Original article:

Role of multi-detector CT coronary Angiography in Post CABG patients

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Abstract-

Objective- To find out the status of venous and arterial grafts in symptomatic and asymptomatic post CABG patients within 10 years of surgery by CT coronary angiography. Compare conduit occlusion rates depending upon type of native coronay vessel on which graft done and type of vessel used for grafting.

Methods- 50 post patients who underwent CABG within 10 years randomly selected at OPD and subjected to multi-detector CT coronary angiography. Graft patency and angina symptom correlation was studied.

Results- Graft patency rates were better in arterial grafts as compared to venous graft. Also correlation of arterial occlusion is correlated with angina symptoms of patient.

Conclusions. After 5 year of CABG surgery, arterial graft occlusion rates are less than venous graft occlusion rates. CT coronary angiography is recommended for all post CABG surgery symptomatic patients irrespective of duration after surgery.

Key words CABG, CTA, IMA, RA, SVG

INTRODUCTION

Coronary artery bypass graft (CABG) surgery is one of the most commonly performed surgical procedures as a therapeutic intervention for CAD. Notwithstanding the clear benefits of bypass grafting, recurrent chest pain after myocardial revascularization is a common postoperative presentation. The long-term clinical outcome after surgery is dependent on the patency of the bypass grafts and the progression of native coronary artery disease (1-3). Conventional coronary angiography has been traditionally used to assess the status of bypass grafts, but technical advances in multidetector computed tomography (MDCT) have given the radiologist the ability to evaluate bypass grafts noninvasively.

METHODS

A Prospective study done at LTMMC & LTMGH, Sion, Mumbai (Tertiary care center) between May 2014 – May 2017 with sample size of 50 Patients. Study was performed on multi-detector CT (A Philips Brilliance 64 – Slice MDCT scanner).

Aims & Objectives Of The Study

- To find out the status of venous and arterial grafts in symptomatic and asymptomatic post CABG patients within 10 years of surgery by CT coronary angiography.
- Compare conduit occlusion rates depending upon surgical technique used

- Native coronary vessel on which graft done- Grafts done on LAD and its branches, Grafts done on LCX branches, Grafts done on distal RCA branches (PDA & PLV) and grafts done on proximal RCA.
- Type of vessel used for graft - LIMA, RIMA, RA, SVG.

Inclusion Criteria

- Asymptomatic and symptomatic but stable patients who have undergone Coronary artery bypass graft (CABG) at our institute.

Exclusion criteria:

- Patients not consenting for the study
- Pregnancy
- Known h/o contrast allergy.
- Severe chest pain / Unstable patients
- Arrhythmia and poor control of the heart rate.
- Poor breath hold

Interpretation of CTA following CABG surgery is done by first assessing the morphology and size of in situ vessel. Then, graft patency is assessed for homogeneous, contrast-enhanced graft lumen and for regular shape and border of the graft wall. The graft is usually divided into 3 different segments: the origin or proximal anastomosis of the graft, the body of the graft, and the single (or sequential) distal anastomosis. In cases in which the distal anastomosis is not well evaluated, the bypass graft is considered patent as long as contrast is evident within the graft lumen

RESULTS-

The maximum number of patients (**42.0%**) belong to age group of 51-60 years with mean age was **57.60 years**. **84.0%** of the cases were male and **16.0%** of the cases were female.

Table 1- Distribution And Occlusion Rates Of The Arterial And Venous Grafts

YRS	No of Arterial grafts used	No of Arterial grafts occluded	Arterial Grafts Occlusion rates (%)	No of Venous grafts used	No of Venous grafts occluded	Venous Occlusion rates (%)	Total Grafts used	Total graft occlusion	Overall occlusion rates (%)
<= 1yr	18	6	33.33	20	5	25	38	11	28.94
1-5	30	7	23.33	26	10	38.46	56	17	30.35
>5	22	0	0	24	10	41.66	46	10	21.73
TOTAL	70	13	18.57	70	25	35.71	140	38	27.14

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Arterial graft occlusion percentage was 18.57% (13/70) with maximum percentage of occlusion belongs to less than 1 year's group. Venous graft occlusion percentage was 35.71% (25/70) with maximum grafts occlusion belongs to more than 5 years group.

In our study overall arterial graft occlusion rate was lower than overall venous graft occlusion and was statistically significant (Z Test p Value = 0.014). In more than 5 years group, arterial graft occlusion rates were lower than venous graft occlusion rates and this was statistically significant (t Test p Value = 0.005).

In less than 1 year and 1-5 Years group, graft occlusion rates for arterial grafts were more than that of venous grafts; but statistically significant correlation was not found.

Table 2- Symptomatic Patients With Arterial / Venous Graft Occlusion

	Total patients	Symptomatic	Percentage symptomatic (%)	No of Patients with Arterial grafts occluded	No Of Patients with symptomatic arterial graft occlusion	No of Patients with Venous grafts occluded	No Of Patients with symptomatic Venous graft occlusion
<= 1yr	14	10	71.42%	6	6	3	3
1-5 years	20	7	35%	5	5	11	1
>5 years	16	6	37.5%	0	0	8	4
Total Grafts	50	23	46%	11	11	22	8

All patients with arterial graft occlusion were found to be symptomatic with a significant statistical correlation (p Value = less than 0.005). Of all patients with venous graft occlusion, 36.36% (8 out of 22) were found to be symptomatic with no significant correlation was found between venous graft occlusion and symptoms in patients.

Table 3- Grafts Distribution Of Native Vessels On Which Graft Had Been Done

Duration between CABG & CT	Grafts in LAD and its branches					Grafts in LCX and its branches					Grafts in Distal RCA branches (PDA & PLV)					Grafts in proximal RCA
	LIMA - LAD	RIMA-D	RSVG-LAD	RSVG-D	Total Grafts	LIMA-OM	RIMA- OM	Radial-OM	RSVG-OM	Total Grafts	RIMA-PDA	Radial - PDA	RSVG-PDA	RSVG-PLV	Total Grafts	
<= 1yr	12	0	2	4	18	2	2	2	4	10	0	0	5	0	5	5
1-5 years	18	2	2	0	22	2	4	1	14	21	3	0	6	3	12	1
>5 years	14	0	2	6	22	0	0	6	6	12	0	2	8	0	10	2
Total Grafts	44	2	6	10	62	4	6	9	24	43	3	2	19	3	27	8

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Table 4-Grafts Occlusion Rates (Overall Arterial And Venous)

	Grafts in LAD and its branches			Grafts in LCX branches			Grafts in Distal RCA branches			Grafts of proximal RCA		
	A	V	TOT	A	V	TOT	A	V	TOT	A	V	TOT
Grafts used	46	16	62	19	24	43	5	22	27	-	8	8
Grafts occluded	5	3	8	6	7	13	2	13	15	-	2	2
Grafts patent	41	13	54	13	17	30	3	9	12	-	6	6
% Occluded	10.86	18.75	12.90	31.57	29.16	30.23	40	59.0909	55.55	-	25	25

Maximum arterial and venous grafts occlusion rate was in distal RCA branches and least arterial and venous grafts occlusion rate was in grafts of LAD and its branches. Graft occlusion rates in LAD and its branches significantly low as compared to the grafts of distal RCA branches (chi square test P value << 0.05) and grafts of the LCX branches (chi square test P value = 0.02) which is statistically significant. Grafts in LCX had lower occlusion rates than grafts in distal RCA branches with significant difference (chi square test P value = 0.03).

Table 5-Distribution of grafts according the origin of vessels used for graft purpose.

Duration between CABG & CT	LIMA based grafts	RIMA based grafts	Radial artery based grafts	Saphenous grafts
Less than 1 yeas	14	2	2	20
1-5 years	20	10	0	26
more than 5 years	14	0	8	24
total	48	12	10	70

Table 6-Occlusion Rates Of Grafts As Per The Origin Of Vessels Used For graft purpose.

TOTAL	LIMA based grafts	RIMA based grafts	Radial artery based grafts	Saphenous grafts
Grafts used	48	12	10	70
Grafts occluded	4	7	2	25
Grafts patent	44	5	8	34
Occlusion rate	8.33333	58.3333	20	35.71

LIMA based grafts having less statistically significant occlusion rates as compared to the saphenous based (Z test P value is <0.05). Radial artery based grafts having less occlusion rates as compared to the RIMA based (Z test P value is <0.05) and saphenous based (Z test P value is <0.05) with statistical significance. Saphenous based grafts having less occlusion rates as compared to the RIMA based (Z test P value is <0.05) with statistical significance. Thus ascending order of occlusion rates LIMA based grafts < Radial based grafts < Saphenous based grafts < RIMA based grafts.

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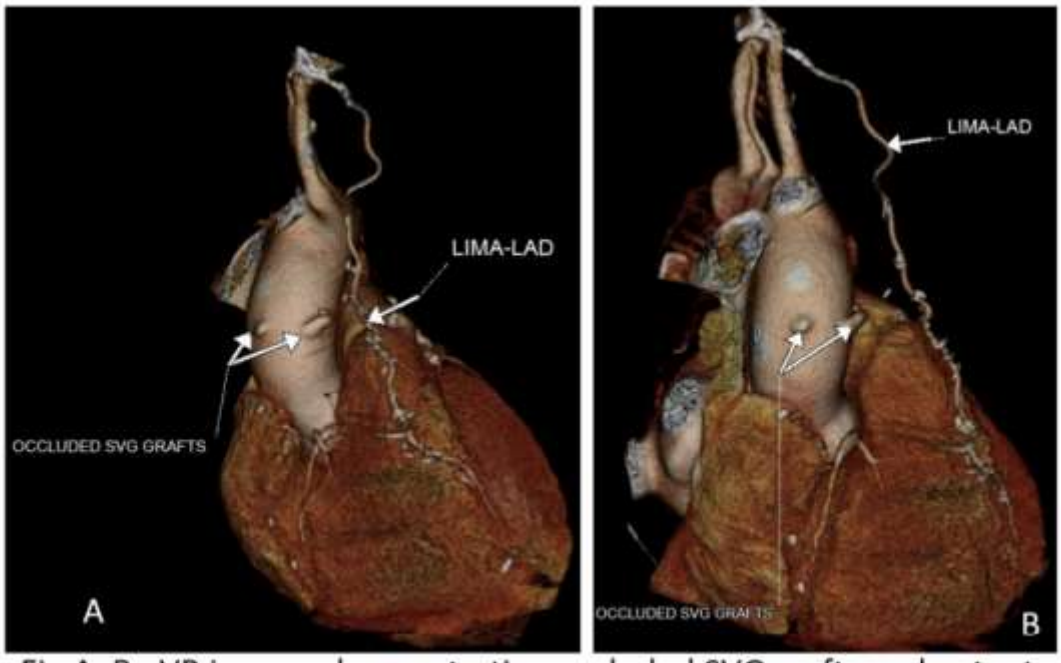

Fig A. B. VR images demonstrating occluded SVG grafts and patent LIMA-LAD grafts

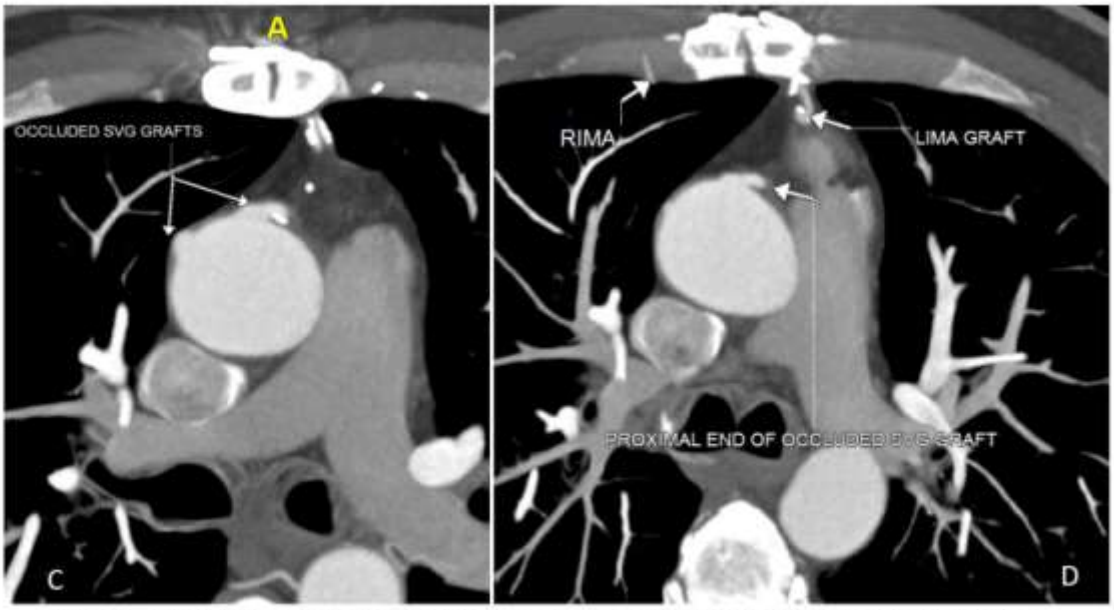

Fig C. D. MPR images demonstrating occluded SVG grafts and patent LIMA-LAD grafts

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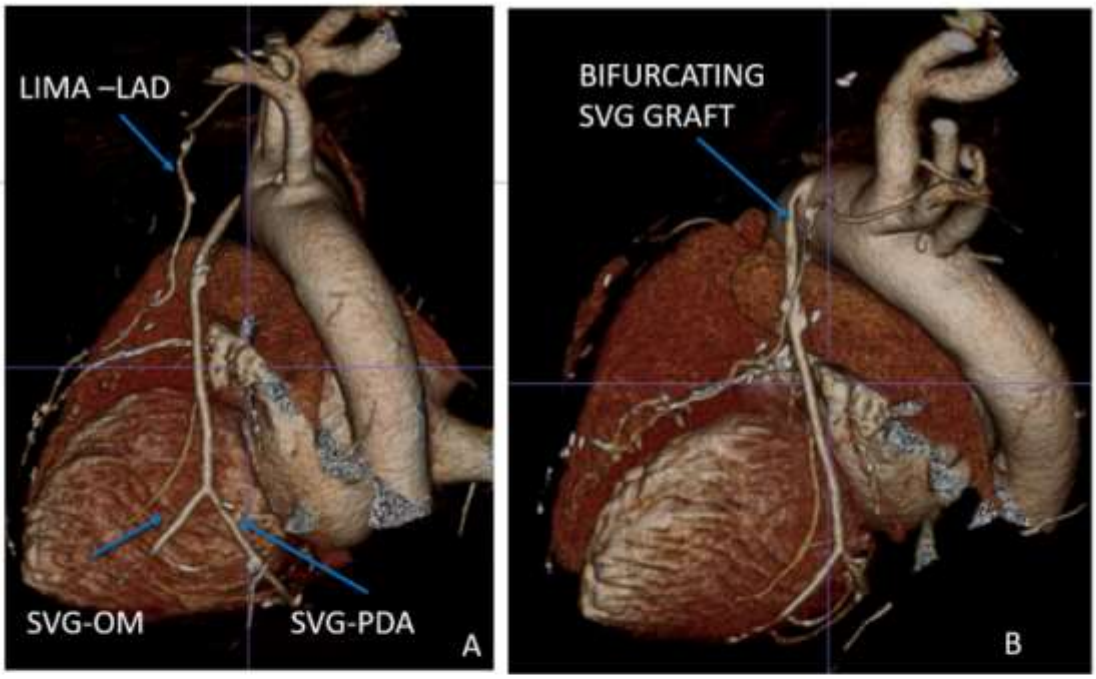

Fig. A & B VR Images showing bifurcating SVG graft and LIMA-LAD graft

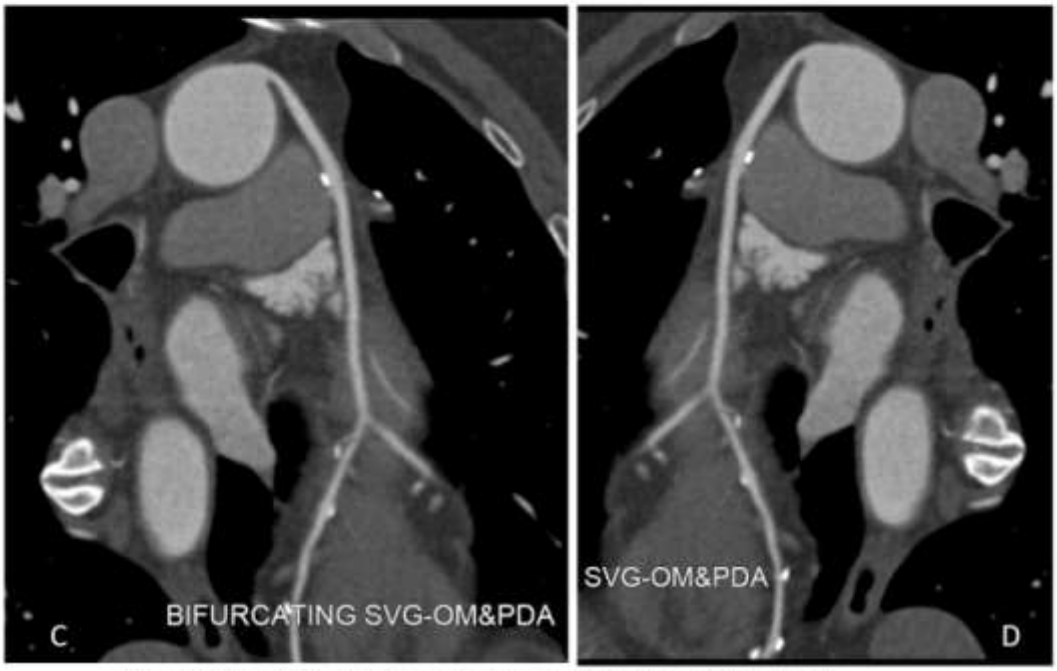

Fig. C & D MPR Images showing bifurcating SVG graft

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DISCUSSION

Coronary artery disease is secondary to narrowing of the coronary vessels from atherosclerosis (4). Risk factors are well known and include age, male gender, lack of exercise, obesity, high blood pressure, elevated blood lipid levels, smoking, and diabetes.

Currently, imaging of coronary artery disease is performed with a variety of methods. Non-enhanced CT (electron-beam CT or multi–detector row CT) is used to detect calcified plaques, a nuclear medicine thallium stress test, CE MRI demonstrates areas of myocardial ischemia or infarction, and catheter coronary angiography allows definition of vascular stenoses.

CT coronary angiography is becoming feasible with the availability of faster mechanical scanners with multi-section imaging capabilities. Potential applications of multi–detector row CT angiography include noninvasive diagnosis of plaques and coronary artery and graft stenosis.

CTA in Post CABG Follow up -Symptoms recur because of the progression of disease in the coronary arteries and de novo disease in venous bypass grafts, arterial grafts. Recurrent angina early after CABG is usually due to technical problems or graft occlusion (5). Later, myocardial ischemia may be due either to disease of the graft or progression of native coronary artery disease.

Recurrence of the patient's typical angina symptoms or occurrence of an acute coronary syndrome often warrants early intra-arterial coronary angiography as the most efficient investigation, as it is definitive and is closely coupled to treatment with percutaneous intervention or repeat surgery (6).

Patients with more atypical symptoms usually benefit from stress testing to document a cardiac cause for their symptoms, to quantify reversible ischemia if present, and to establish functional status and prognosis.

Investigation of asymptomatic patients is more controversial. Current guidelines thus discourage routine stress testing for asymptomatic patients in the first 5 years after CABG (7-10).

CTA is a new, very powerful noninvasive technique that can directly visualize both CABG and the native coronary arteries. CTA is complimentary to functional stress testing in that it provides anatomic information about graft patency and native coronary artery stenosis (6).

Abnormal findings in CTA of CABG patients includes Graft thrombosis and occlusion, Graft malposition, Graft vasospasm, Graft aneurysm, Sternal infection Native vessel Disease progression and Incidental non-cardiac findings including pulmonary embolism, pulmonary nodules, pneumonia, mucous plugging, and pneumothorax (11).

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Diagnostic Imaging Studies Post-CABG (6)

	Symptomatic	**Asymptomatic**
Within first Month of post-CABG	• Invasive coronary angiogram; • CT coronary angiogram	• CT coronary angiogram • new or investigational procedures?
First 5 years	• Stress SPECT • Stress echo; • CT coronary angiogram; • Invasive coronary angiogram	None
After 5 years	• Stress SPECT • Stress echo; • CT coronary angiogram; • Invasive coronary angiogram	• Exercise ECG if normal baseline and good effort tolerance; • Stress SPECT • Stress echo; • CT coronary angiogram?

Korean guidelines for the appropriate use of cardiac CT in post CABG patients are -

1. CT is recommended in the evaluation of graft patency in patients suspected of ischemic chest pain after CABG
2. CT is recommended in asymptomatic patients if more than 5 years have passed since CABG was performed.
3. CT can be considered in asymptomatic patients if it has been less than 5 years since CABG was performed (12).

In our study overall arterial graft occlusion rate lower than overall venous graft occlusion and was statistically significant. In < 1 year and 1-5 years group , occlusion rates for arterial grafts were more than that of venous grafts without statistically significant correlation. In > 5 years group, arterial graft occlusion rates were lower than venous graft occlusion rates and with statistically significant correlation.

In study by Suat Nail Ömeroğlu et al (13) with angiography (2-5 years after CABG), the patency rate of LIMA–LAD anastomoses (95.59%) was significantly better than vein grafts (47.06%). Another a study by Hayat Shaft et al (14) it is seen that after 8 +_5 years of CABG, LIMA grafts has significant better patency rates (89.3%) than saphenous graft (55.7%). The results of both studies are consistent with our results.

In a study, Lucien Campeau et.al (15) observed that by 10 years after surgery only 60% of vein grafts are patent and only 50% of patent vein grafts are free of significant stenosis. Bourassa MG, et al found that only approximately 60% of vein grafts remain patent between 10 and 12 years after surgery (16). Thus venous graft occlusions rates in both studies are consistent with us.

All patients with arterial graft occlusion were found to be symptomatic with significant correlation between arterial graft occlusion and symptoms. Also significant correlation was found between arterial graft occlusion and symptomatic patients in < 1 year and 1-5 year group. However no significant correlation was found between symptoms and venous graft

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Late occlusion of bypass grafts is one of the main issues associated with long-term survival after CABG. In study by Aksut M et.al (17), 92 patients who underwent CABG operation including a right coronary artery (RCA) bypass using saphenous venous graft (SVG). They found that Patency rates were significantly higher in-distal RCA than proximal RCA. However in our study we found that grafts in distal branches of the RCA had higher occlusion rates as compared to the grafts of proximal RCAs.

Highest patency rates in our study were in LIMA based grafts followed by Radial based grafts, Saphenous based grafts and least in RIMA based grafts. Taggart et.al in their study found that IMA has patency rates in the region of 90-95% ten to fifteen years after CABG, SVG failure occurs in approximately 50% of grafts five to ten years after surgery. Thus results of this study were consistent with our study.

In study by Cao and colleagues (18) compared angiographic outcomes in 859 RA and 849 SVG from five RCTs at one- and four-years. RA grafts had significantly higher perfect patency at four years. Strong and accumulating evidence for higher mid- and long-term patency rates for the RA in comparison to SVG was found (19). In another study by Deb et al in which total of 269 patients underwent late angiography (234 DSA, 35 CTA) at a mean of 7.7 ± 1.5 years after surgery. The frequency of functional graft occlusion was lower in radial arteries compared with SVGs. Thus results of both studies by Cao and colleagues and Deb et al were consistent with our study.

CONCLUSION

Overall, our study concludes-

- After 5 year of CABG surgery, arterial graft occlusion rates are less than venous graft occlusion rates.
- Grafts occlusion rates are maximum in the grafts done on the distal RCA (PDA&PLV) followed by grafts done on the LCX branches, followed by grafts done on proximal RCA and least in the grafts done on the LAD and its branches
- Grafts occlusion rates are lowest in LIMA based grafts, followed by Radial artery based grafts, followed by saphenous based grafts and highest in RIMA based grafts.
- CT coronary angiography is recommended for all post CABG surgery symptomatic patients irrespective of duration after surgery.
- In view of the 22 % risk of grafts occlusions and 50% risk of native vessel disease progression of which 70% being asymptomatic, CT coronary angiography may be done in all post CABG surgery patients after 5 years .

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