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Our experience regarding post coronary artery bypass grafting (CABG) complications in king hussein hospital and queen alia cardiac center

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Abstract
Purpose: The aim of the study to evaluate post-operative radiological complications of Coronary Artery Bypass Surgery.
Methods: Our retrospective study include 257 patients, aged 45-75 years, of both sexes, with history of post Coronary Artery Bypass graft at Queen Alia Cardiac Center and scanned at King Hussein Hospital/ Radiology department during the 2019 period.
Results: 81 patients showed complication after Coronary Artery Bypass Surgery with the graft occlusion and severe stenosis being the most common seen in 47 patients followed by graft calcification (Atherosclerosis) in 22 patients, in the other hand 176 patients showed no radiological complication with 68 patients performed the graft more than 10 years ago.
Conclusions: Coronary artery bypass surgery is used to graft blood vessel artery or vein to bypass blockage in the coronary arteries, post-operative radiological complication of CABG include occlusion, calcification thrombosis, spasm and aneurysm formations. Coronary CT angiography is modality of choice to follow up post CABG patients. although the short term outcomes of CABG are generally excellent, patients remain at risk for future cardiac events due to progression of native coronary artery disease and or coronary bypass graft failure.

Keywords: coronary artery bypass surgery, coronary CT angiography, radiological complication, saphenous veins graft, arterial graft

Introduction

Coronary artery bypass grafting (CABG) is defined as open heart surgery in which section of a blood vessel is grafted from the aorta to coronary artery to bypass the blocked section of the coronary artery and improve blood supply to the heart [2].

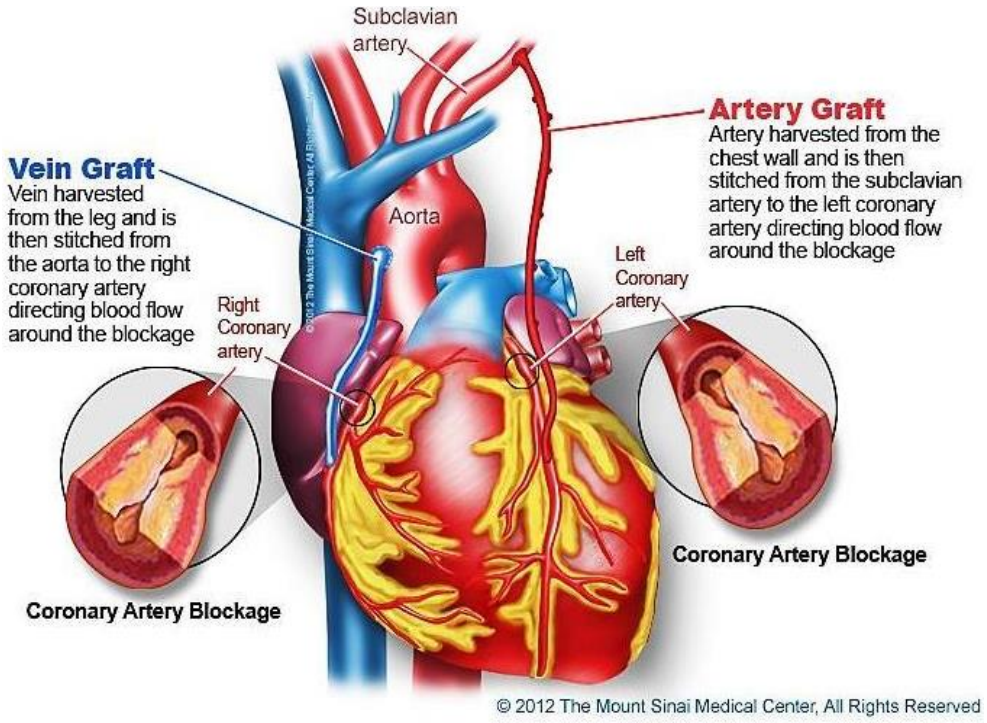

Fig 1: definition of CABG

Materials and methods

This is a retrospective study for 257 adult patients of both genders, with history of post coronary artery bypass grafting at queen Alia Cardiac Center and imaged at king hussein hospital Radiology department. All patients were scanned with SIEMENS CT (Somatom Force) 256-slice in the period from January 2019 to December 2019. patients with heavy calcification and high calcium score within the native coronary arteries (high Agatston score) and obese patients with good quality images were enrolled in this study, patients with high or irregular heartbeats or with inability to comply with instructions of breath holding and patients with excessive motion artifacts were excluded. Preparation of the patients include Renal function test to assess creatinine level and measurement of heart rate prior to imaging. the exam started by the patient holding breath while the images were obtained and intravenous contrast was given. the contrast transit time was estimated by injection of test bolus or using a real-time bolus tracking technique, the images was viewed in axial plane, oblique multiplanar reconstructions MPR, oblique maximum intensity projections MIPs, curved multiplanar reformations cMPRs and volume rendering 3-Dimensional reconstruction technique using Syngo-via software. All patients were examined by two radiology specialists in two separate sessions and the results were analyzed by simple statistical methods.

Results

Our study revealed that the most common complication after coronary artery bypass grafting is graft occlusion or severe stenosis followed by graft calcification.

the total number of patients with occlusion or severe stenosis were 47 patients (18%) and the total number of patients with calcification is 22 (8%) patients other less common complications detected in our study are graft spasm in 10 (4%) patients and graft aneurysm in 2 patients (1%) many of incidental findings seen in follow up Coronary CT angiography like lung nodules, lung cysts such as hydatid cysts and pneumatic consolidation and arch of aorta normal vascular variants are noted.

176 patients (69%) were found without complication related to the CABG surgery and 68 patients (26%) have more than 10 years since the CABG.

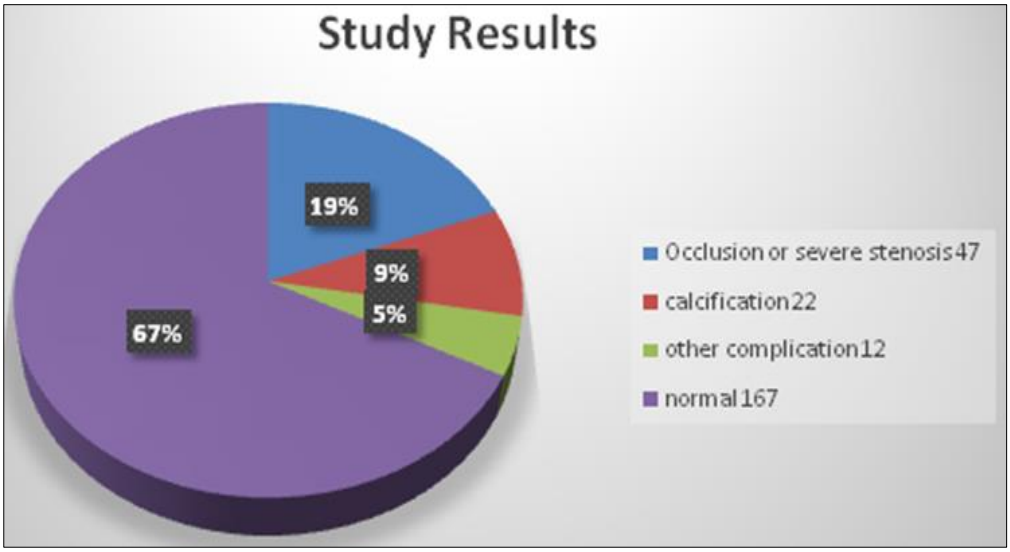

Fig 2: Results of post CABG complications

Discussion

what is coronary artery bypass grafting, it is a surgical procedure that uses another artery or vein to reroute blood around blockage in the coronary artery in order to supply heart with blood and oxygen, cholesterol and fat deposition in native coronary artery vessel called plaque and this process is called atherosclerosis, if plaque continues to build up, coronary vessel can become partially or completely blocked leading to angina (chest pain) or even myocardial infarction [3].

Indications for Coronary Artery Bypass Graft Surgery:

according the American College of Cardiology and the American Heart Association there are six conditions as indications for CABG in patients with stable angina: 1) significant left main coronary artery stenosis. 2) Significant (> 70%) stenosis of the proximal left anterior descending artery LAD and proximal left circumflex arteries. 3) three vessel disease. 4) two vessel disease with significant proximal LAD stenosis and either ejection fraction <0.50 or demonstrable ischemia on noninvasive testing. 5) one or two vessel stenosis without significant proximal LAD stenosis, but with a large area of viable myocardium and high risk criteria on non-invasive testing. 6) Disabling angina despite maximal noninvasive therapy, when surgery can be performed with acceptable risk.

More serious cases of coronary artery disease require coronary artery bypass graft surgery (CABG),it is Performed since the late 1960s, and now one of the most common operations in the United States—up to 500,000 are done yearly [4]. Coronary aortic bypass grafts are performed with the use of cardio pulmonary bypass after chemically arresting the heart (on-pump grafting). In recent years, new surgical techniques permit CABG without a heart-lung machine

or cardio plegia (off-pump grafting). Debate exists among cardiac surgeons as to which of the two surgical approaches is superior, but excellent outcomes can be achieved with either

strategy. Benefits of on-pump CABG are that it is less technically demanding, permits more grafts to be constructed per procedure, and, possibly, has better long-term graft patency. Proponents of off-pump CABG suggest that it decreases the length of hospital stay, the amount of blood loss during surgery, and other complications such as renal insufficiency and neurocognitive dysfunction [5].

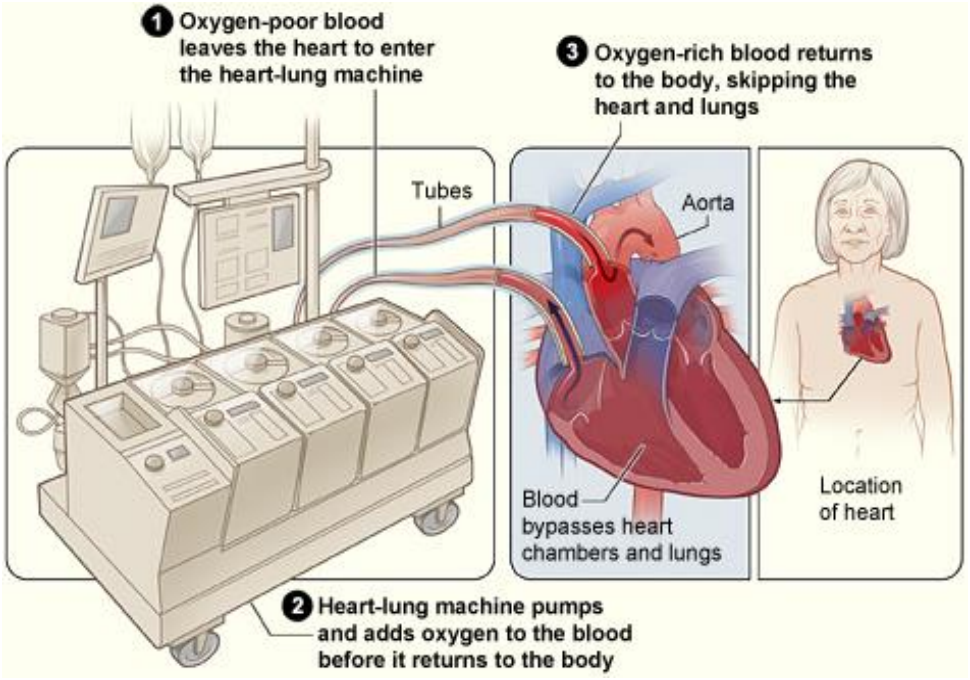

Fig 3: the Heart lung machine used in on-pump CABG.

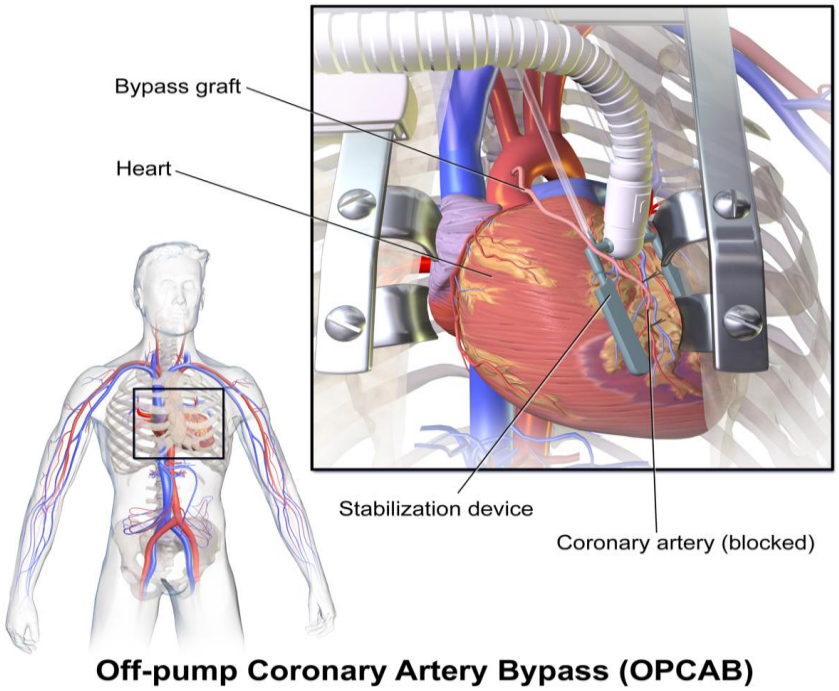

Fig 4: CABG without using heart lung machine off-pump

Long term outcome of coronary artery bypass grafting depends on graft patency, Coronary CT angiography is done for routine assessment of CABG, especially when the patient presented with recurrent angina [6].

Types of coronary artery bypass grafts

Saphenous vein grafts: are the earliest grafts used for CABG, which are still the most widely used in coronary bypass surgeries including our Hospital Queen Alia, Saphenous vein conduits are

Harvested from legs and grafted from ascending aorta (usually anterior aspect) to the coronary artery beyond the obstructive lesion. Right coronary grafts are usually anastomosed to the right coronary artery RCA or posterior descending artery PDA. Left coronary grafts are usually anastomosed to left anterior descending artery LAD, left circumflex, obtuse marginal or diagonal branches. Saphenous grafts are most convenient, however most prone to occlusion. In CT imaging, it may not be possible to see the distal anastomosis, however, continuous contrast column in the graft can be taken as the graft is patent. in comparison with arterial grafts they are widely available more resistant to spasm but with lower patency rate due to hyperplasia and atherosclerosis changes after exposure to systemic blood pressure, graft occlusion occur due to vascular damage during harvesting of the saphenous vein [7]. Left internal thoracic (or mammary) artery (ITA) or (LIMA) grafts have emerged as the preferred bypass graft due to its excellent graft patency (due to presence of vaso vasorum inside the vessel wall which tends to protect against intimal hyperplasia and cellular migration) and close proximity to the LAD. They are often referred to as LIMA grafts (left internal mammary artery grafts). The graft is directly seen on.

Cross-sectional imaging or appears alongside a row of media stinal surgical clips. It's proximal end arises from the normal anatomical origin (first part of the left subclavian artery for the LIMA), and its distal end is usually anastomosed to the LAD. The right ITA (RIMA) graft can also be used in a similar fashion. In two-vessel disease, the LIMA is usually connected to the LAD, and RIMA is attached proximally to LIMA and distally to the second target vessel. In this case, both arterial grafts have better patency rates than venous grafts. the specific reasons for not use the RIMA may include additional time to harvest, concerns over deep sternal wound infection, myocardial hypoperfusion, unfamiliarity and potentially effect on the vascular supply of the forearm and hand, potential spasm and size matching to coronary artery.

other grafts include: Radial artery which is used after harvesting from the non-dominant forearm and Gastroepiploic artery which is used by extended sternotomy and is dissected from the greater curvature of the stomach and anastomosed to the target vessel (difficult and rare surgery).

Table 1: The different types of arterial grafts.

	Les: Spaztic	Internal mammary artery	Internal mammary artery
Type I- Somatic arteries			Inferior epigastric artery
			Subscapular artery
Type II - Splanchnic arteries	Spastic	Gastroepiploic artery	
			Splenic artery
			Inferior Rnezentenc artery
Type III - Limb arteries	Spastic	Radial artery	
			Ulnar artery
			Lateral femoral circumflex artery

The differences between the arterial and venous grafts: 1) arterial grafts are less susceptible to vasoactive substances than veins. 2) the arterial wall is supplied by the vaso vasorum plus through the lumen, while the veins are only supplied by the vaso vasorum. 3) the endothelium of the arteries may secrete more endothelium-derived relaxing factor. 4) the structure of the artery is subject to high pressure, while the vein is subjected to low pressure, as the Saphenous venous graft have to adapt to the high pressure the arterial grafts do not have to which may partly explain the difference in the long term outcome [8].

in our study we found 47 patients with occluded grafts 44 cases of them was in the Saphenous venous graft and only 3 patients with occluded left internal mammary artery graft occlusion.

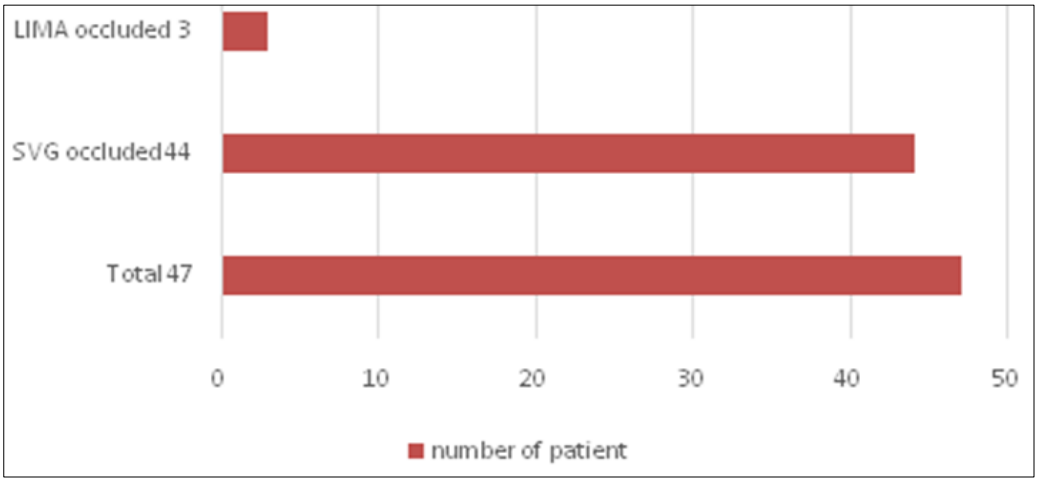

Fig 5: comparison between patency of LIMA and SVG grafts.

The use of SVG, arterial grafts or both during CABG is largely depending on: the site of anatomic obstruction, the availability of good quality conduits, patient preferences, and the clinical condition of the patient. in most of cases the Saphenous vein is used to bypassing non left anterior descending artery lesions (LAD) and arterial bypass grafts for left anterior descending artery lesions [9].

Complications of CABG

Thrombosis: most common in the early postoperative period within one month after CABG, the most common cause of graft failure is thrombosis from platelet dysfunction at the site of focal endothelial damage during surgical harvesting and anastomosis.

Graft malposition or kinking: which can cause graft occlusion it is commonly seen in longer graft and graft with connector devices.

Graft spasm: common in radial artery grafts, it is seen in the early postoperative period. In the case of graft spasm, proximal graft appears narrower than distal graft while graft stenosis the distal graft is narrower than proximal, administiration of alpha-adrenegic blocking agents or calcium channel blockers can overcome cases of graft vasospasm post operatively.

Iatrogenic complications: graft damage during surgery and retained clips.

Graft aneurysms: aneurysmal dilatation of graft >2 cm considered significant and will require surgery, the other form of aneurysm is pseudoaneurysms which may arise at the proximal or distal ends of grafts.

Non-graft related surgical complications

Pleural or pericardial effusion.
Sternal, media stinal or donor-site infection.
Sternal non-union.
Pulmonary embolism.
Media stinal hematoma [10].

The term (Failing graft) is defined as when a graft patency is threatened by a hemo dynamically significant lesion in the inflow or outflow tracts or within the body of the graft. the risk factors for venous graft failure are: 1) At time of harvest the quality of the Saphenous veins may be poor due to pre-existing pathological conditions ranging from significantly thickened walls to post phlebitic changes and varicositis between 2-5% of Saphenous veins are unusable and 12% are considered diseased which reduce the patency rate by one half. 2) The inevitable vascular trauma that occurs during harvesting itself can also lead to damage to the endothelium and contribute to graft failure. 3) Surgical manipulation and high pressure distension to reverse spasm during harvesting leads to loss of endothelial integrity making the graft more prone to subsequent occlusive intimal hyperplasia and or thrombus formation [11].

arterial graft failure are less than veins since they are not removed from the blood circulation but are prepared locally with few ligations and preservation of blood flow, arterial graft failure risk factors are attributed to technical errors and distal anastomosis, the non-technical factors are high levels of LDL-cholesterol (low density lipoprotein)and triglycerides, smoking, hypertension and diabetes mellitus [12].

In all patients post CABG aggressive risk factors reduction is recommended which include aspirin, treatment for hypertension and serum lipids, controlling serum glucose in diabetic patients, Avoidance of smoking. in graft failure Percutaneous Coronary Intervention (PCI) may be an alternative to reoperation (redo CABG) with acceptable results and fewer complications, when multiple grafts are occluded or the graft or native coronary artery appears unsuitable for PCI redo CABG should be favoured, both PCI and redo CABG should only be considered if the graft or coronary artery is of good size, severely narrowed and supplies a large territory of myocardium, redo CABG or PCI should be decided with the heart team [13].

Conclusion

Coronary artery bypass surgery is used to graft blood vessel artery or vein to bypass blockage in the coronary arteries, post-operative radiological complication of CABG include occlusion, calcification thrombosis, spasm and aneurysm formations. Coronary CT angiography is modality of choice to follow up post CABG patients. although the short term outcomes of CABG are generally excellent, patients remain at risk for future cardiac events due to progression of native coronary artery disease and or coronary bypass graft failure.

Ethics approval and consent to participate

This study was approved by ethical committee from our institution and all data was obtained lawfully.

Conflict of interest

None.

Funding source

None.

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