AORTOCORONARY BYPASS GRAFT PATENCY ASSESSED BY CORONARY COMPUTED TOMOGRAPHY ANGIOGRAPHY – UNICENTRIC STUDY

Cristina Luca1*, Raluca Chistol2, Flavia Corciova3, Alina Iliescu1, Gr. Tinică2

University of Medicine and Pharmacy “Grigore T. Popa” Iași
Faculty of Medicine
1. Department of Surgery
2. Institute for Cardiovascular Diseases “Prof. Dr. George I. M. Georgescu” Iași

*Corresponding author. E-mail: cristinavartic@yahoo.com

AORTOCORONARY BYPASS GRAFT PATENCY ASSESSED BY CORONARY COMPUTED TOMOGRAPHY ANGIOGRAPHY – UNICENTRIC STUDY (Abstract): Coronary artery bypass graft (CABG) surgery is used to revascularize ischemic myocardium affected by coronary artery obstruction. Conventional coronary angiography (CCA) is an invasive method used for graft evaluation. Nowadays, in post CABG patients grafts can be assessed noninvasively by using coronary computed tomography angiography (CCTA). Aim: To determine the late patency rate in coronary bypass grafts using CCTA. Methods: To assess graft patency, sixty post CABG patients (51/60 males and 9/60 females) were evaluated using dual source computed tomography (DSCT) angiography. All patients underwent a primary isolated CABG surgery between January 2000 and December 2004, performed by a single surgeon, at the Department of Cardiovascular Surgery, “Prof. Dr. George I. M. Georgescu” Institute for Cardiovascular Diseases, Iași, Romania. The grafts were classified as patent, occluded and stenotic (stenosis >50%). Results: The mean age of patients was 68.05±7.59 years and the mean time after graft implantation was 129.53±16.74 months. The number of assessed grafts was 200, including 146 saphenous vein grafts (SVG) and 54 in situ left internal mammary artery (LIMA) grafts. A total number of 105/146 (71.92%) venous grafts and 52/54 (96.3%) arterial grafts were patent. Conclusion: Nowadays, computed tomography angiography is a modern noninvasive imaging modality used to evaluate the aortocoronary graft patency in early and late postoperative settings. In our study, the late saphenous graft patency rate was superior to that found in earlier angiographic studies. Keywords: CORONARY COMPUTED TOMOGRAPHY ANGIOGRAPHY, CORONARY ARTERY BYPASS GRAFT, SAPHENOUS VEIN GRAFT, LEFT INTERNAL MAMMARY ARTERY GRAFT

Coronary artery bypass graft (CABG) surgery represents the standard of care in the treatment of advanced coronary artery disease in order to restore myocardial perfusion. Triple vessel disease, one or two vessel disease involving the proximal left anterior descending artery (LAD), left main artery stenosis and left ventricular failure are the main clinical indications for CABG (1). The long-term prognosis after myocardial revascularization depends on bypass graft patency and progression of native coronary artery disease (2). Conventional coronary angiography (CCA) is the gold
standard in evaluating the patency of CABG, but it is a two-dimensional projection method that allows evaluation of the vessel lumen, not of the vessel walls, and is characterized by important limitations (invasiveness, high cost, need for hospitalization, low patient compliance). The development of electrocardiographically (ECG) gated multidetector computed tomography angiography has allowed accurate visualization of graft patency noninvasively, to detect or exclude significant stenosis in bypass grafts (3). The superior temporal resolution of dual source computed tomography (DSCT) has substantially improved coronary imaging. Weustink et al., using DSCT angiography, reported a diagnostic accuracy of 100% in the evaluation of graft stenosis on a segment basis. Coronary computed tomography angiography (CCTA) is now used more widely in postoperative settings and in preoperative planning for repeat CABG surgery (2). While asymptomatic CABG patients are not routinely followed by CCA, DSCT represents an opportunity for graft follow up in such as patients, as well as in symptomatic post CABG patients. The aim of this study was to assess graft patency noninvasively using DSCT.

MATERIAL AND METHODS

We performed a single center study that included 60 post-CABG patients, 51 (85%) males and 9 (15%) females, who underwent a primary isolated CABG surgery in the interval January 2000 - December 2004, performed by a single experienced surgeon, at the Department of Cardiovascular Surgery, “Prof. Dr. George I. M. Georgescu” Institute for Cardiovascular Diseases, Iași. All patients underwent CTCA after a written informed consent was obtained. Exclusion criteria were allergy to iodine contrast agents, renal failure and inability to hold breath. The number and types of grafts and the native recipient vessels were extracted from each patient surgical record. An 18G cannula was placed in an antecubital vein for the administration of the iodinated contrast. All patients received nitroglycerin spray 0.8 mg within 5 minutes of scan acquisition.

All CCTA examinations were performed on a second-generation 128-slice DSCT scanner (Somatom Definition Flash; Siemens Healthcare, Forchheim, Germany). Scanning parameters were 100 or 120 kV tube voltage, tube current modulation with Care Dose 4D (reference 320mAs), 128 x 0.6 mm collimation, gantry rotation time 280ms. Peak arterial enhancement time was determined by the bolus tracking method. The contrast was injected by a power injector at 6 ml/sec, followed by 50ml saline flush. Images were reconstructed with a slice thickness of 0.75 mm, using a soft-tissue convolution kernel (B26f) and a sharp-tissue convolution kernel (B46) for vessel wall calcifications, to compensate blooming artifacts. Three-dimensional volume-rendered reconstructions were used to obtain general information about the status and anatomy of the grafts and native coronary arteries. Axial slices were examined for the presence of significant narrowing by determining the presence of ≥50% reduction in luminal diameter and vessel occlusion. The analysis was assisted by curved multiplanar reconstructions of all vessels.

The patients mean age was 68.05 years (range 48 to 82 years), and the mean interval between CABG surgery and CTA was 129.08±16.64 months. Mean body mass index (BMI) was 28.3±3.76 (range 20.53 to 40.57) kg/m². Arterial hypertension was the most common risk factor followed by dyslipidemia and diabetes mellitus (tab. I).
RESULTS

The maximum number of grafts per patient was 5 (one patient) and the minimum number was one (three patients), with a mean number of 3.33 grafts per patient. Six patients had only saphenous vein grafts (SVGs); three of them had only one venous graft on the right coronary artery (RCA), one patient had two venous grafts (on RCA and diagonal arteries), and two patients had three venous grafts (on RCA, diagonal and obtuse marginal arteries).

The grafts were classified as patent if there was continuous lumen visualization at origin, in the body and at its distal anastomosis with native recipient vessels; occluded when only their stumps were seen; stenotic if there was ≥50% diameter narrowing.

The total number of assessed grafts was 200, including 146 SVGs and 54 arterial grafts of in situ LIMA. A total of 105/146 (71.92%) SVGs and 52/54 (96.3%) LIMA grafts were patent; 41 venous grafts and 2 arterial grafts were occluded. The patients with a single SVG/RCA graft were two males (both SVG/RCA were patent) and one female (occluded SVG/RCA).

Thirty-one of the 60 patients (51.67%) had all grafts patent, 17/60 (28.33%) patients had just one occluded graft, 10/60 (16.67%) patients had two occluded grafts, whereas only two patients had three occluded grafts (43/200 occluded grafts and 157/200 patent grafts).

The third segment of RCA was grafted in 40 patients (20% females and 80% males), while posterior descending artery (PDA) was grafted in 20 patients (5% females and 95% males); all patients were right dominant (fig. 1). Left anterior descending (LAD) artery was the most grafted vessel (54 grafts, 7 in females and 47 in males), followed by diagonal branch, 45 grafts in 42 patients, 7 females and 38 males (3 males

<table>
<thead>
<tr>
<th>Variable</th>
<th>Continuous</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years</td>
<td>68.05</td>
<td>7.59</td>
<td></td>
</tr>
<tr>
<td>Follow-up interval, months</td>
<td>129.53</td>
<td>16.74</td>
<td></td>
</tr>
<tr>
<td>BMI, kg/m²</td>
<td>28.27</td>
<td>3.88</td>
<td></td>
</tr>
<tr>
<td>Total cholesterol</td>
<td>187.28</td>
<td>45.88</td>
<td></td>
</tr>
<tr>
<td>HDL</td>
<td>48.93</td>
<td>13.06</td>
<td></td>
</tr>
<tr>
<td>LDL</td>
<td>107.33</td>
<td>40.82</td>
<td></td>
</tr>
<tr>
<td>Triglycerides</td>
<td>157.71</td>
<td>81.83</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Category</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ever smoked</td>
<td>26</td>
<td>43.33</td>
</tr>
<tr>
<td>Male gender</td>
<td>51</td>
<td>85.00</td>
</tr>
<tr>
<td>Family history CAD</td>
<td>18</td>
<td>30.00</td>
</tr>
<tr>
<td>Dyslipidemia</td>
<td>51</td>
<td>85.00</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>26</td>
<td>43.33</td>
</tr>
<tr>
<td>Hypertension</td>
<td>56</td>
<td>93.33</td>
</tr>
</tbody>
</table>

Abbreviations: BMI, body mass index; HDL, high-density lipoprotein cholesterol; LDL, low-density lipoprotein cholesterol; CAD, coronary artery disease.
Aortocoronary bypass graft patency assessed by coronary computed tomography angiography – unicentric study

with two grafted diagonal branches). Obtuse marginal branch (OM) was grafted in 40 patients (10% females, 90% males) with 41 grafts, one male with two grafted obtuse marginal branches (fig. 2).

A number of 54 patients had a LIMA graft to LAD. LIMA graft was not developed in 2 patients.

Fig. 1. Patient M.V. 71-years-old, 12 years after CABG surgery (2001-2013), has 4 grafts (SVG/PDA, LIMA/LAD, SVG/D1, SVG/OM1), all of them permeable

Fig. 2. Patient P.V. 72-years-old, 13 years after CABG surgery (2000-2013), has 5 grafts (SVG/RCA, LIMA/LAD, SVG/D1, SVG/D2, SVG/OM), all of them permeable, except SVG/RCA
The diagonal branch was the second most grafted artery. 45 diagonal branches were grafted in 42 patients, of which 34 (75.56%) patent and 11 (24.44%) occluded venous grafts were visualized. There was one stenotic (stenosis of ≥50%) graft to the diagonal branch.

OM was grafted in 40 patients. There were 41 venous grafts to OM, 32 (78.05%) patent and 9 (21.95%) occluded. Four patent SVGs to OM were stenotic grafts.

On right coronary artery, there were 60 venous grafts, of which 39 were patent (65%), with a worse patency in females. In males, 36/51 SVGs to the RCA (70.59%) were patent, while in females 3 of 9 (33.33%) SVGs to RCA were patent. According to their distal anastomoses, 40 venous grafts anastomosed distally to RCA, proximal to the crux cordis (8 females and 32 males), while 20 SVGs had distal anastomoses to PDA (one female and 19 males). Patent grafts to RCA proximal to the crux had been found in 25/40 (62.5%) patients and 15/40 (37.5%) patients had SVGs to RCA occluded, with a much worse outcome for females 6/8 (75% occluded) than males 9/32 (28.12% occluded). Two patients had stenotic graft to RCA (≥50% stenosis). 14/20 (70%) grafts anastomosed distally to the crux, to PDA, were patent, while 6/20 (30%) were occluded, with a better outcome for female (100%) than for male (68.42%) (fig. 3).

![Graph](image)

**Fig. 3.** Distribution of graft patency rate by distal anastomoses and sex (FPG, graft patency in females; MPG, graft patency in males; GPG, general graft patency)

The overall patency rates for arterial LIMA and venous grafts in this patient population were 96.3% and 71.92% respectively. There were 67.12% (98/146) saphenous venous good quality grafts, without any stenosis at origin, in the body or at their insertion with native vessel (7 SVGs were stenotic grafts).

**DISCUSSION**

Conventional coronary angiography (CCA) is the standard investigation for the evaluation of native coronary arteries and bypass grafts in post CABG patients (4). CCA is an invasive procedure, which has a significant risk in post CABG patient, associated with stroke, cardiac arrhythmia,
Aortocoronary bypass graft patency assessed by coronary computed tomography angiography – unicentric study

Contrast allergy, nephrotoxicity, high cost, and radiation exposure (5). CCTA is a noninvasive method used for the assessment of coronary arteries and bypass grafts, which has been improved with the advent of DSCT scanners and has shown a high degree of accuracy for the detection of significantly lesions (6). Nonselective injection of contrast on CCTA abolishes such serious risks as arrhythmia, graft dissection, myocardial infarction or embolic events as compared to the selective injection of contrast agents in bypass graft on CCA. The current CCTA technology is able to evaluate a higher number of grafts as compared to the earlier CCTA technology, with a sensitivity of 100% for detecting significant lesions and a NPV of 100% (7). High sensitivity and high NPV indicate that negative CCTA results exclude significant graft lesions and the need for diagnostic CCA. Moreover, CCTA graft imaging can be done prior to planned CCA for graft visualization or in redo CABG for preoperative planning (8).

In contrast to arterial grafts, SVGs usually appear larger on CCTA images and fewer streak artifacts from surgical clips are seen. The proximal anastomosis of a graft is typically better visualized than its distal part on CCTA. Distal anastomoses that are not well visualized are considered patent when contrast is present within the graft conduit lumen.

All right-sided grafts in this study were SVGs, whereas left-sided grafts were represented by in situ LIMA graft on LAD and SVGs on diagonal branches or obtuse marginal arteries.

The advantages of LIMA graft conduit include decreased postoperatively mortality and improved cardiac event-free survival rates. The LIMA grafts are more resistant to atherosclerosis and have a long-term patency rates superior to those of SVGs (9). The wall of the arterial conduit is better suited to a high-pressure system and high flow velocity after CABG surgery. LIMA is used most often to revascularize the LAD or its branch territory. In situ LIMA grafts are commonly used to target the LAD (10). Sequential distal grafting is sometimes performed proximal side-to-side anastomosis to diagonal branches and distal end-to-side anastomosis to LAD or both to LAD (11). In our study, all LIMA were in situ grafts, with end-to-side anastomosis to LAD, without sequential anastomosis performed. On CTA, the LIMA graft is usually seen as a vessel along the left anterior mediastinum and may be difficult to visualize distally because of its size and artifacts. Long-term patency rate of the LIMA grafts, over 90% at 10 years after the surgery, was demonstrated by several studies.

Using SVGs for coronary arteries revascularization offers many advantages such as availability, accessibility, ease of harvest, resistance to spasm, but SVG occlusion in the later stages, due to plaque formation in the bed of fibrointimal hyperplasia and development of atherosclerosis, represent the main limitations. SVGs patency rate have increased due to continued improvements in surgical techniques, combined with antiplatelet or anticoagulant agents and lipid lowering drug therapy. The use of no-touch techniques to harvest the saphenous vein (SV) has been reported to significantly improve long term graft patency. Souza et al. (12) reported that the harvesting of SV with surrounding tissue provides high short- and long-term patency rates comparable to the LIMA (angiography at 8.5 years showed a patency rate for the conventional group of 76% and 90% for the no-touch group). Hata et al. (13) reported a SVG patency rate of 64.7% at 8 years.
Campbell et al. reported 66.7% patency rate of SVG at 7.3 years, while Naveed et al. (14) reported 66.1% venous grafts as patent at a mean follow up of 8.01 years.

CONCLUSIONS

In our study, patency rate for SVGs at 129 month was 71.92%, which is higher than in the previous reports. The secondary prevention methods, statins, antiplatelet agents, lipid lowering therapy, and lifestyle factor modification, contributed to improvement of SVG patency rate thus, venous graft occlusion had developed at a slower rate than found in earlier angiographic studies. While the association of arterial hypertension with the other risk factors related to the metabolic syndrome in elderly patients makes them more prone to the development of cardiovascular diseases (15, 16), further studies are required to determine whether a more aggressive pharmacological therapy could favorably modulate patency in venous conduits.

REFERENCES


---

**CYTOLOGICAL ANALYSIS OF THE PERIODONTAL POCKET IN PATIENTS WITH AGGRESSIVE PERIODONTITIS AND CHRONIC PERIODONTITIS**

Oral exfoliative cytology includes the study and interpretation of the features cells exfoliated from the oral mucosa. The aim of a study realized by a group of argentinian researchers was to analyze cytological changes in the periodontal pocket of patients with different clinical stages of aggressive periodontitis and chronic periodontitis. Patients, aged between 24-54 years, of whom 41 were diagnosed with aggressive periodontitis, 40 with chronic periodontitis, sub-classified as mild, moderate and severe periodontitis, and 40 healthy individuals who were the control group. For the cytological study were taken samples of the epithelium of the periodontal pocket. Superficial and intermediate cell values were significantly greater in patients with aggressive periodontitis than in patients with chronic periodontitis or the control group. Histiocyte number was higher in patients with chronic periodontitis than in those with aggressive periodontitis, and differed significantly in both types of periodontitis compared to the control group. There were significant differences in polymorphonuclear neutrophil leukocytes when both types of periodontitis were compared to the control group. Microbial flora was statistically higher in patients with chronic periodontitis, and there were differences between patients with periodontitis and the control group. The cytological study demonstrated that patients with aggressive periodontitis had greater tissue damage, shown by the increase in intermediate and superficial cells of the epithelium of the periodontal pocket compared to the group of healthy subjects and to a lesser extent, to patients with chronic periodontitis. Only superficial cells made it possible to differentiate the sub-stages of the disease (Cecilia EC, Myriam AK, Maria EL. Cytological analysis of the periodontal pocket in patients with aggressive periodontitis and chronic periodontitis. *Contemp Clin Dent*, 2014; 5 (4) : 495-500).

*Irina Grădinaru*