Original Article

Impact Of CABG On Regional Wall Motion Score Index One Year After Surgery

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DOI: 10.47750/pnr.2023.14.02.412

Abstract

Background and Objectives Coronary artery disease is a significant global health problem and is a leading cause of disability and death. In this study, the effect of coronary artery bypass graft (CABG) surgery on left ventricular (LV) systolic functions and regional wall motion abnormalities preoperative and one year postoperative was evaluated through echocardiographic techniques. **Methods** This is a prospective observational cross-sectional descriptive study. Two hundred adult patients with proven coronary artery disease selected without gender discrimination underwent coronary artery bypass grafting surgery at Cardiothoracic Surgery Department, Kasr Al Ainy hospitals, Cairo University in the period from March 2021 to October 2021. Regional wall Motion score index (RWMSI) was used by echocardiography to note if segmental left ventricular wall motion at basal, mid and apical levels were normal, hypokinetic, akinetic, dyskinetic, or aneurysmal preoperative and one year post-operative. **Results** All patients had chest pain preoperatively, and most of them were in Canadian Cardiovascular Society (CCS) Class III and IV. All patients had multi vessel disease and the left anterior descending was the most common vessel affected, complete revascularization was done in all patients using 3 to 5 grafts and left internal mammary artery was used in all patients. There was significant improvement in LVEF that changed from (59.33 to 62.76) . There was also a significant improvement of WMSI that changed from (1.19 to 1.10) one year after surgery. **Conclusion** This study suggests that CABG has a positive effect on LV systolic functions and improvement of RWMSI one year post-operatively as confirmed through echocardiographic techniques.

Keywords: CABG, Segmental wall motion, RWMSI, Coronary artery disease.

INTRODUCTION

Coronary artery disease (CAD) is a significant global health problem and it is a leading cause of disability and death.[(1)] It is the most common reason behind adult's hospitalization. [(2)] Moreover, it accounts for 17 million deaths worldwide every year and is expected to increase to more than 23 million by 2030. [(3)]

Risk factors for CAD have been divided into the non-modifiable and modifiable types. Non modifiable risk factors include age, male gender, family history and genetic disposition, whereas modifiable risk factors include hypertension, dietary fat intake, cholesterol level, tobacco smoking, diabetes mellitus (DM), physical inactivity and obesity. [(4)]

As a default, stable CAD is treated initially with optimal antianginal medications and revascularization if drugs treatment failed or in high-risk patients, an acute coronary syndrome is best managed with percutaneous revascularization. [(5)]

CABG is the modality of treatment of choice over PCI for several CAD patterns such as multivessel disease and left mainstem disease. [(4, 5)]

In addition, certain clinical and anatomical characteristics favor CABG such as the presence of DM, degree of LV systolic function, contraindication to antiplatelet therapy and severely calcified lesions limiting the use of balloon expansion. [(6)]

CABG has proven utility to preserve and improve left ventricular function in patients with coronary artery disease. [(7)]

Improvement in regional wall motion is determined by three major factors, these include the severity of regional wall motion abnormality, completeness of revascularization in these areas of abnormal motion and identification of ischemic perfusion territories for strategic surgical planning. [(8)]

Left ventricular regional wall motion analysis is usually based on grading of contractility of individual segments. For the purpose of analysis, the left ventricle is divided into basal, mid and apical levels. The basal and mid-levels are each subdivided into 6 segments and the apical level is subdivided into 4 segments, all of these 16 segments can be visualized from different tomographic planes during surface echocardiography.

A Wall Motion Score Index (WMSI) is derived by the formula WMSI = sum of wall motion scores/ number of visualized segments [(9)]

These left ventricular segments or regions can be easily related to the coronary artery perfusion beds. [10]
The purpose of this study was to determine the Impact of CABG on Regional Wall Motion Score Index one year after coronary artery bypass grafting surgery

Patient and Methods

This was a prospective observational cross-sectional descriptive study. Two hundred adult patients with proven coronary artery disease selected without gender discrimination underwent coronary artery bypass grafting surgery, at the Cardiothoracic Surgery Department, Kasr Al Ainy hospitals, Cairo University in the period from March 2021 to October 2021 to asses difference between RWMSI preoperatively and one year post operatively and delineate its effect on the outcome of the study.

Inclusion criteria: Elective On Pump coronary artery bypasses grafting surgery

Exclusion criteria: Patients requiring emergency coronary artery surgery, patients requiring an additional cardiac surgical procedure besides coronary coronary bypass surgery, patients having cardiomyopathy other than ischemic cardiomyopathy, patients undergoing redo CABG surgery and patients undergoing Off Pump CABG
All patients will be evaluated by the following:

Preoperative assessment: Age, sex, Body Mass Index(BMI). Risk factors; DM-HTN-Dyslipidemia-Smokin.

Complaint: Chest pain: According to CCS Classification **and** dyspnea: According to NYHA classification. **Clinical**

examination: General examination: Vital data (blood pressure, pulse and respiratory rate). Assessment of lower limbs to detect presence of edema, assess distal pulsations, and presence of varicosities. Cardiac Examination: Local chest and cardiac examination to delineate the presence of pulmonary congestion, any valvular murmurs.

Routine investigations: **Routine preoperative laboratory investigations:** Complete blood count (CBC), liver function tests (bilirubin: total & direct, liver enzymes, serum albumin, total proteins, prothrombin time and concentration), kidney function tests (serum urea and creatinine) **and** fasting blood sugar and serum electrolytes.

Radiological examination: Plain chest x-ray, electrocardiography: looking for evidence of ischemia, echocardiography: EF, RWMA, WMSI, preoperative Duplex on carotid arteries and both lower limbs (venous duplex in all patients and arterial duplex if ischemia is suspected) and coronary angiography.
The preoperative parameters were:_Age, sex, BMI, Hypertension, Diabetes, Smoking, Hypercholesterolemia and angina class.

Intra operative assessment: Surgical technique and the intraoperative parameters were: Number of grafts and type of conduit.

Post-operative assessment: Routine post-operative course, postoperative parameters:
Transthoracic echocardiography was done one year after discharge (EF, RWMA, WMA index score)

Echocardiographic assessment: Transthoracic two-dimensional (2D) echocardiography at rest was performed preoperatively and one year postoperatively, regional contractile function was evaluated.

Statistical Analysis

Data were coded and entered using the statistical package for the Social Sciences (SPSS) version 28 (IBM Corp., Armonk, NY, USA). Data was summarized using mean, standard deviation, minimum and maximum in quantitative data and using frequency (count) and relative frequency (percentage) for categorical data. Comparisons between quantitative variables measured pre and postoperative were done using paired t test. For comparison of ordinal measurements pre and postoperative, the non-parametric Wilcoxon signed rank test was used **(Chan, 2003a)**. Correlations between quantitative variables were done using Spearman correlation coefficient **(Chan, 2003b).** P-values less than 0.05 were considered as statistically significant.

Results

Our study was carried out on 200 patients with coronary artery disease indicated for Coronary artery bypass grafting surgery, all of them underwent on pump CABG.

Table (1) showed Mean age was 57 years old, the age ranged from 40 to 74 years. Most of patients were males 159 (79.5%). Mean BMI was 29.85, the BMI ranged from 28 to 33.

Table (1) Demographic data

	Mean	SD	Minimum	Maximum
Age	57.09	7.60	40.00	74.00

BMI	29.85	1.44	28.00	33.00

Table (2) showed the most prevalent risk factors were Hypertension (75.5% of the cases) followed by Smoking (65% of the cases) followed by Hypercholesterolemia (60.5% of the cases) followed by DM (53.5% of the cases).

Table (2) Risk factors

		Count	**%**
HTN	**Yes**	151	75.5%
	No	49	24.5%
DM	**Yes**	107	53.5%
	No	93	46.5%
Smoking	**Yes**	130	65.0%
	No	70	35.0%
Hypercholesterolemia	**Yes**	121	60.5%
	No	79	39.5%

Table (3) showed 30(15%) patients underwent CABG with 3 grafts, 100(50%) patients underwent CABG with 4 grafts, 70(35%) underwent CABG with 5 grafts. Bilateral mammary and SVG used in 35(17.5%) of patients, LIMA and SVG used in 165(82.5%).

Table (3) number of grafts, type of conduit

		Count	**%**
N of grafts	**3 grafts**	30	15.0%
	4 grafts	100	50.0%
	5 grafts	70	35.0%
Type of conduit	**LIMA,RIMA,svG**	35	17.5%
	LIMA,svG	165	82.5%

Table (4) showed Mean preoperative RWMI is 1.19 and Mean RWMI one year post operative is 1.1

Table (4) Preoperative and post operative RWMI

	Mean	**SD**	**Minimum**	**Maximum**
Preoperative RWMI	1.19	0.34	1.00	2.56
Post operative RWMI	1.10	0.27	1.00	2.44

Table (5) showed improved WMSI in 123(61.5%), the same in 69(34.5%) and deterioration in 8(4%) of patients

Table (5) Improvement in WMSI

		Count	**%**
Improvement of WMSI	improved	123	61.5%
	same	69	34.5%
	deterioration	8	4.0%

Table (6) showed Mean preoperative EF is 59.33 and mean post operative EF is 62.76

Table (6) Preoperative and post operative EF

	Mean	**SD**	**Minimum**	**Maximum**
Preoperative EF %	59.33	8.70	30.00	67.00
Post operative EF %	62.76	7.65	35.00	72.00

Table (7) showed that LVEF was improved one year postoperative significantly with P value< 0.001. Compare the improvement in WMSI from preoperative to one year postoperative, which revealed significant improvement between (1.19)preoperative and (1.10) year post operative P value< 0.001.

Table(7) comparison of preoperative and post operative RWMI and EF

	Preoperative		**Postoperative**		**P value**
	Mean	**SD**	**Mean**	**SD**	
RWMI	1.19	0.34	1.10	0.27	<0.001

EF %	59.33	8.70	62.76	7.65	<0.001

Table (8) There was statistically significant correlation (improvement) between the increase in the number of grafts and WMSI (P value 0.027).

Table (8) correlation between number of grafts and WMSI

		Post operative RWMI
N of grafts	**Correlation Coefficient**	0.156
	P value	0.027
	N	200

Discussion

Patients with Coronary Artery Disease and impaired left ventricular function, who had surgical revascularization, have a better prognosis compared to patients who had Percutaneous Coronary Intervention.[11, 12] These patients represent a population that gains a survival advantage with surgical revascularization and shows a significant improvement in segmental and global myocardial function.[13, 14]

Left ventricular segmental wall motion abnormality, which is another term for left ventricular dysfunction, is a condition which may be caused by myocardial hibernation. [15]
Hibernating myocardium may be associated with chronic hypoperfusion or result from repetitive episodes of ischemia which can have a cumulative effect on contractile function.
Myocardial hibernation leads to reversible ultra-structural changes in the myocytes, including the loss of myofilaments and accumulation of glycogen. Due to these structural changes, the affected myocytes do not start contracting as soon as myocardial revascularization has been carried out, but may resume normal contractile activity within a short span of time. [15]

Coronary artery revascularization often results in improvement of myocardial dysfunction. It is most pronounced after 6-24 hours of surgery, primarily due to increased myocardial perfusion. Improvement in segmental wall motion has been observed in areas of scarring from previous myocardial infarction, even 12 months after CABG. [16]
Timing to see the resumption of normal contractile activity in hibernating myocardium after revascularization has always been variable in various studies. Especially, the studies investigating early changes postoperatively have yielded conflicting results.

Some have revealed contractile improvement already intraoperatively or within the first weeks postoperatively, while other studies have detected no change or a deterioration of function. [17] There are multiple parameters for estimation of the LV systolic function.
Assessment of regional wall motion and calculation of wall motion score index (WMSI) represent a powerful tool for estimation of myocardial function, which in turn is used for risk prediction and extent of damage or improvement of myocardial function.

Our study included 200 patients who underwent CABG for Left main and/or Multivessel Coronary Artery disease.
In our study the Mean age was 57 years old, the range was from 40 to 74 years. Most of the patients were males 159 (79.5%), females represented 41(20.5%) patients. In the study by **Awan et al., [18]** to determine the early effects of Coronary Artery Bypass Grafting on regional left ventricular wall motion abnormality, the sample size of 75 patients was included in the study. There were 72 males (96%) and 3 females (4%). The mean and standard deviation for age were 52.28 ±8.79 with a minimum of 36 and maximum of 71 years.

We found**,** Mean BMI was 29.85 meaning that overweight and obesity are associated with increased risk of IHD. In the study of **Ismael et al.,** [19] the mean BMI was 27.35.
In our study, the most prevalent risk factors were Hypertension (75.5%) followed by Smoking (65%) followed by Hypercholesterolemia (60.5%) followed by DM (53.5%).
In the study of **Soraas et al.,** [17] the most prevalent risk factors were Hypercholesterolemia (90%) followed by Hypertension (60%) followed by Smoking (33%) followed by DM (24%).

All of our patients had complete revascularization with On Pump coronary artery by-pass graft surgery.
The majority of the patients 100(50%) received 4 grafts, 30(15%) of the patients received 3 grafts and 70(35%) received 5 grafts; there is significant correlation between the increase in the number of grafts and WMSI.
Patients who underwent CABG with Bilateral mammary and SVG were 35(17.5%), LIMA and SVG was used in 165(82.5%) of the patients.

The LIMA conduit was used in all patients and this was reflected by significant improvement of clinical symptoms (CCS class), all our patients had chest pain preoperatively most of them in CCS class III and IV which was improved

post operatively ,this was similar to a study by **Krishnan et al.,** [20] in India which included 40 patients and showed that most of the patients were in Class III CCS, and that there was a significant improvement of CCS class early after surgery, especially in those who received LIMA graft more than with SVG grafts. Nevertheless, LIMA is a better conduit in terms of improvement in angina and LVEF.
The mean and standard deviation of preoperative EF were 59.33 ±8.7 % with a minimum of 30% and maximum of 67%, the LVEF showed significant improvement one year after surgery with mean 62.76 ±7.65 (P value ≤ 0.001), this can be explained by the concept that hibernating myocardium takes longer time to recover after the restoration of normal blood flow by revascularization similar to the literature. [21]

In a study by **Öztürk c et al.,** [22] found that improvement of the LVEF was insignificant in the first 2months and only become statistically significant in the 6 and 12 months postoperatively. In addition, there was no significant improvement of LVEF at early post revascularization,

CABG surgery has variable effects on myocardial regional wall motion which can be either improvement, no changes, or deterioration of contractility, and these conflicting results may be due to differences in the imaging technique used or because the method used for analysis of wall motion is uncertain, also the timing of the postoperative evaluation and graft patency rate may be important determinant, WMSI reflects the magnitude of myocardial damage and total extent of wall motion abnormalities.[23]

In a study by **Kamal et al.,** [24] concluded that prognostic value of echocardiographic WMSI was higher than LVEF in patients who underwent CABG with viable myocardium and LVEF <50%.
In our study, we found a significant improvement in function one year postoperative from 1.19 to 1.10 With P ≤ 0.001 which indicates gradual improvement of wall motion post CABG, reflecting that the myocytes gradually regain their function and contractility gradually after reperfusion (hibernating myocardium).
A study done in Karachi, Pakistan, by **Awan et al.,** [18] found no significant difference of WMSI between pre- and early postoperative period.

In our study, among 484 hypokinetic segments preoperatively, there was an improvement in 296 between pre and one year postoperative and was mainly observed in basal inferoseptal, mid inferoseptal, and inferior apical segments. But unfortunately, across the study, there was deterioration in some segments, particularly occurring in basal inferior and apical septal segments

Also in this study, the segments that are already akinetic (32 segments) or dyskinetic (20 segments), there were no changes one year postoperative which can be explained by the fact that if the myocardium was necrotic, then its function could not be improved by any intervention.
In a study by **Camilla CL, et al.,** [17] akinetic segment was improved between two postoperative follow-ups. Furthermore, this researcher found that the most improvement occurs in posterior segments.

Conclusion

Wall motion score index reflects the magnitude of myocardial damage and total extent of wall motion abnormalities. The study suggests that CABG has a positive effect on LV systolic functions and regional wall motion abnormalities one year after surgery as confirmed through echocardiographic techniques.

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