coronary vasculature beyond the LM ostia and no calcification. We found two such cases in our current report as described in the next section.

METHODS

This study was approved by the IRB committee of the University of Minnesota under the number 1102E96072.

Figure 1 Classification of the left main coronary obstruction level as proximal, midportion, and distal.

Figure 2 A case of left main proximal coronary obstruction.

Between January 1, 1992 and December 31, 2000, 8720 coronary angiograms were performed on 5529 patients with coronary disease. Ostial or LM coronary obstruction was found in 468 patients (8.46%). We classified the position of the obstruction at three levels to plan our surgical approach as shown in Fig. 1. An ostial or proximal obstruction was found in 151 (32.2%) (Fig. 2), midpoint obstruction in 74 (15.8%) (Fig. 3), and distal LM obstruction in 243 (52%). Therefore, the great majority of patients with LM obstruction have distal LM disease, which in our criteria was not amenable for direct surgical approach (Fig. 1). Therefore, only the patients showing disease in the first two categories were considered candidates for the type of operation planned. Among these 225 patients comprising the two categories, only 16 patients had LM obstruction with no distal atherosclerotic disease (7.1%). This constituted Group I that we subsequently selected for surgery. Another 15 patients that constituted Group II (6.6%) had in addition right coronary obstruction amenable for correction. Of

Figure 3 Another case of left main obstruction in the midportion.

these 31 patients, 19 underwent direct widening of the LM trunk using either a short patch of saphenous vein or pericardium. The remaining 12 patients which although were considered to be candidates for this operation underwent the standard aortocoronary bypass grafting surgery as decided by the independent cardiac surgeons treating these individuals.

The operated group of 19 patients consisted of 8 women and 11 men. The age group of patients ranged from 47 to 83 years with a mean of 60.9 years. Three of the operated patients also underwent simultaneous aortic valve replacement for aortic stenosis. Two women, 47 and 53 years of age, were diagnosed as having LM coronary spasm. One patient's spasm was classified as Prinzmetal angina following an angiogram that showed LM obstruction of approximately 40%, which within 2 months (during a second cardiac catheterization procedure) increased to 90%. The second patient showed 95% ostial stenosis who had sustained three episodes of chest pain in the past with two angiograms showing previously normal opening of the coronary artery. Both these patients did not have any distal coronary disease or calcifications in the LM vessel.

OPERATIVE TECHNIQUE

All operations were conducted implementing the cardiopulmonary bypass with moderate hypothermia at 32°C. Cold blood cardioplegia was used (antegrade and retrograde) for monitoring the heart septal temperature until it reached between 9 and 15°C. After the heart had arrested, we switched totally to a retrograde cardioplegia infusion, with adjunct topical hypothermia provided by saline solution cooled to 4 to 6°C poured over the heart continuously, and removing it from the operative field with a wall suction system.

As a first step, the pulmonary artery was detached from the ascending aorta at its root and retracted laterally to expose the origin of the LMCA. A transverse anterior aortotomy was used in all cases and additionally an incision was made in a T fashion at the left end of the incision extending it down to the level of the ostia of the LM orifice (Fig. 4A). The incision is therefore carried down across the left coronary ostia into the midportion of the artery without reaching the bifurcation. In Group I, either a short piece of a saphenous vein or of pericardium was used as a patch material. This was tailored in the proper fashion and laid over to widen the diameter of the vessel (Fig. 4B). No endarterectomies were done in any of these cases. The patch was laid over sewing it with 6-0 Prolene in running fashion, and bringing the patch up toward the edge of the transverse aortotomy. Upon its completion, the aorta was closed in the routine manner using a double layer of everting stitch followed by whipping suture over the everted edges.

In Group II patients, who also had right coronary obstruction, implant of a coronary bypass graft beyond the obstruction site was performed first using a saphenous vein in a nonreverse fashion after implementing valvotomy of the vein segment as described in a previous publication.⁹ It was connected to the coronary artery and then cold blood cardioplegia perfusion applied through this graft throughout the entire time that the patch angioplasty of the LMCA was being done. This provided adequate and optimal protection of the myocardium in addition to a retrograde cardioplegia that was used via the coronary sinus. After the aortotomy was completed and the heart had been de-aired and the aortic clamp released, the proximal end of the coronary graft going to the right coronary artery was attached to the ascending aorta using a side-biting clamp.

Figure 4 (A) Opening of the left main trunk in a "T" fashion from the transverse aortotomy. A patch is being placed to widen the artery. (B) Enlarging the coronary lumen after patch placement.

Three patients had undergone previous cardiac surgeries therefore they were redos at this time. One patient had undergone a previous internal mammary artery (IMA) to the LAD bypass and a saphenous vein graft to the circumflex system for LM obstruction of ~70%. The circumflex graft occluded 4 years later and she became severely symptomatic. The LM obstruction had remained unchanged at 70%. At the time of her reoperation the LM was patched with saphenous vein graft without disturbing the graft to the LAD which was still patent. This patient, 11.5 years later, remains asymptomatic and is doing well. The second patient suffered initially from bacterial endocarditis that evolved to severe regurgitation of the aortic and mitral valves. At that time, the LMCA was found to have 80 to 90% obstruction. At the time of the first surgery, both valves were replaced. The aortic valve was replaced with a Toronto SPV tissue valve size 23. The LMCA was patched using a segment of saphenous vein. The aortic prosthesis showed increased degree of stenosis with an aortic valve area of 0.5 cm² at 2 years. The angiogram showed perfectly wide open LM coronary trunk. The patient therefore was recommended to have the aortic valve reoperated and replaced. At the time of the second surgery, a St. Jude prosthesis was implanted into the aortic orifice. The LMCA was perfectly normal, and healed with no residual obstruction. The third patient who was found originally to have LM severe stenosis had undergone saphenous vein grafts to the LAD and the second obtuse marginal (OM2). There were no problems during that initial surgery, however, postoperatively she suffered a cardiac arrest from which she was resuscitated and she survived. The patient refused more interventions, refused cardiac catheterization at that point and she was discharged home. She continued having recurring chest pain and a second angiogram performed showed that the graft to the OM2 had occluded totally and the graft to the LAD had also severe obstruction of ~80%. The LMCA showed once more 90% occlusion

(Fig. 5A). Therefore, she was reoperated, and at this time we proceeded directly to implant a patch in the LM coronary, and since there were no significant obstructions in the proximal LAD or the OM of the circumflex the patch angioplasty of the LM was the only procedure undertaken. She recovered quite nicely and the follow-up angiogram 10 years later shows (Fig. 5B) the LM perfectly open, well healed, and with no more evidence of coronary disease.

LONG-TERM FOLLOW-UP

The long-term survival follow-up was done by direct contact with the patients via telephone, by return appointments to our clinic, or both, and in the case of failed follow-up appointments we implemented the monitoring using the Social Security Death Index method to assure their status. The period of follow-up has been therefore obtained up till December 2010. We found that five patients had died since the operation and one was lost to follow-up after the patient changed her original name and could not be tracked down. However, the latter is a young person and we presume that the patient being a woman may still be alive. Death in those five patients who succumbed occurred at various times. One died of a stroke just 2 months after the operation. He developed a large brain infarct, developed renal failure, and pneumonia. No autopsy was allowed by the family. The second patient died 4 years after the operation from a stroke, renal failure, and diabetes. The third patient died 6 years later as a consequence of trauma due to a car accident. The fourth patient died 1 year after the operation from heart failure, which did not improve significantly following intervention. At the time when the surgery was performed he had suffered, before the surgery, a massive heart attack for which he required the use of intra-aortic balloon pump. Even though he recovered, he developed progressive heart failure. Autopsy showed that the LMCA was widely

Figure 5 Typical preoperative ostial stenosis (A) with the contrast medium refluxing into the sinus of Valsalva. (B) Postoperative angiogram obtained 10 years later showing wide patency of the left main trunk.

patent with no evidence of further obstruction. The fifth patient died 7 years later from advanced lung cancer. Therefore, assuming that the patient lost to follow-up is still alive giving the benefit of the doubt, we have 13 surviving patients with a time ranging from 10 to 18 years. It is important to note that none of the five deaths we documented was a cardiac death due to recurring coronary obstruction. The only cardiac death (the fourth patient) was due to progressive heart failure although no further episodes of myocardial infarction or reobstruction of the LM coronary vessel occurred.

COMPLICATIONS

There were no intraoperative complications. Postoperatively, one patient (63 years of age) developed gastrointestinal bleeding that required blood transfusions, although no surgery was recommended by the general surgery consultant, and the patient eventually recovered. Another patient (60 years of age) developed postoperative leg ischemia after the intra-aortic balloon pump implanted preoperatively was removed. This was required during the acute event when he developed unstable angina. This complication was detected as soon as the balloon was removed 24 hours after the vein patch operation. An exploration of the femoral artery required endarterectomy and patch plasty of the femoral artery, but he recovered eventually and there were no further problems with the leg circulation. Another complication occurred in an 83-year-old man who was the oldest patient operated with this technique and did well for ~5 days. His condition deteriorated after he developed renal failure, mental confusion, and pneumonia. This patient also developed a brain infarct demonstrated by a CT scan examination. This is one of the patients who died in the postoperative period. No autopsy was allowed by the family. Therefore, in total, there were four postoperative complications that occurred in this group.

CONCLUSIONS

Direct surgical approach to the LMCA is seldom performed because most patients with coronary disease have multiple distal obstructions as was shown by our analysis reviewing the total number of cardiac catheterizations done during this 10-year period. However, patients who have isolated LMCA obstruction as well as patients who have in addition only obstruction of the right coronary

artery should be evaluated more carefully for direct widening of the LMCA, which can be done safely in these selected cases. We recommend implementing this technique only on patients who have ostial, proximal, or midportion stenosis of the main trunk. The operation can be performed very safely and may benefit the patient more than a distal coronary bypass graft placed in the distal vessels providing questionable adequate retrograde flow to a large area of myocardium. In our experience, the anterior aortotomy approach provides much better exposure and direct view of the coronary trunk rather than the posterior approach as originally recommended by Hitchcock. The long-term results of this small series show durable and optimal healing using either saphenous vein or pericardial patch to accomplish the widening of the main trunk. The follow-up with coronary angiography or reoperation needed for other reasons show the results to be highly satisfactory. The operation provides for normal antegrade flow to all these areas of compromised myocardium at the base of the heart.

REFERENCES

1. Hitchcock JF, Robles de Medina EO, Jambroes G. Angioplasty of the left main coronary artery for isolated left main coronary artery disease. *J Thorac Cardiovasc Surg* 1983;85(6):880-884
2. Effler DB, Sones FM Jr, Favaloro R, Groves LK. Coronary endarterectomy with patch-graft reconstruction: clinical experience with 34 cases. *Ann Surg* 1965;162(4):590-601
3. Dion R, Verhelst R, Matta A, Rousseau M, Goenen M, Chalant C. Surgical angioplasty of the left main coronary artery. *J Thorac Cardiovasc Surg* 1990;99(2):241-249; discussion 249-250
4. Jönsson A, Jensen J, Olsson A, Holm P, Liska J. Follow-up of patients operated on with arterial patch angioplasty of the left main coronary artery. *Ann Thorac Surg* 2006;81(4):1249-1255
5. Chikwe J, Kim M, Goldstone AB, Fallahi A, Athanasiou T. Current diagnosis and management of left main coronary disease. *Eur J Cardiothorac Surg* 2010;38(4):420-428
6. Raanani E, Kogan A, Shapira Y, Sagie A, Kornowsky R, Vidne BA. Surgical reconstruction of the left main coronary artery: fresh autologous pericardium or saphenous vein patch. *Ann Thorac Surg* 2004;78(5):1610-1613
7. Deuvaert FE, De Paepe J, Van Nooten G, Peperstraete B, Primo G. Transaortic saphenous patch angioplasty for left main coronary artery stenosis. An alternative to coronary artery bypass. *J Cardiovasc Surg (Torino)* 1988;29(5):610-613
8. Sabiston DC Jr. Manuscript reviewer's comment of Hitchcock et al. *J Thorac Cardiovasc Surg* 1983;85:884
9. Molina JE. Nonreversed saphenous vein grafts for coronary artery bypass grafting. *Ann Thorac Surg* 1989;48(5):624-627