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Original Article

May Coronary Artery Bypass Grafting Affect Native Coronary Atherosclerosis progression?

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Abstract

Background: Coronary artery bypass grafting (CABG) continues to be the best standard in the management of severe coronary artery disease (CAD), providing good symptom management and life extension. Although CABG was first performed by reversed saphenous veins (SVGs), surgeons have increasingly adopted arterial conduits because of their longer-term patency and resistance to atherosclerosis. CABG's efficacy may potentially be affected by the extension of atherosclerosis in the native coronary arteries. Few researches have investigated the long-term angiographic disease progression of native coronary arteries after surgical revascularization, or the variables that may impact this progression. Proximal native disease progression was presented to be two to six times more common than distal disease progression, with greater rates of progression in coronaries bypassed by SVGs than arterial grafts. The goal of this research was to determine influence of CABG on the extension of native coronaries atherosclerosis.

Methods: This prospective study was established on 25 patients who were diagnosed to have ischemic heart disease in cardiothoracic surgery department in Faculty of Medicine Menoufia University.

Results: The study showed that according to the risk factors among the studied cases, smoking was (60%), Dyslipidemia was (32%), HTN was (32%) and Diabetes was (32). According to grafts in proximal lesions, there was progression of atherosclerosis up to total occlusion, but in Distal lesions, there was significant regression of atherosclerosis. As result, there was statistically significant difference between proximal with distal lesions. Also, study showed that there was a significant difference between left system (LAD, D, OM) in comparison with right system (PDA) regarding distal lesion. Our results showed that univariate logistic regression analysis for progression in distal lesion regarding Dyslipidemia and Diabetes.

Conclusion: Progression of disease is more evident in coronary segment proximal to anastomosis, while regression of disease is more evident in coronary segment distal to anastomosis with statistically significant difference between them, also the risk of disease progression post CABG was found to be multifactorial, as certain risk factors can affect progression of the disease as Diabetes mellitus and dyslipidemia that were of statistically significance.

KEYWORDS
Coronary Artery Bypass Grafting; Coronary Artery diseases; Native Coronary Atherosclerosis

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Introduction

Coronary artery bypass grafting (CABG) has been established as a routine therapeutic option for patients with complicated coronary artery disease (CAD), owing to its excellent long-term survival rate [1].

CABG provides comparative benefits, most notably a decreased incidence of recurrent revascularization. Although, it is limited in efficacy by recurring symptoms caused by conduit failure or advancement of atherosclerosis in the native arteries, which is assessed to influence more than half of patients 25 years after surgery [2].

Unlikely, data on atherosclerosis progression in operatively bypassed native coronary arteries are less clear and are based mostly on research completed more than the past three decades, before to the use of left IMA and radial grafts widespread use of statin [3].

Atherosclerosis development in bypassed arteries has been found to be up to ten times faster than in un-bypassed arteries in some investigations [3]. Other studies showed regression of coronary atherosclerosis in bypassed coronaries rather than that not bypassed [4].

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Table 1: Comparison between proximal with distal lesion according to grafts

	Proximal		Distal		MH	P
	No.	%	No.	%		
Total	(n = 70)		(n = 70)			
Regression	0	0.0	63	90.0	112.0*	<0.001*
Progression	55	78.6	7	10.0		
Same	15	21.4	0	0.0		
LAD	(n = 25)		(n = 25)			
Regression	0	0.0	24	96.0	42.0*	<0.001*
Progression	17	68.0	1	4.0		
Same	8	32.0	0	0.0		
Diag	(n = 9)		(n = 9)			
Regression	0	0.0	9	100.0	9.0*	<0.001*
Progression	8	88.9	0	0.0		
Same	1	11.1	0	0.0		
OM	(n = 20)		(n = 20)			
Regression	0	0.0	18	90.0	30.0*	<0.001*
Progression	18	90.0	2	10.0		
Same	2	10.0	0	0.0		
PDA	(n = 16)		(n = 16)			
Regression	0	0.0	12	75.0	26.0*	<0.001*
Progression	12	75.0	4	25.0		
Same	4	25.0	0	0.0		

LAD: left anterior descending artery, Diag: diagonal artery, OM: obtuse marginal artery, PDA: posterior descending artery
MH: Marginal Homogeneity Test
p: p value for comparing between proximal and distal lesion
*: Statistically significant at $p \leq 0.05$

The goal of this study was to assess effect of CABG using different conduits on the progression of native coronaries atherosclerosis

Patients and Methods

This prospective study was established on 25 cases who were diagnosed to have ischemic heart disease in cardiothoracic surgery department in Faculty of Medicine Menoufia University. All patients who were indicated for CABG are included in study, but we exclude patients with associated other cardiac operative procedures (e.g., mitral valve repair or replacement, tricuspid valve repair or replacement and aortic valve replacement surgery), previous open-heart surgery and Emergency CABG.

All patients underwent to full data taking, clinical investigation, Radiological investigations: Coronary Angiography, CT coronary angiography, echocardiography and chest x-ray.

Operative details were taken, CABG using different conduits, name and numbers of coronaries bypassed, name and number of conduits used, Operation time, total bypass time, cross clamp time and units of blood needed to be transfused. Post-operative data was collected, mechanical ventilation period, ICU stay, hospital stay, utilizing of Intra-aortic balloon, echocardiography, ECG and chest x-ray-CT coronary angiography to evaluate progression of atherosclerosis at the end of follow up period (after 6 months) or if indicated before 6 months.

Analysis of coronary artery atherosclerosis was done on native coronaries on both studies (pre-operative and 6 months post-operative) to clarify the progression of native atherosclerosis either bypassed or not.

Statistical analysis

The computer was given the data and the IBM SPSS software program version 20.0 was used to analyze it. (Armonk, New York: IBM Corporation) Numbers and percentages were used to describe qualitative data. The range (minimum and maximum values), mean, standard deviation, median, and interquartile range were used to characterize quantitative data (IQR). The significance of the acquired data was determined at the 5% level.

Results

This study shows that male predominance (76%) among the studied cases, regarding age ranged between 47 and 63 with mean (55.04 ± 4.83), according to the risk factors among the studied cases, smoking was (60%), Dyslipidemia was (32%), HTN was (32%) and Diabetes was (32%). By comparing degree of atherosclerosis in both proximal and distal coronary segments before and after CABG, the results were as shown in Table 1.

Table 2: Comparison between LAD with other grafts (Diag, OM, PDA)

	LAD		Other grafts (Diag, OM, PDA)		χ^2	P
	No.	%	No.	%		
Proximal	(n = 25)		(n = 45)			
Regression	0	0.0	0	0.0	2.581	0.108
Progression	17	68.0	38	84.4		
Same	8	32.0	7	15.6		
Distal	(n = 25)		(n = 45)			
Regression	24	96.0	39	86.7	1.556	$^{FE}p=$ 0.408
Progression	1	4.0	6	13.3		
Same	0	0.0	0	0.0		

LAD: left anterior descending artery, Diag: diagonal artery, OM: obtuse marginal artery, PDA: posterior descending artery

χ^2: Chi square test FE: Fisher Exact

p: p value for comparing between LAD with other grafts

Table 3: Comparison between left system (LAD, D, OM) with right system (PDA)

	Left system (LAD, D, OM)		Right system (PDA)		χ^2	P
	No.	%	No.	%		
Proximal	(n = 54)		(n = 16)			
Regression	0	0.0	0	0.0	0.157	^{FE}p= 0.734
Progression	43	79.6	12	75.0		
Same	11	20.4	4	25.0		
Distal	(n = 54)		(n = 16)			
Regression	51	94.4	12	75.0	5.185*	^{FE}p= 0.043*
Progression	3	5.6	4	25.0		
Same	0	0.0	0	0.0		

LAD: left anterior descending artery, Diag: diagonal artery, OM: obtuse marginal artery, PDA: posterior descending artery
χ^2: Chi square test FE: Fisher Exact
p: p value for comparing between left system (LAD, D, OM) with right system (PDA)
*: Statistically significant at p ≤ 0.05

By comparing between atherosclerosis in LAD with other grafts (Diag, OM, PDA) the results as shown in Table 2. By comparing between atherosclerosis in left system (LAD, D, OM) with right system (PDA), the results as shown in Table 3. Risk stratification of native coronary artery atherosclerosis progression was shown in Table 4. Post operative results as shown in Table 5.

Discussion

In this study there was male predominance (76%) among the studied cases. Regarding age ranged between 47 and 63 with mean (55.04 ± 4.83) and median [55.0 (51.0 – 59.0)], and this is approximately similar with Santini et al. [5], as they studied 42 patients had CABG and included 35 males (83%) and 7 females (17%) resembling the fact that CAD are more common in males.

The current study showed that according to the risk factors among the studied cases, smoking was (60%), Dyslipidemia was (32%), HTN was (32%) and Diabetes was (32%). And this is in line

Table 4: Univariate logistic regression analysis for progression in distal lesion regarding to different parameters

	Distal lesion		OR (95%C. I)	p
	Regression® (n = 63)	Progression (n = 7)		
Male	49 (77.8%)	4 (57.1%)	0.381 (0.076 – 1.907)	0.240
Female	14 (22.2%)	3 (42.9%)	2.625 (0.524 – 13.139)	0.240
Age (years)	54.95 ± 4.47	52.14 ± 4.41	0.860 (0.708 – 1.045)	0.130
Smoking	39 (61.9%)	2 (28.6%)	0.246 (0.044 – 1.370)	0.110
Dyslipidemia	17 (27.0%)	5 (71.4%)	6.765 (1.197 – 38.219)	0.030*
Hypertension	21 (33.3%)	2 (28.6%)	0.800 (0.143 – 4.474)	0.799
Diabetes	16 (25.4%)	5 (71.4%)	7.344 (1.295 – 41.639)	0.024*

Quantitative data was expressed using Mean ± SD.
Qualitative data was expressed using Number (%)
OR: Odds ratio ®: Reference group
C.I: Confidence interval LL: Lower limit UL: Upper Limit
p: p value for Odds ratio for comparing between Regression and Progression

with Kamellia et al. [2], that showed individuals with hypertension, diabetes, and advanced atherosclerosis are at higher danger for CAD progression.

Table 5: Distribution of the studied cases according to postoperative course (n = 25)

	No. (%)
ICU stay	
Min. – Max.	1.0 – 4.0
Mean ± SD.	2.0 ± 0.71
Median (IQR)	2.0 (2.0 – 2.0)
Drainage	
Min. – Max.	210.0 – 1150.0
Mean ± SD.	416.0 ± 210.2
Median (IQR)	360.0 (280.0 – 420.0)
Blood units	
1	6 (24.0%)
2	16 (64.0%)
3	3 (12.0%)
Reoperation	
No	23 (92.0%)
Yes	2 (8.0%)

IQR: Inter quartile range
SD: Standard deviation

The results showed that according to grafts in proximal lesions, in LAD, there was progression of disease up to total occlusion. In distal lesions, there was significant regression of atherosclerosis. As result, there was statistically significant difference between lesions of coronary segments proximal and distal to anastomosis.

This coincides with Pereg et al. [6] study that revealed that total blockage of a native coronary vessel is prevalent in the surgical individuals on both before and after angiograms surgery, with >40% of post-CABG patients acquiring a novel CTO of a native coronary artery at one year.

In Yoon et al. [7] analyses, the recent occlusion rates were 9.5 % in LAD and 18.0 percent in those without LAD. Also, after adjustment, CABG increased the probability of new non-LAD occlusion by almost thrice compared to non-CABG.

This does not coincide with Abazid et al. [8] who discovered no difference in annualized CCS percent change across coronary arteries (LM, LAD, LCx, and RCA) or segments proximal to anastomosis compared to non-grafted coronary arteries.

This can be explained by flow competition theory. In proximal lesions, progression of disease is more evident as there is decreased flow proximal to anastomosis, but in distal lesions, regression of disease is more evident because of antegrade flow in coronaries [9]. It may be also due to vasodilator substances released by arterial grafts (Nitric oxide) [10].

This study also presented that there was an insignificant association between LAD grafts in comparison with other grafts (Diag, OM, PDA) regarding proximal and distal lesion. These results do not coincide with Kamellia et al. [2] suggested that when compared to SVGs, arterial grafts are linked with a lower risk of disease development in the native coronary arteries. Generally, across all coronary areas, the use of arterial grafts resulted in a 75% decrease in disease progression. In symptomatic patients, SVGs were more expected to be discovered to be malfunctioning than arterial grafts.

Malfunctioning conduit with disease progression was also presented in 23% of the territories treated with SVGs compared to 5% in arterial graft regions. However, it is unknown if there is a correlation between the low progress of atherosclerosis and the conduit's patency. Overall free from disease progression and treatment failure (malfunctioning graft) were better in coronary territories treated with arterial grafts than in territories bypassed with SVGs [2].

The second Medical, Angioplasty, or Surgery Study post-hoc analysis (MASS II) [11]. shown that LIMA grafts lead to a slower development of disease in the LAD artery than SVG grafts.

But this contradiction may be because of the early results after only 6 months which may be not a sufficient period for progression of disease.

This study also showed there was no statistically significant difference between left system (LAD, D, OM) in comparison with right system (PDA) regarding proximal lesion. While there was statistically significant difference between left system (LAD, D, OM) in comparison with right system (PDA) regarding distal lesion.

This in agreement with Kamellia et al. [2] which had the greatest overall disease progression rate in the RCA zone, was mostly revascularized using SVGs. It is unknown if the increased rate of atherosclerosis formation is due to SVG failure or to disease progression being accelerated in the RCA zone. The INTACT (International Nifedipine Trial on Anti atherosclerotic Therapy) study [12] also demonstrated that the RCA area saw a greater rate of disease progression after revascularization.

Kamellia et al. [2]. results propose that arterial grafting reduced native CAD progression and may clarify the documented survival benefit of RA grafting than with SVGs [13,14].

This may be explained by more prevalence of usage of arterial conduits on left system, may be also due to diastolic flow difference between left and right coronaries that means that the flow amplitudes are less pronounced in right coronary than in the left coronary artery.

Our results showed that univariate logistic regression analysis for progression in distal lesion regarding the parameters there was an insignificant difference. While there was statistically significant difference regarding Dyslipidemia and Diabetes.

This is not in agreement with Pereg et al. [6]. revealed that at one year, the incidence of all conventional cardiovascular risk factors, involving DM, was comparable across individuals with and without new coronary artery blockage.

Among established risk factors for CAD, diabetes was the sole predictor of an annualized percent change in the total CCS more than 15% after CABG which was previously discovered by Hong et al [15] who discovered that individual with diabetes had a greater amount of whole plaque and a faster growth of calcified plaque than non-diabetics.

Study limitations

Small sample size and short follow up duration are the limitations of this study. longer duration of follow up and larger sample would provide more precise results.

Conclusion

Progression of disease is more evident in coronary segment proximal to anastomosis, while regression of disease is more evident in coronary segment distal to anastomosis with statistically significant difference between them. The risk of disease development post CABG was found to be multifactorial, as certain risk factors can affect progression of the disease as Diabetes mellitus and dyslipidemia that were of statistically significance. Regression of disease is markedly affected by ante grade flow of blood on the coronary artery.

Conflict of interest: Authors declare no conflict of interest.

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