

Total Arterial Revascularization: Bypassing Antediluvian Notions

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Abstract

The last two decades have witnessed a surge of studies that show superiority of total arterial grafting in multivessel coronary artery disease. The last 4 decades have confirmed that left internal thoracic is the gold standard and currently evidence suggest that the right internal thoracic artery behaves in the same way. Radial artery grafts in several randomized trials comparing favorably with the saphenous vein. Currently less than 5% of cases in USA and less than 10% of coronary bypass surgeries in UK receive multiple arterial grafts compared to our 85% in indicated patients. Those with less than 70% stenosis to left and less than 90% stenosis to right coronary system receive a vein graft in our set up which would eliminate them from the total arterial group by definition but still could be included in the multiple arterial complete revascularization groups. Technical difficulties, time taken and cost are some of the deterrents of its more extensive use. Perioperative complications are infrequent (1.4%). Long term benefits of total arterial revascularization are thereby denied to a huge cohort. Total arterial revascularization (TAR) has been shown to improve survival and reduce morbidity in patients with multivessel coronary disease. The low incidence of postoperative neurologic morbidity associated with the long-term survival advantage reported with TAR makes off pump coronary artery bypass an attractive alternative to conventional on-pump surgery.

Keywords: Coronary Artery Bypass Grafting (CABG); Internal Thoracic Artery (ITA); Radial Artery (RA); TAR Total Arterial Revascularization; Coronary Artery Disease (CAD); Bilateral Internal Thoracic Artery (BITA); Right Internal Thoracic Artery (RITA); Left Internal Thoracic Artery (LITA); Complete Arterial Revascularization Therapy (CART)

Introduction

Total arterial revascularization has converted coronary surgery to a highly specialized and skilled area in cardiac surgery, with its undeniable superiority over vein conduits, versatility; long term patency and freedom from cardiac events and reoperations are added advantages. This has been a story of surgical success, with only limitations to currently undertaking this procedure being an unstable patient or inadequate graft flow, or low life expectancy. Arterial grafts have a lower failure rate and patency rates that are close to 92 - 95% at 15 years. They have an added protective effect on retarding the native disease coronary progression. Even in patients receiving vein grafts, addition of a second arterial conduit, particularly on the left system, confers a significant survival advantage. Despite the evidence for arterial grafting and its increasing use, only a few surgical groups have reported a BIMA grafting rate greater than 10%. Surgeons are often guided by the necessity of quick surgery and event free short survival, which makes them avoid technical complexities and time

consuming procedures with short term success being the current reward incentive. But for the concerned surgeon patient well-being even long term would be of paramount importance-may be a legislation necessitating need for use of multiple arterial grafts may be warranted at present. Funded randomized trials in UK could be very supportive on this regard. On the other hand, some surgeons have adopted a policy of extensive or total arterial revascularization using one or both IMA and alternative conduits such as the RA or right GEA grafts.

Objectives

'Total-arterial' and 'complete' revascularization are cardiac surgical principles that have been proven to beneficially impact outcomes in coronary artery bypass graft (CABG) surgery. The use of total arterial revascularization (TAR approach) with beating heart approach over 2 decades is compared with standard CABG (Artery Vein approach).

Methods

From January 2002 to October 2017, a total of 1,084 patients underwent isolated off-pump coronary artery bypass graft surgery at our institution of practice. Of these 1,084 patients, 665 underwent total arterial revascularization (AR) and 419 underwent a combination of artery and vein revascularization (AVR). We compared the clinical results between the two groups using the propensity score matching technique. Thirty day mortality was noted. Morbidity patterns analyzed include re sternotomy for bleeding; perioperative MI, arrhythmias, cerebrovascular accidents, renal failure, and sternal dehiscence were the main outcome measures. Contraindications to total arterial grafting were significantly impaired ventricular function (ejection fraction < 30%) because of the likelihood of requiring inotropes (which predispose to arterial graft spasm) and a limited life expectancy/Patients on angiotensin converting enzyme (ACE) inhibitors which predispose to a vasoplegic state after cardiopulmonary bypass and may require vasoconstrictors (which predispose to arterial graft spasm)/Obese insulin dependent diabetics (but not diabetics with a normal body mass index), because of increased risk of sternal problems with bilateral ITA grafts/and an abnormal Allen test as a contraindication to the use of the radial artery. Contraindications to BIMA harvesting were grossly obese (BMI > 40) patients, insulin dependent patients, diabetics, or those with severe COPD. Those on radiotherapy or immunosuppressants were also excluded from this technique. RA was also avoided in renal failure patients. Multiple arterial still can be performed in these patients using LIMA and both radial arteries in a composite fashion avoiding the RIMA.

Surgical technique

The ITA conduits were harvested with a fully skeletonized extra pleural approach rather than a pedicled technique to decrease the risk of sternal devascularisation, and the radial artery was also harvested in a fully skeletonized fashion with very low electrocautery settings (10) and double clip and cut technique. The ITA was treated topically with papaverine (60 mg in 100 ml of blood) to prevent spasm and the radial artery irrigated internally and externally with papaverine in blood. Total arterial, off-pump bypass grafting was the optimal operative strategy for coronary revascularization. ITA is used maximally on anterior vessels like LAD and diagonals in a skip fashion. If RITA is used to LAD LITA can be used to RI or OM, for double LAD we use both LITA and RITA, remaining gaps being filled up with radial artery. RITA to obtuse marginal artery is coursed anterior to aorta and the radial artery placed to the posterior descending artery. RITA is placed to PDA on right if narrowing is more than 90% and it is the dominant artery. The proximal anastomosis ("top ends") of the radial artery was initially performed on the aorta directly by spatulating to 4 - 6 mm. Composite grafting is preferred only in case of inadequacies of ascending aorta to receive the proximal anastomosis. We prefer independent grafts as the flow to myocardium is better than composite grafts and maintain *in situ* pattern for both ITA. RITA is extended with radial to reach PDA is length is a problem, in indicated patients.

Results

All procedures were performed using the off-pump technique without conversion to on-pump. 2 patients in the conventional CABG group (0.5%) and 0 in the TAR group (0%) died in hospital. Multivariate analysis revealed that chronic kidney disease ($p < 0.001$), urgency ($p < 0.001$), and body mass index ($p = 0.02$) were independent risk factors for hospital death. Follow-up was complete for 99.6% of the patients to a maximum of 14 years. According to the Kaplan-Meier method, the rate of 14- year freedom from all causes of death was 79.6% for the conventional CABG group and 99.54% for the TAR group ($p = 0.002$). By multivariate Cox regression analysis, total arterial reconstruction was identified as a preventive factor for late cardiac events. There were no differences in perioperative stroke, myocardial infarction or mortality

Discussion

Total arterial revascularization is achievable in most patients with three-vessel CAD. ITA grafts function into the third decade with significant freedom from failure. Tatoulis [1] recently published need to be noted with extensive use of RITA. There was no significant difference between the RITA and the LITA when grafted to the LAD. Similar patency between RITAs and LITAs were found when grafted to the circumflex system. Radial Artery Patency Study (RAPS) confirms a functional benefit of the RA in comparison to the SVG [2]. 1.3% incidence of sternal complications is noted. This is found in patients with diabetes, body mass index of more than 35, females and in those with chronic obstructive airway disease. Full skeletonization, interlocking 4 figure of 8 sternal wires, low electrocautery settings and proper antibiotics often reduces the incidence of sternal complications. If more than 2 of these complications exist in the same patient it is better to avoid bilateral ITA. Both ITAs to the left system is extremely rewarding in terms of patency. Second ITA even if routed to the right was suggested not to influence the outcome of coronary bypass grafting [3].

Total arterial grafting is readily applicable in many very elderly patients [4]. Technically perfect harvesting with good conduit flows and preservation of the integrity of the pleural cavities reduces postoperative morbidity, pulmonary complications, and reduces hospital stay [5]. Extra pleural fully skeletonized harvest is the rule, but if tension due to inadequacies of length is noted, it is prudent to make a track to reduce the tension on the anastomosis.

There are situations that preclude both BITA use and RA harvesting. When native coronary stenosis is less than 70%, risk of competitive flow leads to less durable grafts, the use of the SV is mandated. We are currently dealing with a more morbid angioplasty failed or complicated group with diffuse multivessel disease where total arterial revascularization is achievable in more than 85% cases in our set up. An ultimate advantage noted in long term outcome is reduced rate of progression of native vessel disease, higher graft patency, with reduced cardiac reinterventions rate and optimal long-term survival.

Conclusion

With current patient spectrum being referred for surgery total arterial revascularization is achievable in most patients with three-vessel CAD with excellent clinical and angiographic results. Vein grafts need to be avoided if native coronary stenosis is more than 70% on the left system and more than 90% on the right coronary system. Even in high risk patient multiple arterial revascularizations can be achieved though it is advisable to achieve total arterial complete revascularization with LITA and RA rather than BITA if more than 2 of the risk factors are present in a single patient. Inadequate conduit flows, reduced life expectancy, haemodynamically unstable patient being the only current contraindications in our unit to total arterial revascularization. We prefer independent grafts whenever possible, composite grafts are being resorted to only in case of ascending aortic complications or conduit shortage. Complete arterial revascularization therapy (CART) should be the standard of care in current coronary practice.

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