

# 24 Years Follow-Up Of Complete Pedicle Arterialization For Exceedingly Advanced Coronary Artery Arteriosclerosis

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## Abstract

**Objective.** Patients with advanced and diffuse peripheral coronary arteriosclerosis signify a surgical challenge. The operative risk is markedly increased, and these patients are often refused for coronary surgery. Use of multiple pedicle arterial grafts might be an option in this demanding situation. We aimed to investigate real long-term outcomes for such patients after in situ coronary arterialization with foremost focus on the right gastroepiploic artery. **Method.** Patients were consecutively and prospectively registered during the period 1989 through 1990. Data collection was done retrospectively. Survival status by December 2013 was established through the Norwegian National Registry.

**Results.** The study includes 14 patients with mean age of 49 years (range 37 – 69). All were operated with the right gastroepiploic artery (RGA) as a pedicle graft to branches of the right coronary artery. Additional revascularization was done by the use of pedicle internal mammary artery (IMA) grafts. After 24 years follow-up seven patients had died, but only two from a cardiac cause. The survival for the entire study cohort was longer than statistically expected. Follow-up angiography at median 16 years showed that 78 % of RGA grafts, 100 % of right IMA grafts, and 78 % of left IMA grafts were patent. Five patients had undergone laparotomy and in one of them the RGA graft was injured.

**Conclusion.** Patients with exceedingly complex peripheral coronary artery disease can be operated with pedicle arterial grafts with successful long-term outcomes.

## INTRODUCTION

During the 1980s it became clear that use of the left internal mammary artery (LIMA) in surgical coronary grafting led to better survival than saphenous vein grafts alone (1).

Subsequent reports have demonstrated that use of both IMAs could improve outcomes further (2). In line with this, the right gastroepiploic artery (RGA) was introduced as a new arterial conduit (3). These arterial grafts, LIMA, right internal mammary artery (RIMA), and RGA, can be harvested as in situ pedicles or free grafts. Our preference has been to use the arterial grafts as pedicles.

Inspired by our mentor (Stig Ekeström, Karolinska Sjukhuset) we have employed complete coronary arterialization for triple vessel disease in selected patients from the 1980s. Our hypothesis was that patients with complex coronary pathology would benefit from multiple arterial grafts as a solution to secure long-term patency and thus probably survival. A highly selected cohort of patients

has been offered this procedure and their long-term outcomes are presented in this report with focus on the RGA graft.

## MATERIALS AND METHODS

The study was approved by the institutional review board. In a 20 months period during 1989 and 1990 sixteen patients were included in this particular treatment program. The selection criterion was an angiogram showing advanced and diffuse coronary artery disease (CAD) with suboptimal coronary target vessels in all territories. Nowadays the angiographic appearance corresponds to point 12 (diffuse disease/small vessels) in the syntax scoring system.

## DATA COLLECTION AND ENDPOINTS

The patients were registered prospectively, but the data were retrieved retrospectively from medical records including communications with local hospitals and general practitioners. The endpoints were all-cause and cardiac

specific mortality by December 2013. The survival status was established through the Norwegian National Registry. Survival was compared with the expected remaining lifetime based on national statistical tables from the years 1989 and 1990 as described by Hotvedt et al. (4). Results of repeat-angiography and new coronary interventions were also documented.

## **PERI-OPERATIVE MANAGEMENT**

Anesthesia, operative procedures, and postoperative care were standardized throughout the study interval. The operations were undertaken on cardiopulmonary bypass with non-pulsatile flow at moderate hypothermia. After aortic cross-clamping, cold crystalloid St. Thomas II cardioplegia was delivered solely antegradely and repeated every 20 minutes during the time of cross-clamping. Retrograde administration of cardioplegia was not used. Cold blood cardioplegia was given in two patients with ejection fractions below 30.

In two patients the RGA was deemed of bad quality and was not used in the procedure. In the remaining 14 patients the RGA was anastomized to the posterior descending coronary artery, in two of these also as a sequential graft to another distal branch from the right coronary artery (RCA). LIMA was used to the left anterior descending artery (LAD) in seven patients (as a sequential graft in two) and to branches of the circumflex artery (CX) in six patients. RIMA was anastomized to the LAD in seven patients and to the CX in five patients. The standard postoperative drug regime was the use of beta-blockers and aspirin for at least one year. Statin treatment was not employed at the study time.

## **RESULTS**

Table I lists baseline data

Early (30-day) postoperative course

No patients died. One patient had hypoxia-induced ventricular fibrillation and required mechanical ventilation for more than 24 hours. Two patients were treated for new-onset atrial fibrillation. Otherwise, there were no complications, neither myocardial infarction, stroke, renal failure, deep – or superficial wound infections, nor abdominal complications.

Survival

Seven patients (50%) were alive after 24 years (Table II) and thus seven (50%) had died (Table III). The cause of death

was cardiac related in two of these patients, but both had longer survival times than statistically expected. The three patients with shortened lifetime compared to the statistically expected died from non-cardiac causes.

Graft patency at repeat angiography

At a mean follow-up of 16 years (range 6 – 19 years) seven of nine (78%) RGA grafts were unremarkable. The occlusion of one of the grafts was iatrogenic occurring during a follow-up catheterization procedure. LIMA was normal also in seven of nine (78%) patients, whereas the RIMAs had a 100% patency (nine patients). The overall arterial graft patency was 23 of 27 conduits (85%). Five patients did not undergo re-catheterization.

Re-interventions

No patients had undergone redo coronary surgery. Percutaneous coronary intervention (PCI) on native coronary arteries had been undertaken in three patients.

Late abdominal complication and operations

Five patients were re-laparotomized during the observation period. One patient was admitted for ruptured abdominal aortic aneurysm. A well functioning RGA graft was injured and reconstructed with a vein graft segment. The four other patients were operated upon for a variety of abdominal conditions (penetrating ventricular ulcer, gynecological disorder, incisional hernia) without damage to the RGA graft.

## **DISCUSSION**

Our follow-up study presents real long-term outcomes from a highly selected cohort of patients with an extensive CAD which often has been deemed unsuitable for meaningful coronary artery bypass grafting (CABG). The patients were relatively young with an early onset CAD. In spite of this fact, the results are satisfying and above our expectations. Most of the patients have lived longer than statistically estimated based on a validated estimation method. (4,5). Only two of the patients died from a cardiac related cause, and the need for coronary re-interventions was also low compatible with a long-lasting high patency rate.

It has been argued that both IMAs (BIMA) should be used more frequently than just one of them (LIMA) because it increases survival, reduces recurrence of symptoms and re-interventions (6). The disadvantage from such a procedure

applied on a routine basis has been the reported increased incidence of postoperative mediastinitis, especially in diabetic patients (7). However, some authors have not found any difference in the rate of deep infection between LIMA - and BIMA grafting (8).

In 1990, statins were not in use and lifelong treatment with aspirin was not standard therapy.

The breakthrough for postoperative use of statins came with the 4S-study (9), and this study has been strengthened by research documenting a beneficial effect of statins for CABG patients (10). Other studies have demonstrated the effectiveness of aspirin for graft patency (11). It is possible that reports like these have contributed to the sustained use of only one IMA to the LAD territory and vein grafts for supplementary revascularization. As we have no control group and the cohort is small, we have no data to shed light on this controversy. Yet, the present findings, although in a small and special cohort of patients, are supporting the use of three viable pedicle arterial grafts for such selected patients with poor prognosis due to advanced diffuse triple vessel CAD.

It is an ongoing debate which graft (IMA, RGA, radial artery, saphenous vein) that should be chosen for revascularization of the RCA territory. Two studies have shown improved survival with RGA graft compared with a vein graft (12,13). An additional study demonstrated no survival difference between these grafts (14). Also, Di Mauro and coworkers reported that the RGA graft group had higher long-term mortality than the vein graft group (15). Finally, Pevni et al. have presented a group of patients with no grafting of a diseased RCA with equal six year survival compared to the grafted groups (16).

Some of the conflicting results regarding RGA patency can probably be explained by various degrees of stenosis of the RCA. It has been reported that there must be an occlusion or high-grade (80%) stenosis of the RCA to obtain a good patency rate from the RGA (17). This was not known in the 1990s. In our series 10 patients had occluded RCA and the remaining patients had high-grade stenosis, i.e. a favorable pathology for the use of RGA.

Three of our patients had undergone first-time CABG with only vein grafts for triple vessel disease six, eight, and nine years earlier. At redo CABG all grafts were occluded whereas the arterial grafts were open 13, 15, and 16 years after the redos. It is a comprehensible discrepancy although,

we acknowledge, somewhat anecdotal.

After a mean of 16 years 78 % of the RGA conduits were well functioning. This is comparable to a Japanese study with a cumulative 67 % RGA graft patency after ten years (18).

None of our patients had early abdominal complications. These are also rare, but it has been reported gastric perforation (19), herniation of the stomach to the mediastinum (20), intra-abdominal abscess with extension to the mediastinum (21), gastrojejunal fistula (22), tamponade due to incarcerated small intestine in the pericardial cavity (23), and coronary steal syndrome caused by stenosis in the celiac trunk with concurrent low-grade RCA stenosis (24).

The location of the RGA pedicle can represent a challenge during abdominal operations, foremost gastric surgery. With good planning the RGA graft can be preserved. If there is uncertainty about preservation of the RGA graft versus ensuring complete cancer elimination, pre-operative PCI should be considered. Alternatively, preparations must be done to reconstruct the RGA conduit (25).

Five of our patients had laparotomy following CABG. In one of them the RGA graft was inadvertently injured. In this patient, as in most of the others, the RGA graft was placed anterior to the pylorus and the liver since it is technically the simplest and ensures the best control of bleeding and prevent twisting of the conduit. The disadvantage is that this location makes the graft more susceptible to iatrogenic damage at re-laparotomy. Therefore, it has been recommended that the graft should be positioned behind the pylorus and the left liver lobe (26). This was done in a minority of our patients.

A drawback of using the RGA graft is the added operating time. This and the routine use of lifelong aspirin and statins, as well as the contradictory reports on the RGA efficiency, implied the discontinuation of our RGA program. We continued to use the BIMAs in selected patients and the third graft was either the saphenous vein or the radial artery. However, we are now prepared for the revived use of the pedicle RGA in our department, based on the present encouraging results.

Two (13 %) of our patients had dismal RGA quality and the graft could not be used which also is the experience of others (27,28). In one report 12 % (27), and in one other 14 % (28), of the RGAs were not usable. The latter study found good correlation between pre-operative computerized



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