

Minimally Invasive Coronary Artery Bypass Grafting for Myocardial Muscle Bridging

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ABSTRACT

Myocardial bridging is a congenital anomaly of the left anterior descending coronary artery (LAD), which is associated with myocardial ischemia and infarction, cardiac arrhythmias, and sudden cardiac death. Two cases are reported of symptomatic myocardial bridging refractory to medical management treated by minimally invasive coronary artery bypass grafting without cardiopulmonary bypass. We conclude that minimally invasive coronary artery bypass techniques are appropriate alternatives to endovascular stent placement, muscle bridge division, or aortocoronary grafting with cardiopulmonary bypass for the management of symptomatic myocardial bridging.

INTRODUCTION

Myocardial bridging is a congenital anomaly of the left anterior descending coronary artery (LAD), which has been associated with angina pectoris, myocardial infarction, cardiac arrhythmias, and sudden cardiac death [Feldman 1986, Bestetti 1991, Feld 1991, Smith 1997]. Percutaneous transluminal coronary angioplasty (PTCA), intracoronary stent placement, traditional coronary artery bypass grafting, and division of the overlying myocardial tissue band have all been used to treat patients with myocardial ischemia related to muscle bridging that is refractory to medical management [Hill 1981, Watanabe 1989, Prasad 1995, Stables 1995, Klues 1997, Smith 1997].

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We present what we believe to be the first use of minimally invasive surgical revascularization without cardiopulmonary bypass in the management of this lesion.

CASE REPORT

Case 1

A 41-year-old man was admitted to our hospital for further evaluation and treatment of angina. Eight months previously, he had been evaluated for new onset of severe chest pain. He smoked one pack a day for 25 years and had a family history of heart disease from his father. A stress test at that time was normal. He returned with a second episode of substernal chest pain six months later and underwent cardiac catheterization which revealed normal coronary arteries except for the presence of a myocardial bridge in the mid-portion of the LAD. The patient was prescribed diltiazem, metoprolol, and isosorbide mononitrate and did well for two months until he was hospitalized with more severe, sharp substernal chest pain during exertion, radiating to the left arm and associated with diaphoresis and shortness of breath.

Physical examination, serial enzyme analysis, and electrocardiogram were normal. Exercise tolerance testing at this point was positive. Selective coronary angiography again showed the muscle bridge at the LAD with a reduction of luminal diameter by greater than 75% during systole (see Figures 1 and 2). The patient was scheduled for minimally invasive direct coronary artery bypass grafting (MIDCAB).

Surgical Technique: The chest was opened via a left anterior thoracotomy using a submammary incision over the fourth intercostal space. The left internal mammary artery (LIMA) was mobilized using direct visualization. The pericardium was opened, revealing a 2-mm LAD that had a muscular wall, but no visible atherosclerosis. The LIMA was anastomosed to the LAD after stabilization was achieved on the beating heart (Optiflex, US Surgical Corp., Norwalk, CT). Cardiopulmonary bypass was not instituted.



Figure 1. Angiographic demonstration of myocardial bridging of LAD during diastole; LAD—left anterior descending coronary artery.



Figure 2. Systolic compression of the mid portion of the LAD by the muscle bridge.

The postoperative course was remarkable for severe chest pain on postoperative day 1 associated with 4-mm of ST-segment elevation across all of the precordial leads. Selective coronary angiography revealed a widely patent LIMA-LAD anastomosis distal to the muscle bridge of the LAD (see Figure 3 ©). He was treated with indomethacin for post-cardiotomy pericarditis without further sequelae and was pain free within 24 hours. The patient was discharged two days later. A treadmill stress test six weeks later was normal. The patient has remained pain free for more than four months with the resumption of full activities.

Case 2

A 57-year-old female was evaluated for exertional angina. She had experienced chest pain for six months, radiating to her left arm and neck, and shortness of breath associated with mild physical activity such as house cleaning. She was a nonsmoker, had a history of hypercholesterolemia, and a family history of coronary artery disease.

Physical examination and electrocardiogram were normal. Stress echocardiography showed hypokinesis of the anterior wall of the left ventricle, suggesting underlying ischemic heart disease. Cardiac catheterization and angiogram revealed mild atherosclerosis (10–25% stenosis) of the LAD with 50% diameter reduction by systolic compression. The patient was managed medically with diltiazem for two months. However, persistent angina prompted evaluation for surgical revascularization by MIDCAB.

Surgical Technique: The LIMA was mobilized via a left submammary incision. However, it was quite small (< 1 mm) and fragile distally, leaving a segment too short to bypass the muscle bridge. A median sternotomy was then performed. Even as a free graft, the LIMA was unsuitable due to its small size, and, therefore, a 3-mm left radial artery was harvested as a free graft. This graft was anastomosed to the aorta using a side-biting aortic cross clamp. The distal

anastomosis to the LAD was performed using stabilization on the beating heart (Optiflex, US Surgical Corp., Norwalk, CT) without the use of cardiopulmonary bypass.

The patient was discharged 3 days later after an uneventful postoperative course. Six weeks later, the treadmill stress test was normal. The patient has remained asymptomatic for 16 months.

DISCUSSION

Myocardial bridges are a relatively uncommon congenital anomaly of the coronary artery, recognized by the characteristic angiographic "milking effect" or systolic compression of a discrete coronary segment. As an angiographic finding, the reported incidence is 0.5–4.5%. Muscle bridges are significantly more common on pathological examination, where the reported incidence ranges from 5–85% [Angelini 1983, Ferreria 1991]. Muscle bridges are more common in men than women and tend to affect patients in their fourth decade of life [Angelini 1983]. Although there are few reports of right coronary artery involvement, the LAD is the vessel affected in the majority of cases [Woldow 1994]. The muscle bridge most often surrounds the proximal or midportion of the LAD and is thought to arise from the right ventricle adjacent to the interventricular septum [Ferreria 1991].

The clinical significance of this lesion is variable with little correlation between symptoms, electrocardiographic changes, and metabolic testing. Although most patients are asymptomatic, common symptoms associated with muscle bridging can range from angina pectoris to myocardial infarction to ventricular tachycardia and sudden death [Feldman 1986, Bestetti 1991, Feld 1991, Smith 1997].

The mechanism by which muscle bridges induce myocardial ischemia and related symptoms remains unclear. Several studies have shown that the phasic sys-

tolic vessel compression of the coronary artery persists as a vessel diameter reduction into diastole. This incomplete relaxation of the bridge during diastole results in increased intracoronary flow velocities, reduced diastolic coronary flow, retrograde coronary flow, and a reduction in coronary flow reserve, resulting in a lowered ischemic threshold [Hill 1981, Klues 1997]. With the addition of tachycardia occurring during increased work, the already compromised diastolic coronary flow is diminished even further by the increased time of the ventricle spent in systole [Pichard 1981]. Coronary vasospasm associated with muscle bridges has also been proposed as a mechanism for ischemia [Ciampricotti 1988, Kodama 1998]. These proposed mechanisms are the basis for medical management with calcium channel antagonists to relieve vasospasm and beta-blockers to control heart rate, to decrease oxygen consumption and myocardial contractility (mural compressive forces), and to prolong diastole. Nitrates are useful in the resolution of anginal attacks related to vasospasm, but they can worsen ischemia associated with muscle bridges by accentuating the luminal narrowing at the bridging site in the systolic phase [Noble 1976].

In addition to the clinical and prognostic relevance of myocardial bridges, controversy exists regarding adequate therapy for symptomatic patients' refractory to medical management. Percutaneous transluminal coronary angioplasty and, more recently, intracoronary stent placement have been proposed as treatments [Stables 1995, Klues 1997, Smith 1997]. Stenting offers the advantage of internally stabilizing the coronary artery lumen from the compressive physiology. However, long-term results are not available in regards to the ability of stents to maintain geometry and withstand compressive forces or for stent stenosis from neointimal proliferation. Surgery has traditionally been comprised of supra-arterial myotomy, myectomy, and/or coronary artery grafting [Hill 1981, Watanabe 1989, Prasad 1995]. Simply incising or resecting the constricting band may result in injury to the ventricular wall, ventricular aneurysm formation, or subsequent scar formation with recurrent extrinsic compression and is usually performed via a median sternotomy with cardiopulmonary bypass. In addition, localizing the point of compression may be difficult and require the use of intraoperative echocardiography [Watanabe 1989]. Coronary artery bypass avoids these risks and difficulties by bypassing the segment of obstruction and offers the advantage of relieving future ischemia.

We present two cases in which minimally invasive surgical revascularization techniques were effectively employed in the treatment of symptomatic muscle bridging of the LAD. MIDCAB on the beating heart, without cardiopulmonary bypass, has been proven to be a safe and effective procedure for proximally LAD lesions [Borst 1997, Calafiore 1997]. The efficacy of this procedure should also apply to muscle bridging. Minimally invasive coronary bypass offers the advantage of avoiding the morbidity associated with the use of cardiopulmonary bypass.

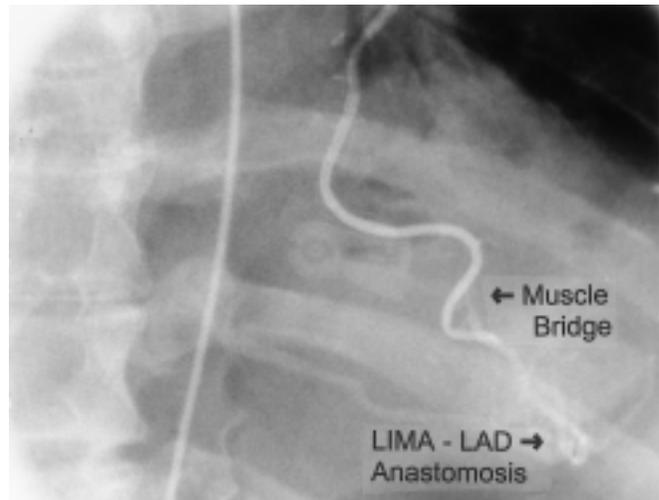


Figure 3. LIMA to LAD anastomosis distal to muscle bridge; LIMA-left internal mammary artery.

Coronary bypass using the left internal mammary artery is the preferred conduit in young patients with LAD disease. The radial artery is an excellent alternative conduit when the LIMA is of poor quality or of inadequate length, as in the second case reported herein [Manasse 1996].

In conclusion, minimally invasive coronary artery bypass techniques are appropriate alternatives to PTCA, endovascular stent placement, supra-arterial myotomy/myectomy, or aortocoronary grafting with cardiopulmonary bypass in the management of symptomatic myocardial bridging.

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