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Left internal mammary artery (LIMA) first: A unique approach to maximize patient safety for combined carotid endarterectomy and coronary artery bypass grafting

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Abstract

We present a patient with concomitant symptomatic carotid artery disease and coronary artery disease (CAD) who underwent a modification of the combined approach consisting of left internal mammary artery (LIMA) to left anterior descending artery (LAD) bypass off-pump followed by carotid endarterectomy (CEA) off-pump and then completion of coronary artery bypass grafting (CABG) on-pump.

Keywords

coronary artery bypass graft; carotid endarterectomy; staged approach; reversed staged approach; left internal mammary artery off-pump

Abbreviations

LIMA: Left internal mammary artery; CAD: Coronary artery disease; LAD: Left anterior descending artery; CEA: Carotid endarterectomy; CABG: Coronary artery bypass grafting; CVA: Cerebrovascular accident; CTA: Computed tomography angiography; PDA: Posterior descending artery; PL: Posterior lateral branch; ICU: Intensive care unit

Introduction

Patients with symptomatic carotid artery disease and symptomatic CAD are at higher risk for cerebrovascular accident (CVA) versus patients that are only symptomatic from one disease process [1]. Minimizing the stroke risk is of paramount concern to both vascular surgeons and their patients. In this paper, we present a modification of the combined approach, which we refer to as the "LIMA first approach."

Case Presentation

A fifty-one year old male with a significant past medical history of hyperlipidemia and thirty pack year smoking history presented with chest tightness for two months that was worse with exertion and accompanied by pain down the right arm. The patient delayed treatment because he believed his symptoms were from an asthma attack. In addition to chest tightness, the patient reported an episode of amaurosis fugax, which he described as "a shade coming down over his eye" with subsequent resolution of vision after a few seconds.

The patient had unremarkable routine laboratory work preoperatively. Nuclear stress test demonstrated normal left ventricle and normal gated wall motion. There was evidence of prior infarct involving the inferior apical segment and peri-infarct ischemia of the distal inferior segment. The calculated and visually estimated ejection fraction was 64% (End diastolic volume: 95ml and end systolic volume: 34ml). Due to classic symptoms of carotid disease, the patient underwent computed tomography angiography (CTA) of the neck, which demonstrated a short segment of near occlusion involving the right internal carotid artery just past the bifurcation (Figures 1-3).

Cardiac catheterization showed multi-vessel disease. There was plaque throughout the mid to distal LAD. There was moderate plaque in a small codominant left-sided posterior descending artery (PDA). First obtuse marginal had an 80% to 90% proximal stenosis. Second obtuse marginal was subtotally occluded, 99% with faint left-to-left collaterals filling the distal vessel. Left anterior descending had diffuse 50% disease at the ostium, 60% stenosis at the first diagonal, which is small with 2 cm midvessel occlusion with bridging collaterals filling the distal vessel, which wrapped around the cardiac apex. The first diagonal branch had a short subtotal occlusion while the second diagonal branch had 60% to 80% stenosis. The right coronary artery showed small to medium caliber codominant right coronary artery with 50% proximal stenosis, tandem/sequential 80% midvessel stenosis, and plaque distally before a small codominant right-sided PDA. Two small obtuse marginal branches have 60% to 80% ostial disease. Left heart catheterization (Figure 4) and left ventriculogram (Figure 5) showed normal size and systolic function.

Given the symptomatic multivessel CAD and symptomatic severe carotid artery stenosis, the patient underwent a modification of the combined CEA and CABG technique that we refer to as the "LIMA first approach," which is detailed below.

A transesophageal echocardiogram was performed intraoperatively. After midline sternotomy, the LIMA was harvested in the usual fashion. The veins were harvested from the lower extremity using endoscopic vein harvesting technique. An epiaortic ultrasound was carried out intraoperatively, which showed no major calcification of the aorta. After systemic heparinization, the off-pump portion of the operation was commenced. Left pericardial sutures and deep left pericardial sutures were placed. These rotated the heart to the right side exposing LAD. Stabilizing platform was then placed in the LAD. Arteriotomy was made using 11 blade and Potts scissors. A 1.5-mm intracoronary shunt was placed in the LAD. A distal anastomosis between left IMA and LAD was performed in an end-to-side fashion using running 7-0 Prolene suture. Just prior to completion of the anastomosis, the shunt was removed and anastomosis was completed. The anastomotic site was intact without any leakage. The heart was returned to its normal anatomic position. A sterile moist lap was placed within the mediastinum and a towel was placed over the open sternum. Focus was then shifted to performing the right carotid endarterectomy. The carotid endarterectomy was performed without a shunt due to the stump pressures being greater than 50 mmHg. There was plaque in the internal carotid artery from the bulb to a few centimeters above the bulb which was removed in its entirety. The endarterectomy was closed using a bovine patch angioplasty. This portion of the surgery was uneventful. After the right carotid endarterectomy was completed, focus was redirected to the coronary bypass. After further systemic heparinization, the ascending aorta was cannulated with an aortic cannula and right atrium with 3-stage venous cannula. We then went on cardiopulmonary bypass.

After establishing bypass, an antegrade cardioplegia catheter was inserted. Aortic cross-clamp was placed and cardioplegia was given. A gray bulldog clamp was placed in the left IMA pedicle. We first performed distal anastomosis between reverse saphenous vein graft and PDA in end-to-side fashion using running 7-0 Prolene suture. In similar fashion, vein was anastomosed to the posterior lateral branch (PL) and to ramus intermedius and to the diagonal artery. Intermittent cardioplegia was given down the vein grafts. Patient rewarming was then begun. The proximal anastomosis between the two vein grafts and proximal aorta was done in end-to-side fashion using running 6-0 Prolene sutures. These were vein grafted to the PDA on the right side and to the ramus intermedius on the left side. We then attached the proximal portion of the vein graft to diagonal to the mid portion of the vein graft to ramus intermedius in end-to-side fashion using running 7-0 Prolene suture, thus creating a Y-graft. In similar fashion, the proximal portion of the vein graft to PL was attached to mid portion of the vein graft to the PDA. Gray bulldog clamps were placed to the vein grafts and the patient was placed in deep Trendelenburg position and root vent was turned on. Aortic cross-clamp was removed. Each of the vein grafts were de-aired using a 25 gauge needle. After adequate de-airing, Gray bulldog clamps were removed. Distal and proximal anastomotic sites were checked and noted to be intact without leakage. The left pericardium was opened in T-fashion. The patient was rewarmed and reversed with protamine. Decanulation was uneventful and the patient was closed in the standard fashion after placing chest tubes. The patient was taken to the intensive care unit (ICU) for recovery.

Discussion

Cerebrovascular accidents are considered as one of the most feared complications of CABG. A prospective study done over the past 30 years revealed a stroke incidence of 1.6%, with 40% occurring intra-operatively and 58% occurring post-operatively [2]. The stroke rates are drastically increased in patients with carotid artery stenosis who undergo CABG. Those who underwent CABG with a 50-99% carotid stenosis had a 7.4% stroke risk and increased to 9.1% with >80% stenosis [3]. In patients with symptomatic carotid artery disease and symptomatic coronary artery disease, the role of combined CEA and CABG has been debated for decades. Due to the potential risk of CVA, there are several approaches to performing CEA and CABG. Some reported approaches are the staged approach (CEA to CABG), reversed staged (CABG to CEA), and combined (synchronous CEA and CABG). It must also be taken into consideration whether the bypass was performed on-pump versus off-pump.

Another event that can increase perioperative stroke rates during CABG is cross clamping of the aorta [4]. Atherosclerosis of the ascending aorta is a major risk factor for developing perioperative strokes due to cerebral thromboemboli [5,6]. The use of epiaortic ultrasound intraoperatively has a role to evaluate the aorta for calcification prior to clamping [7]. Being able to visualize any calcifications in the aorta on ultrasound allows the surgeon to choose the best place for aortic cross clamping. By doing so helps decrease the incidence of perioperative stroke rates, which is of major concern.

The ideal patient for the combined approach is one who has symptomatic carotid artery disease along with unstable angina or left main CAD [1,8]. This patient experienced the classic symptoms of amaurosis fugax along with chest pain upon exertion. His history of hyperlipidemia places him at higher risk of CVA and CAD. According to the Framingham Heart Study, there is a relation to elevated cholesterol and CAD not only in the elderly, but younger individuals as well [9]. Being that this patient is fifty-one years of age, it correlates with the study of interest.

The aim of this study was to propose a novel technique for revascularizing the carotid and coronary arteries via the “LIMA first approach” while off-pump. Even though there has been a dilemma to the preferred method of treating patients with symptomatic carotid artery disease and coronary artery disease, recent data seems to show off-pump being more beneficial when assessing postoperative risks; most important being stroke rates [10]. After reviewing an analysis of a 10-year nationwide data evaluating patients undergoing staged or synchronous CEA and CABG, staged approach was associated with a greater risk of overall complications; which include higher morbidity, cardiac, wound, respiratory, and renal complications. Those who underwent a synchronous procedure via on-pump CABG were associated with higher stroke rates (OR=1.6, 95%CI 1.3-1.9, $p<0.001$) compared to being off-pump [11].

Given the higher stroke rates with on-pump CABG, we propose a unique solution where the LIMA to LAD anastomosis was performed first, followed by CEA off-pump. After CEA was completed off-pump, the remainder of the CABG was performed on-pump.By performing an intraoperative epiaortic ultrasound, it allowed us to successfully clamp the aorta where there were no visible signs of atherosclerosis. By harvesting the LIMA and anastomosing to the LAD at first off-pump, also allows us to decrease the risk of a perioperative stroke from the carotid artery stenosis.

Conclusion

In conclusion, we present a fifty-one year old male with concomitant symptomatic carotid artery disease and coronary artery disease. To the best of our knowledge, we present this first case of the "LIMA first approach" off-pump being an effective procedure. However, there is a limitation to this procedure and peri-operative complications due to only one successful case.

Figures

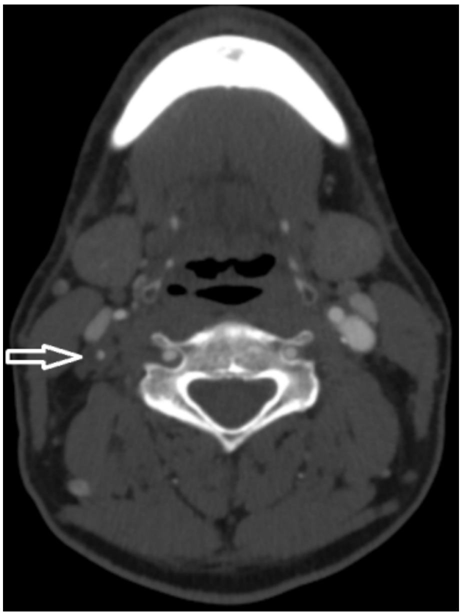

Figure 1: CTA showing right carotid artery stenosis

Figure 2: CTA showing right carotid artery stenosis

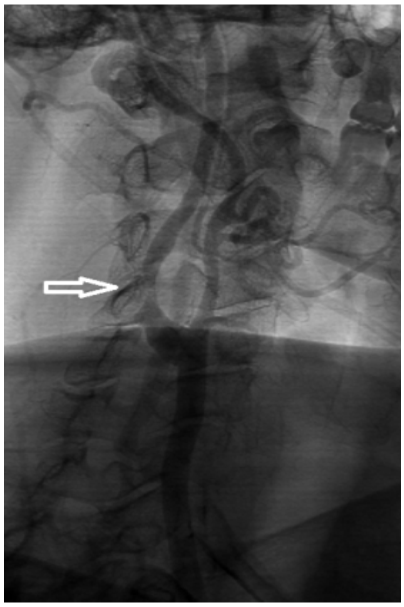

Figure 3: CTA showing right carotid artery stenosis

Figure 4: Left heart catheterization

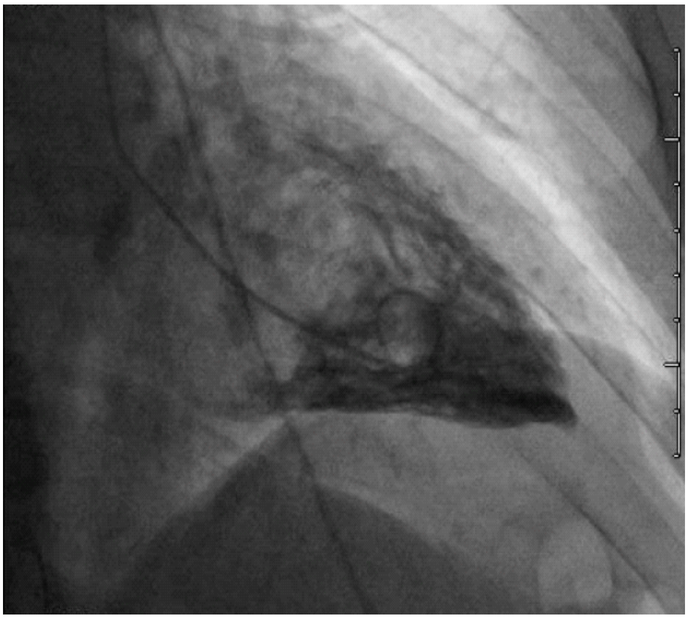

Figure 5: Left ventriculogram

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