Original Article

Echocardiography Assessment of the Left Ventricular Systolic Function and Regional Wall Motion Abnormalities Pre- and Post-Coronary Artery Bypass Grafting Surgery

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Abstract

Background and Objective: 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 in the 1st week and 3rd month after surgery was evaluated through echocardiographic techniques. **Patients and Methods:** Fifty patients who underwent elective isolated CABG at Azadi Heart Center were included and studied prospectively from November 2018 to May 2019. Transthoracic two-dimensional echocardiography was used to assess the LV-systolic function (LV ejection fraction [LVEF]) and wall motion score index (WMSI) and abnormalities. **Results:** Almost all patients had chest pain preoperatively, and 32% and 38% of them were in Canadian Cardiovascular Society (CCS) Class III and IV, respectively. Ninety percent had multivessel disease, and the left anterior descending was the most common vessel affected (86%), complete revascularization was done in all patients using 3–6 grafts, and left internal mammary artery was used in 48 patients (96%). There was no significant improvement in LVEF in the early postoperative period ($P = 0.28$). On the contrary, there was a highly significant improvement of LVEF lately postoperatively, which was improved from (49.62%–56.92%) at ($P \leq 0.001$). As well, there was a substantial improvement of WMSI at lately postoperative ($P = 0.026$) that changed from (1.204 to 1.12). **Conclusions:** The present study suggests that CABG has a positive effect on LV systolic functions and regional wall motion abnormalities 3-month post-operatively as confirmed through echocardiographic techniques.

Keywords: Coronary artery bypass grafting surgery, coronary artery disease, echocardiography

Introduction

Coronary artery disease (CAD) is a significant global health problem,[1] and it is a leading cause of disability and death. It is the most common reason behind adults' hospitalization.[2] Moreover, it accounts for 17 million deaths per annum worldwide and is expected to increase to more than 23 million by 2030.[3] The prevalence of early-onset CAD in Kurdistan was estimated to be 31% in a recent study.[4]

CAD is a condition in which cholesterol deposits called plaque builds up on the inner walls of the coronary arteries triggering an inflammatory reaction leading to wall thickening and luminal narrowing or occlusion called atherosclerosis. Narrowed arteries lead to reduced blood flow, which can manifest clinically as chest pain, especially when active (angina pectoris).[5] Eventually, an area of plaque might rupture causes a blood clot to form on the surface of the plaque. If the clot becomes large enough, it can block the flow of oxygen-rich blood to the portion of heart muscle fed by the artery. Blocked blood flow to the heart muscle causes a heart attack (acute coronary syndrome).[6]

Risk factors for CAD have been divided into the nonmodifiable and modifiable types. Nonmodifiable risk factors include aging, male gender, family history, and genetic disposition, whereas modifiable risk factors include hypertension, dietary fat intake,

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cholesterol level, tobacco smoking, diabetes mellitus (DM), physical inactivity, and obesity.[7]

The management of CAD has improved significantly over the last few decades, resulting in improved life expectancy and survival.[8] This can be achieved by modification of risk factors, pharmacological therapy, or invasive therapy. The invasive therapy includes either percutaneous coronary intervention (PCI) or coronary artery bypass graft (CABG).[9] The objectives of revascularization are to get better the blood perfusion for ischemic myocardium, improve left ventricular (LV) function, reduce LV volume, prevent ventricular remodeling, allay heart failure signs, and improve outcomes.[10]

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.[11] CABG is the modality of treatment of choice over PCI for several CAD patterns such as multivessel disease and left main stem disease.[1] In addition, certain clinical and anatomical characteristic favors 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.[12]

The LV structure and systolic function are assessed qualitatively and quantitatively by echocardiography.[13] On the other hand, assessment of LV systolic function is one of the most important determinants for prognosis in patients with CAD.[14] More than that, the role of echocardiography has gained predominantly in clinical practice to evaluate global LV systolic function among other noninvasive image techniques because it is feasible[15] and reproducible techniques that can provide a broad range of information about heart structure and function.[16]

Rational and importance of the study

Several studies showed that the myocardium might regain contractile function after revascularization if viable dysfunctional myocytes are present.[17] However, the time course of recovery is still unknown.[18] Especially, the studies investigating early changes postoperatively have yielded conflicting results. Some have published contractile improvement already intraoperatively or within the 1st week postoperatively, whereas different studies did not detect any changes or deterioration of function.[19]

To the best of my knowledge, this study is the first of its kind in Kurdistan and Iraq that estimate the evolution in the role of the nursing staff as a cardiac specialist nurse with full adult transthoracic echocardiography training.

The present study aimed to evaluate the effect of CABG surgery on LV systolic functions and regional wall motion abnormalities early (1st week) and late (3 months) after surgery through using echocardiographic techniques.

The study objectives were:

- To find out patients characteristic, risk factors, angiography, and operation technique related to CAD
- To study the clinical (symptoms) improvement post-CABG surgery
- To study the echocardiographic improvement of regional wall motion abnormalities and LV systolic function early and late after CABG.

Materials and Methods

Study design and patients

In this prospective investigation, 30 patients diagnosed with CAD and treated with CABG were included following taking ethical approval from the local health ethics committee and written consent form from all patients.

A nonprobability (purposive) sample of fifty patients between November 2018 and May 2019 was used for all elective isolated patients undergoing off- and on-pump coronary artery bypass surgery on preoperative (1 day), 1 week, and 3-month postoperatively. The echocardiography was performed for the patients underwent CABG surgery to evaluate LV systolic function pre- and post-CABG surgery preoperatively, 1 week and 3 months postoperatively. The patients were recruited from Duhok Cardiac Center between November 7, 2018 and May 14, 2019 in Duhok City.

Inclusion and exclusion criteria

The following inclusion criteria were applied: elective isolated CABG, traditional CABG (on-pump coronary artery bypass surgery), and off-pump CABG.

The following exclusion criteria were applied to the patients: patient requiring intra-aortic balloon pump or inotropic therapy postoperatively, patients requiring emergency CABG, and patients requiring an additional cardiac surgical procedure besides CABG like valve repair or replacement.

Ethical consideration

The ethical clearance of the present study was obtained from the local health ethics committee registered as 12,666 in 2018-10-31. The verbal consent was obtained from all the patients before the assessment. The patients did not undergo any medical procedure for the study purposes. The confidentiality of the personal information of the patients was protected throughout the study steps.

Assessment

Regional contractile function was evaluated in the left lateral decubitus position by using a GE Vingmed Vivid E 9 echocardiography, equipped with (M5Sc-D) 2.4–8 MHZ transducer. Moreover, checklist and physical assessment of the patient blood pressure, body mass index (BMI), was measured by weight scale: for measuring patient's weight, tape measuring: for measuring patient's height, and sphygmomanometer: for measuring arterial blood pressure.

Method of data collection

Data were collected as adapted by generic American Society of Echocardiography guidelines.[20] The schedule consists of patient characteristics, assessment of the functional state, and echocardiography measurement. The patients were interviewed to assess functional state and echocardiography measurement according to the special plan. Each patient had the same schedule and technique and spend approximately 30–40 min for each follow-up to assess preoperatively, 1 week and 3 months postoperatively. The predesigned questionnaire covered the following parts.

Part 1: Patients' characteristics

The following information were taken from the patients. The information were age, gender, BMI, blood pressure, risk factor, preoperative medication, and coronary anatomy, type of vessel diseased, number of graft, type of conduit, and type of cardiopulmonary bypass.

Part 2: Assessment of functional state

The assessment of function was performed in accordance with Canadian Cardiovascular Society (CCS) classification for degree stratification and angina pectoris improvement.[21]

Part 3: Echocardiography measurement

Transthoracic two-dimensional (2D) echocardiography at rest was performed 1 day preoperatively, 1 week and 3 months postoperatively. Regional contraction function was evaluated in the left lateral decubitus position by using GE Vingmed Vivid E 9 echocardiography, equipped with (M5Sc-D) 2.4–8 MHZ transducer.

- LV end-systolic and diastolic volumes were estimated by using the Simpson biplane method[20] and LV ejection fraction (LVEF) was calculated
- Each echocardiographic study consisted of standard views of parasternal long- and short-axis view and apical two- and four-chamber view. Moreover, the views of four standards of LV were digitally acquired in the archive (GE Vingmed Ultrasound) for later offline analysis. Improvement of LV functions more than 5% was considered as improved of EF as used in a previous study[22]
- Regional wall motion was evaluated using a 16-segment model recommended by the American Society of Echocardiography. The LV was divided into six basal segments (anterior, anterolateral, inferior, inferolateral, anteroseptal, and anteroseptal), six middle segments (same subgroups), and four apical segments (anterior, septal, inferior, and posterior).[23] By visual analysis of systolic wall thickening, including in patients with abnormal septal motion after opening the pericardium during surgery, segments were assigned a wall motion score (WMS) as follows: 1 = normal or hyperkinesia, 2 = hypokinesia (reduced thickening), 3 = akinesia (absent or negligible thickening), and 4 = dyskinesia (systolic thinning or stretching)[20]
- WMS index (WMSI) was calculated by dividing the total of WMS of segments by 16.[24] Normal WMSI = 1, more than one was considered as abnormal wall motion as used in the previous study.[19] Improvement of wall motion was defined as a post-CABG WMS lower than pre-CABG WMS; similarly, deterioration of wall motion was defined as a post-CABG WMS grater higher than pre-CABG WMS
- Echocardiography was performed by a single experienced cardiologist, and a registered nurse was involved during the measurement of data. Echo images and loops were acquired and stored in the archive and were reviewed and compared in all three visits.

Statistical analysis

The data of the present study were prepared, organized, and entered into the computer file, through the application of several statistical analyses by using Statistical Package for the Social Sciences version 25 (SPSS, IBM Corp; Chicago, USA), which are consisted of the following:

a. Descriptive data analysis: The approach was performed through the determination of frequency, percentage, means, and standard deviation
b. Inferential analysis as one-way analysis of variance test: This approach was applied for determining the effect of CABG through the three follow-up and evaluate improvement ejection fraction, WMSI, and the functional state.

Results

The mean age of the patients and their BMI were 59.92 years and 29.07, respectively. Most of the patients were male (74%). Most common risk factors of CAD in the study patients were hypertension (72%), hyperlipidemia (70%), and smoking (62%), as shown in Table 1.

Most of the patients who were included in this study were underwent on-pump CABG surgery (96%). Majority of patients (90%) had two and more vessel diseases, left anterior descending was the most affected vessel in 43 patients (86%) and most of them received four grafts (48%). Moreover, left internal mammary artery (LIMA) was used as a conduit in nearly all of the patients (96%) and SVG graft 54% of the patients [Table 2].

The comparison of CCS angina class between preoperative and early postoperative and late postoperative showed a significant difference ($P < 0.001$), [Table 3].

The distribution of CCS angina classes was shown in Table 4. The study revealed that most of the patients in the preoperative stage had CCS Class III, compared to CCS I in early postoperative (82%) and CCS I in late postoperative (86%).

The study showed that LVEF indicators were improved significantly with 7.3 mean reductions from preoperative to late postoperative stages ($P < 0.001$) and 5.28 mean reduction from early postoperative to late postoperative ($P = 0.005$) [Table 5 and Figure 1].

Table 6 and Figure 2 compare the improvement in WMSI from preoperative to early and late postoperative, which revealed significant improvement between preoperative and late

Table 1: Baseline characteristics of patients

Patient baseline characteristics	Statistics (*n*=50)
Age (years)	59.92±9.62
Gender (%)	
Male	37 (74)
Female	13 (26)
BMI	29.07±3.6
Blood pressure	
Systolic blood pressure	127.98±22.19
Diastolic blood pressure	81.08±15.55
Risk factors	
Hypertension	36 (72)
DM	24 (48)
Hypercholesterolemia	35 (70)
Smokers	31 (62)
Previous MI	16 (32)
Stroke	1 (2)
COPD	1 (2)
Renal impairment	1 (2)
Obesity	4[25]
Preoperative medication	
Lipid lowering	43 (86)
Aspirin	45 (90)
Nitrate	33 (66)
ACE inhibitor/ABRs	27 (54)
Diuretics	9[25]
Beta-blocker	25 (50)
Calcium-channel blocker	5 (10)
Digoxin	2 (4)

BMI: Body mass index, DM: Diabetes mellitus, MI: Myocardial Infarction, ABRs: Angiotensin-receptor blockers, COPD: Chronic Obstructive Pulmonary Disease, ACE, ACE: Angiotensin-converting enzyme

postoperative ($P = 0.026$), but in the early postoperative period, there was no significant improvement of WMSI ($P > 0.05$). Moreover, WMSI was changed from (1.204) preoperatively to (1.189) early postoperatively and to (1.12) lately postoperatively. Hence, there was a gradual improvement of WMSI over time, as illustrated in Figure (4.2). Ultimately, the WMSI significantly reduced from preoperative to lately postoperative.

Table 7 shows the effective of CABG on regional wall motion from preoperative to 1 week and 3 months postoperative; 800 segments were studied at rest by transthoracic echocardiogram; in general, most of the segments were neurokinetic 666 (83.25%), followed by hypokinesia which were 121 (15.125%) segments, and there were only eight segments akinetic and five dyskinetic which represented as (1% and 0.625%), respectively. As indicated, there was improvement between preoperative and early postoperative in only 16 segments; all of them were hypokinesia; in contrast, there was deterioration in three segments which one of them became akinesia and two dyskinesias. Even so, this improvement was particularly observed in basal inferoseptal, mid inferoseptal, and apical inferior. In the late postoperative period, significant improvement was observed in 58 hypokinetic segments and 1 hypokinetic segment deteriorated to dyskinesia.

Table 2: Angiography and operation technique characteristics

Angiographic and operative technique characteristics	*n* (%)
Coronary anatomy	
One-vessel disease	5 (10)
Two-vessel disease	19 (38)
Three-vessel disease	21 (42)
Four-vessel disease	5 (10)
Type of vessel disease	
LMS	6 (12)
LAD	43 (86)
LCX	36 (72)
RCA	41 (82)
Number of graft	
Three grafts	21 (42)
Four grafts	24 (48)
Five grafts	4[25]
Six grafts	1 (2)
Type of conduit	
LIMA	48 (96)
RIMA	1 (2)
Radial	27 (54)
SVG	37 (74)
Type of cardiopulmonary bypass	
On-pump CABG	48 (96)
Off-pump CABG	2 (4)

LAD: Left anterior descending, LCX: Left circumflex artery, RCA: Right coronary artery, LMS: Left main stem, LIMA: Left internal mammary artery, RIMA: Right internal mammary arteries, SVG: Saphenous vein graft, CABG: Coronary artery bypass graft

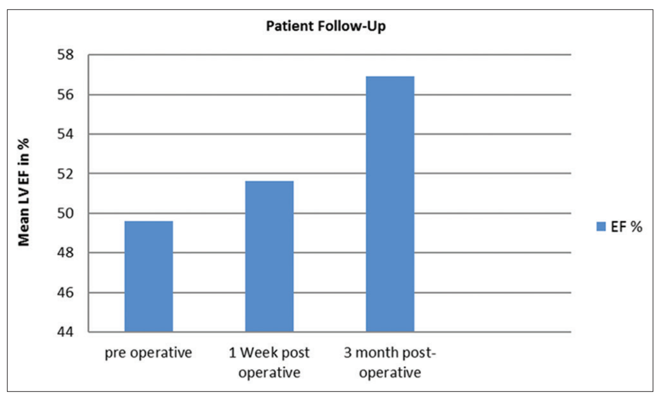

Figure 1: Left ventricular ejection fraction change preoperative, 1 week and 3 months postoperative

Discussion

The goal of CAD treatment is coronary revascularization and repair of cardiac perfusion, and the aim of myocardial revascularization (by PCI or CABG) is to minimize residual ischemia so improving clinical symptoms, wall motion abnormalities, and LV-systolic function.

Cardiovascular Canadian society angina class clinical improvement

In our study, almost all of the patients had complete revascularization, and the majority of patients received

Table 3: Cardiovascular canadian society angina class in the preoperative, 1 week and 3 months postoperative period

CCS class evaluation for angina	Mean difference	SE	*P*
Preoperative			
Early postoperative	1.66	0.138	≤0.001*
Late postoperative	1.72	0.138	≤0.001*
Early postoperative			
Preoperative	−1.66-	0.138	≤0.001*
Late postoperative	0.06	0.138	0.664

*The mean difference is significant at the 0.05 level. One-way ANOVA test was performed for statistical analyses. SE: Standard error, CCS: Cardiovascular Canadian Society

Table 4: Distribution of preoperative, early and late postoperative angina capacity according to cardiovascular canadian society classification

Stages	Mean±SD	CCS angina class *n* (%)			
		I	II	III	IV
Preoperative	2.86±1.05	8 (16)	7 (14)	19 (38)	16 (32)
Early postoperative	1.20±0.452	41 (82)	8 (16)	1 (2)	0 (0)
Late postoperative	1.14±0.351	43 (86)	7 (14)	0 (0)	0 (0)

SD: Standard deviation, CCS: Cardiovascular Canadian Society

Table 5: Transthoracic echocardiography measurement changes from preoperative to 1 week and 3 months postoperative

Indicator	Patient follow-up	Mean difference	SE	*P*
LVEF				
Preoperative	Early postoperative	−2.02	1.86197	0.28
	Late postoperative	−7.3-	1.86197	≤0.005*
Early postoperative	Preoperative	2.02	1.86197	0.280
	Late postoperative	−5.28-	1.86197	≤0.001*

*The mean difference is significant at the 0.05 level. One-way ANOVA test was performed for statistical analyses. SE: Standard error, LVEF: Left ventricular systolic function

Table 6: Wall motion score index improvement from preoperative to early and 3 months postoperatively

	WMSI	Mean difference	SE	*P*
Preoperative	Early postoperative	0.01491	0.037196	0.689
	Late postoperative	0.08368*	0.037196	0.026
Early postoperative	Preoperative	−0.01491	0.037196	0.689
	Late postoperative	0.06877	0.037196	0.066

*The mean difference is significant at the 0.05 level. One-way ANOVA test was performed for statistical analyses. SE: Standard error, WMSI: Wall motion score index

four grafts (48%), and the LIMA-conduit was used in most patients (96%), and this was reflected by significant improvement of clinical symptoms (CCS class). Almost all of our patients had chest pain preoperatively, and most of them were in CCS Class III (32%) and Class IV (38%) which was significantly improved in the early postoperative period ($P \leq 0.001$) and continue to improve in the late postoperative period ($P \leq 0.001$). This was similar to that which was seen in a study by Krishnan *et al* in India[26] which included 40 patients who showed most of the patients in Class III, and 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, also in a study by Martínez-González *et al*.[27] concluded that the best long-term outcome is achieved by harvesting LIMA conduit. In another study in Italy by Bax *et al*.[28] found that significant improvement in CCS class was only seen lately after CABG.

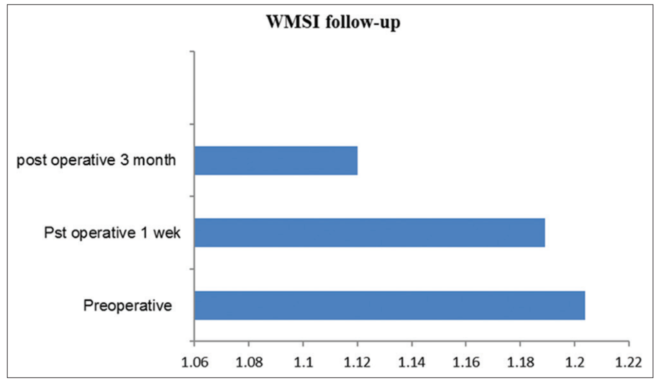

Figure 2: Wall motion score index change preoperative, 1 week and 3 months postoperative

Effect of coronary artery bypass graft on left ventricular systolic function

Improvement of the LV systolic function is possible if viable myocardium is present.[29] In many studies, several variables have been described to predict an improvement in LV function. These include the presence of myocardial viability, less extensive LV remodeling and presence and extent of stunned and hibernating myocardium, the surgeon's ability to completely revascularize hibernating tissue, perioperative myocardial infarction and postoperative graft complication,[30] and early coronary revascularization are the major determinants of improvement in the EF following surgical revascularization.[31]

In our study, there LVEF was not significantly changed in the 1st week after surgery, but it showed it marked significant improvement of the mean LVEF in the late postoperative period, from 49.62% to 56.92%. With $P \leq 0.001$, 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.[32]

Furthermore, in a study by Öztürk and Yavuz, found that improvement of the LVEF was insignificant in the first 2 months and only become statistically significant in the 6 and 12 months postoperatively.[33] In addition, there was no significant

Table 7: Effective of coronary artery bypass graft on regional wall motion preoperative, 1 week and 3 months postoperative improvement

Segments	RWM abnormality	Preoperative *F* (%)	Early post-operative *F* (%)	Late post-operative *F* (%)
Basal anterior	Normokinesia	49 (98)	48 (96)	50 (100)
	Hypokinesia	1 (2)	2 (4)	0 (0)
Basal anteroseptal	Normokinesia	39 (78)	35 (70)	44 (88)
	Hypokinesia	10 (20)	14 (28)	4[25]
	Akinesia	0 (0)	0 (0)	1 (2)
	Dyskinesia	1 (2)	1 (2)	1 (2)
Basal inferoseptal	Normokinesia	31 (62)	35 (70)	46 (92)
	Hypokinesia	19 (38)	15 (30)	4[25]
Basal inferior	Normokinesia	40 (80)	40 (80)	44 (88)
	Hypokinesia	10 (20)	9[25]	4[25]
	Dyskinesia	0 (0)	1 (2)	2 (4)
Basal inferolateral	Normokinesia	46 (92)	46 (92)	49 (98)
	Hypokinesia	4[25]	4[25]	1 (2)
Basal anterolateral	Normokinesia	49 (98)	48 (96)	50 (100)
	Hypokinesia	1 (2)	2 (4)	0 (0)
Mid anterior	Normokinesia	49 (98)	48 (96)	50 (100)
	Hypokinesia	1 (2)	2 (4)	0 (0)
Mid anteroseptal	Normokinesia	37 (74)	30 (60)	40 (80)
	Hypokinesia	11 (22)	17 (34)	8 (16)
	Akinesia	1 (2)	2 (4)	1 (2)
	Dyskinesia	1 (2)	1 (2)	1 (2)
Mid inferoseptal	Normokinesia	39 (78)	40 (80)	47 (94)
	Hypokinesia	11 (22)	9[25]	3 (6)
	Dyskinesia	0 (0)	1 (2)	0 (0)
Mid inferior	Normokinesia	43 (86)	47 (94)	48 (96)
	Hypokinesia	6 (12)	2 (4)	1 (21)
	Akinesia	1 (2)	1 (2)	1 (2)
Mid inferolateral	Normokinesia	47 (94)	49 (98)	49 (98)
	Hypokinesia	3 (6)	1 (2)	1 (2)
Mid anterolateral	Normokinesia	46 (92)	47 (94)	50 (100)
	Hypokinesia	4[25]	3 (6)	0 (0)
Apical anterior	Normokinesia	37 (74)	40 (80)	43 (86)
	Hypokinesia	8 (16)	5 (10)	2 (4)
	Akinesia	3 (6)	3 (6)	3 (6)
	Dyskinesia	2 (4)	2 (4)	2 (4)
Apical Septal	Normokinesia	32 (64)	34 (68)	35 (70)
	Hypokinesia	14 (28)	12 (24)	10 (20)
	Akinesia	3 (6)	3 (6)	3 (6)
	Dyskinesia	1 (2)	1 (2)	2 (4)
Apical inferior	Normokinesia	37 (74)	47 (94)	46 (92)
	Hypokinesia	13 (26)	3 (6)	4[25]
Apical lateral	Normokinesia	45 (90)	48 (96)	49 (98)
	Hypokinesia	5 (10)	2 (4)	1 (2)

RWM: Regional wall motion

improvement of LVEF at early postrevascularization, as Hedman, specified in his report that Vanoverschelde and their Colleague in 2000 have illustrated that the improvement of LVEF may take up to 1 year in some patients.[34]

Coronary artery bypass graft and wall motion abnormalities

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.[35]

In a study by Kamal *et al*. concluded that the higher prognostic value of echocardiographic WMSI than LVEF in patients underwent CABG with viable myocardium and LVEF <50%.[36]

The main difference between WMSI and LVEF is that the WMSI rates equally normokinesia and hyperkinesia avoiding the compensation that hypercontractile segments make on the dysfunctional ones in the measurement of LVEF and therefore assessing more directly the intensity and extent of the myocardial damage.[37] For that combined analysis of both WMSI and LVEF is indicated and more preferable than the measurement of LVEF alone.

In this study, we found a significant improvement in function from preoperative to the late postoperative period which indicates gradual improvement of wall motion after the 3-month post-CABG, reflecting that the myocytes gradually regain their function and contractility 3 months after reperfusion (hibernating myocardium). This was similar to the result of a study done in Karachi, Pakistan, by Awan *et al*. who found no significant difference of WMSI between pre- and early postoperative period.[38] On the contrary, some other studies disagreed with our results, and they reported that the WMSI significantly improve 2–4 days postrevascularization, the reason was due to viable stunning myocardium, that leads to early improvement of WMSI.[19] Moreover, it is expected that the number of factors affecting on the improvement of myocardial contractility, which include the presence of viable myocardium, myocardial ischemia, and early CABG surgery.[39]

Moreover, Søraas *et al*. found that WMSI was significantly reduced during the study period. Furthermore, they found a significant reduction in WMSI from preoperatively to 2 days postoperatively and from preoperatively to 7 weeks postoperatively. In addition, there was a borderline significant change in WMSI between the two examinations postoperatively.[19]

Deterioration of the wall motion or new wall motion abnormalities postoperatively can be explained by total occlusion of native vessels proximal to a patent bypass or occlusion of a bypass graft which can occur early or late after surgery.[40]

In our study, among 121 hypokinetic segments preoperatively, there was an improvement in 16 segments in the early postoperative period. Moreover, marked improvement was seen between pre- and late postoperative in 58 segments 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 (8 segments) or dyskinetic (5 segments), there were no changes in the early nor the late postoperative period 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 Søraas *et al*., they found that 51% of hypokinetic segments were improved, but this changing was opposed to our time of improvement, that extremely improved early (1 day) post-CABG. Besides, the akinetic segment was improved between two postoperative follow-ups. Furthermore, this researcher found that the most improvement occurs in posterior segments.[19] Similarly, a study that was done in Turkey by Mavi *et al*. who observed through transesophageal echocardiographic, there was a significant improvement of severely impaired contraction function (akinesia and dyskinesia) 30 min post-CABG surgery.[41]

Conclusions

The present study suggests that CABG has a positive effect on LV systolic functions and regional wall motion abnormalities 3-month postoperatively as confirmed through echocardiographic techniques.

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Conflicts of interest

There are no conflicts of interest.

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