Clinics in Surgery

Case Report
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Intraoperative Angiography to Find an Intramyocardial Coronary Artery

Derek D Muehrcke, Will Shimp and Martin Casillas*

Department of Cardiovascular Surgery, Flager Hospital, USA

Abstract

We described the use of Intraoperative Fluorescent Imaging (IFI) to locate a completely unseen intramyocardial coronary artery during coronary artery bypass grafting. This simple technique reliably localizes buried intramyocardial vessels and is straightforward to perform.

Keywords: CABG; Angiography; Intramyocardial

Case Presentation

Our patient was a 52-year-old homeless man who presented with chest pain, mild troponin elevation and an EKG revealing loss of R-wave progression from V1 to V5. Cardiac catheterization showed severe two-vessel coronary artery disease; with a 80% left main stenosis, 100% mid left anterior descending coronary artery occlusion, a 90% proximal circumflex stenosis, and a 90% first diagonal stenosis. His ejection fraction was estimated at 35%. He was taken urgently to surgery and underwent Coronary Artery Bypass Grafting (CABG) x 3 on cardiopulmonary bypass using a single cross-clamp technique. His left internal thoracic artery was used to bypass the left anterior descending coronary artery; a reverse saphenous vein graft was used to bypass the first diagonal coronary artery. Unfortunately, the circumflex coronary artery was completely covered by myocardium. It could not be palpated, nor it have any distal branches visible. We injected 60 cc of a dilute Indocyanine Green (ICG) dye into the isolated aortic root via the antegrade cardioplegia needle with the heart arrested and a cross-clamp on. The intramyocardial circumflex vessel lit up immediately and extremely brightly (Figure 1). We used a felt marker to localize the vessel on the surface of the heart and using sharp dissection easily identified the circumflex artery 3 mm below the surface of the heart. The vessel was easily bypassed and the operation completed. We routinely use IFI to ensure the patency of our bypass grafts during CABG surgery. Each vein bypass graft is injected with 10 ccs of dilute ICG dye to ensure good flow down the vein, across the anastomosis and into the coronary vessel. The IMA graft if imaged by injecting 0.8 ccs of the dilute ICG dye into the heart lung machine as the only blood supply to the heart with the cross clamp on is the IMA. After the proximal anastomoses are completed, the vein grafts are imaged again by injecting. A 3 ccs of dilute ICG via a central line after the cross clamp has been removed. The patient did require the use of an intra-aortic balloon pump to separate from cardiopulmonary bypass and made a full recovery and was discharged home on POD 5.

Comment

Intramyocardial coronary arteries have vexed cardiac surgeons performing bypass surgery for years. CT angiograms have identified intramyocardial vessels in up to 60% of patients. Often times

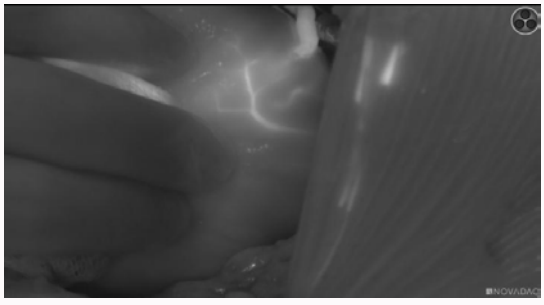

Figure 1: Intraoperative fluorescent angiogram of large circumflex obtuse marginal intramyocardial vessel.

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Correspondence:
Derek D Muehrcke, Department of Cardiovascular Surgery, Flager Hospital, 300 Health Park Blvd, Saint Augustine, Florida 32086, USA, E-mail: dmuehrcke@aol.com

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it can be extremely difficult to find intramyocardial bypass targets and sometimes they are not found nor bypassed. Failing to bypassing diseased coronary vessels leave patients incompletely revascularized and at a higher risk of myocardial infarction, angina, and early death from cardiac events [1]. The commonest intramyocardial artery is the most important coronary artery; the left anterior descending artery (62.5%), with the marginal branch of the right coronary artery second (16.7%) [2]. Several techniques are currently used to find intramyocardial coronary arteries including palpating for the vessel, performing an arteriotomy in a distal exposed branch of the vessel and retrograde placing a coronary probe and then cutting down to the palpable artery. Oz described placing a suture loop snare underneath to general location of the artery and using traction to bring the vessel to the surface of the heart [3]. We describe the use of Intraoperative Fluorescent Imaging (IFI) to visualize a completely intramyocardial circumflex obtuse marginal vessel which could not be seen nor palpated. We have routinely use intraoperative fluorescent imaging to ensure bypass graft patency during coronary bypass procedures for the last five. One of the purported limitations of the IFI technology is the limited penetration of the ultraviolet light used to fluoresce the intramyocardial vessels. We found this not to be a limitation in identifying intramyocardial vessels. We have also used IFI to identify epicardial vessels during redo bypass surgeries operations and to find left anterior descending to pulmonary artery fistulae covered by myocardium. SPY intraoperative fluorescence imaging received FDA 510 (K) clearance in 2005 as a system to assess graft patency after CABG surgery. The IFI system SPY™, (STYKER corporation, Kalamazoo MI), depends on the fluorescent properties of Indocyanine Green (ICG) dye [4]. ICG rapidly binds to the plasma proteins when injected intravenously and is therefore confined to the intravascular compartment. Indocyanine green is excreted unchanged by the liver with a half-life of 3 min to 5 min, thus there is no potential for nephrotoxic effects for those patients with compromised renal function. The dye also has an excellent safety profile. The incident of allergic reactions to ICG is approximately 1 in 40,000 and it has been reported mainly in patients with an allergy to iodine. The risk of allergic reactions is strongly dose dependent, being greatest with a dose in excess of 0.5 mg/kg weight. A lower density laser with a total output of 2.7 w spread over an area of 7.5 cm × 7.5 cm at a distance of 30 cm has a depth of penetration of about 2 mm to 4 mm to avoid thermal damage. ICG fluoresces when illuminated with a laser light of 806 nm and emits light at the longer wavelength at 830 nm. The imaging camera head is a charged couple device video camera and is positioned over the exposed heart, and the laser is activated before the first pass of a bolus of ICG through the field of view. Images of the coronary arteries and bypass grafts are acquired at a rate of 30 frames/s and may be viewed in real time. The concentration we use is made up by placing 0.5 cc's of ICG (concentration 2.5 mg/mi) into 500 ccs of Normal Saline. Sixty ccs of this solution are mixed with 40cc's of heparinized blood. 60 ccs of the final mixture are injected into the aortic root with the cross clamp on as images are acquired over the area where the intramyocardial vessel likely is. It is easy to inspect large areas of the heart quickly by simply rotating the heart under the camera. When the intramyocardial vessel illuminates, its location is marked on the surface of the heart using a sterile felt marker. One needs to simply cut along the line to find the subtended vessel. As there is little blood flow through the arrested heart, the dye continues to illuminate the locate the intramyocardial vessel until washed out by non-coronary collateral flow. Our technique of using IFI to identify intramyocardial vessels is simple, reliable, and straightforward.

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