Basrah Journal of Surgery

Bas J Surg, March, 9, 2003

TOTAL ARTERIAL MYOCARDIAL REVASCULARIZATION

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Summary

Eighty-five patients underwent myocardial revascularization using artery grafts alone and were followed up for 30 months. Twenty-seven patients (31.7%) had single vessel disease, 28 patients (32.94%) had two-vessel disease and 30 patients (35.3%) had three or more obstructed coronary arteries. Eight of the patients had undergone previous surgical revascularization. The left internal mammary artery (LIMA) was routinely used for the left anterior descending branch (LAD). In 8 patients (9.4%), the in situ right internal mammary artery (RIMA) was used for revascularization of the right coronary artery (RCA) and its branches. The RIMA was sometimes used as a free graft from the aorta or as an artificial "Y" from the LIMA to the diagonal and marginal branches. We used the left radial artery (RA) as arterial conduit in 51 patients (60%). There were 2 intraoperative deaths. Hospital mortality was 9% (n=8). Of the fatal cases, 3 were redo surgeries, 3 underwent combined procedures (one for left ventricular aneyrysm, one for double valve replacement and one for mitral valve replacement) while only 3 of the fatal cases underwent revascularization as a primary and isolated procedure. It is concluded that complete arterial reconstruction carries an acceptably low operative mortality and excellent short-term follow-up. This strategy is particularly important for young patients to reduce the probability of future reoperation.

Introduction

Direct myocardial revascularization has also undergone several technical changes since it was first introduced. In 1968, Rene Favarolo and the Cleveland Clinic surgeons popularized the use of the greater saphenous vein as a bridge between the ascending aorta and the obstructed coronary arteries[1,2]. Initially proposed for the treatment of right coronary stenosis, saphenous vein grafts (SVGs) proved to be very versatile and were quickly adapted for

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revascularization of all regions of the heart, with good initial results.

Saphenous vein grafts were considered optimal vascular conduits for coronary artery bypass since they were easy to remove and prepare and could be used for multiple grafts. However, the weaknesses of the saphenous vein as a conduit were exposed over a period of 10 to 12 years after its initial use. The main weaknesses are accelerated progression of intimal hyperplasia and atherosclerosis, and persistent incidence of lower extremity wound complications due to saphenous harvesting[2,3].

After the 1970s, the internal mammary artery (IMA)[4] was favored as an excellent alternative to saphenous veins for myocardial revascularization. Initially; it was mostly used in patients without adequate saphenous veins or in patients with single vessel disease. Loop et al reported the use of this graft in 175 consecutive patients with a mortality of 0.6%[5]. Subsequent data from the Cleveland Clinic indicated the importance of the left internal mammary artery (IIMA) to the left anterior descending (LAD) anastomosis in preventing late cardiac events and reoperation[5,6].

Excellent long-term patency of the LIMA-LAD anastomosis began to convince other surgical programs to incorporate internal mammary arteries into their procedures[5,6]. Initial reticence was based on concerns about perceived difficulties with its dissection, fragility, vascular spasm and limitations in the initial flow rates. However, with broadening experience and improved surgical techniques, these concerns were gradually dispelled. Publications from such renowned centres as the Cleveland Clinic [5], and others, proved the efficacy of IMA grafts for the long-term survival of patients, especially compared to long-term survival rates when using saphenous vein conduits alone[7,8]. The influence of these studies led to the LIMA surpassing the saphenous vein as the conduit of choice for myocardial revascularization.

Long-term angiographic patency of LIMA-LAD grafts has been well documented[6,9,10]. These data encouraged surgeons to use other arteries of similar diameter and wall characteristics as potential long-term coronary grafts, and in most cases with promising results. Among the newer and popular choices are the right gastroepiploic artery (RGEA), the inferior epigastric artery (IEA) and the radial artery (RA) [10].

This study is aimed at evaluating the early clinical course of patients undergoing myocardial revascularization exclusively with arterial grafts.

Patients and Methods

From July 1998 to December 2000 (30 months), 85 patients received full myocardial revascularization without venous grafts. Eighty-one percent of the patients were males. The mean age of the patients was 58.6 years (range 36-78 years). Eight patients had undergone previous revascularization ("redo"), 27(31.76%) had single-vessel disease, 28 (32.94%) had two-vessel disease and 30 (35.3%) had lesions in three or more coronary arteries.

The LIMA was routinely used for the LAD. The right internal mammary artery (RIMA) was used in situ for the main right coronary artery (RCA), the diagonal branches of the LAD or the left marginal branches. Proximal anastomosis of the RA was preferably used directly to the ascending aorta or as an artificial "Y" from the LIMA and was subsequently anastomosed to the branches of the lateral wall of the heart.

Results

The LIMA was used in 83 patients (97.64%) and the RIMA in 8 patients (9.4%). The RA was used in 51 patients (60%). Overall, 135 arterial grafts were

used in this group of patients, with 272 coronary anastomosis. In patients with lesions in three or more obstructed arteries, the mean number of revascularization coronary targets was 3.2 per patient.

There were two intraoperative deaths. Hospital mortality was 9% (n=8). Of the fatal cases, were three Redo Surgery, three had combined procedures (one for left ventricular aneurysm, one for double valve replacement and one for mitral valve replacement), and three had undergone revascularization as a primary and isolated procedure. Four of the eight fatalities died from low cardiac output syndrome.

Discussion

Saphenous vein grafts often degenerate over time. The anatomicopathologic changes observed in their structure, however, are different than those observed in the coronary arteries. Studies of veins obtained from reoperation or necropsies show that some months after the initial surgery, most of these grafts reveal some degree of hyperplasia of the intimal layer. Although this hyperplasia is not responsible for graft occlusion, it is likely a cause for the development of late venous atherosclerosis[7].

Venous grafts assessed after three years frequently display lipid infiltration into the media. The atherosclerotic process tends to be progressive and may, especially after the fifth postoperative year, develop stenosis with clinical symptoms. Venous atherosclerosis as opposed to sclerosis of the coronary artery, tends to be circumferential, diffuse and extremely friable[7,8].

The development of artherosclerosis in venous grafts is more frequent and rapid in patients with diabetes, hypercholesterolemia (>300 mg/dl) and hypertriglyceridemia (>180 mg/dl)[8]. Unfortunately, even patients with normal serum lipids are at risk of developing graft atherosclerosis. However, there is evidence that postoperative treatment with diet and drugs that decrease serum lipids may attenuate graft occlusion.

Angiographic studies carried out by Lytle et al.[8] evaluating 646 patent saphenous grafts observed that after 5 to 12 postoperative years, 19% of the grafts developed atherosclerotic stenosis and 26% were totally occulded. Even though the saphenous vein is considered an excellent graft for elderly or hemodynamically unstable patients[1,2], the evidence reported above has led to the choice of internal mammary artery grafts over venous grafts in younger patients[4,5].

Kolessov [4] pioneered the use of IMA graft in six patients. In five of them the IMA was anastomosed into the anterior descending branch and in the remaining patient into the circumflex artery, with one fatality. However, the surgical planing was based only on clinical data and electrocardiograms, and most of these patients were operated upon without hemodynamic studies.

Green et al.[3] based on an experimental study in 42 dogs, operated on two patients whose IMAs were anastomosed to the anterior interventricular branch. The authors of the Green article used a microscope with 16X power to perform the anastomosis. According to the authors, at least 120 to 160 hours of laboratory training were required to master the surgical technique using an operative microscope. For this reason, in 1968 Favarolo et al. started to perform the anastomosis without a microscope, using instead 3.5X optical magnifying lenses[2]. This technical simplification facilitated the use of IMA grafts by other centres and permitted their use for additional targets, such as the diagonal and circumflex arteries.

The advantage of total arterial myocardial revascularization is based on the superior long-term survival of these grafts compared to the saphenous vein. Evidence is based on the low mortality

and morbidity observed in selected groups of patients, especially young ones, operated upon in the late 1970s and early 1980s. The follow up of patients using the internal mammary artery showed that the IMA maintained its patency in a large number of patients throughout the years, suggesting that they are resistant to atherosclerosis. Moreover, IMA grafts provided a higher late survival rate and lower reoperation rates when compared to venous grafts alone[8,9,10].

This evidence and the experience acquired in the last two decades has led us to expand our use of multiple arterial grafts. In our current series, the LIMA was used in 97.4% of the patients, mostly for the LAD. The RIMA was used in 9.4% of the patients in this study, especially for the RCA or its branches. Harvesting the RIMA as a skeletonized graft will allow it to become elongated enough to reach the beginning of the RCA branches along the diaphragmatic wall[9,10].

The disadvantages of the IMA graft are few. It may develop acute spasm, it rarely develops atherosclerosis and its diameter is usually appropriately matched to the diameter of the target coronary artery. Length limitations may be overcomed by using it as a free graft. With increasing experience, we have noted fewer contraindications to its use. Currently, elderly patients can receive at least one of these arteries.

However, we have avoided the use of both mammary arteries in insulin-dependant diabetic patients to reduce the probability of sternal wound stenosis, in acute myocardial infarction, and in cases of mild stenosis of the arteries to be revascularized in order to avoid problems with competitive flow.

The radial artery has been used as an important alternative in myocardial revascularization, especially in combination with the IMA, in order to achieve complete arterial reconstruction[10]. Evidence of radial artery spasm, confirmed by early postoperative angiography, which disappeared after 6 to 12 months suggests that RA grafts experience decreased vascular tone over time. We believe that administration of calcium-channel blockers is mandatory in the early postoperative period after RA grafts.

The radial artery was initially used as a free graft from the aorta to less important branches of the left coronary artery. Soon, however, it was used for the revascularization of all coronary branches. Its diameter, usually close to 3 mm, allows for the performance of several sequential anastomosis without concern for luminal narrowing. This, combined with the hypothesis of greaterspasm when undergoing direct aoretic pressure, has led most surgeons to anastomosis the proximal RA to the LITA[1]. In our series, the RA was used in 51 patients (60%). In approximately two of these patients, the RA was anastomosed end-to-end to the LIMA, making an artificial "Y". This technique permits revascularization of all the major left coronary vessels using just the LIMA and an RA segment.

Conclusion

We concluded that complete myocardial revascularization may be carried out using arterial grafts alone with low morbidity and mortality rates in a selected group of young patients. The favourable long-term clinical results observed with the use of arterial grafts, especially with the IMA, has led us to choose them over venous grafts.

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