RESEARCH ARTICLE

Effect of left ventricular hypertrophy on the outcome of coronary artery bypass grafting

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Abstract

Objective: To evaluate the relationship between left ventricular hypertrophy (LVH) and coronary artery bypass grafting (CABG) procedure especially on the early outcome during the first 6 months following surgical intervention

Methods: This prospective cohort study included 82 patients with coronary artery disease indicating CABG. These patients were admitted, operated and followed -up in cardiothoracic surgery departments in the faculty of medicine, Kafrelsheikh university hospitals in the period from April 2019 till November 2021.The patients included in this study were divided into two groups according to presence or absence of left ventricular hypertrophy, Group I had 38 (46.34%) patients with LVH and Group 2 had 44 (53 .65%). patients without LVH.

Results: The time to regain mechanical activity was longer (5.76±1.82) minutes in LVH patients (p <0.001). LVH group had a significantly longer period of mechanical ventilation 16.50±4.25 hours (p <0.001) compared to non LVH group which was 9.61±3.78 hours. Also, the mean duration of ICU stays in the LVH group compared to the non LVH group was 3.81±1.20 days versus 2.56±0.81 days respectively. The ICU follow up showed a statistically significant relationship of arrhythmias with LVH (*p* =0.022), infections (*p* =0.005) and wound infections (*p*<0.001).

Conclusion: In patients undergoing CABG surgery, LVH has been associated with increased morbidity and poor outcome.

Keywords: Hypertrophy, left ventricular, coronary artery disease, respiration, artificial, coronary artery bypass, morbidity, wound Infection, arrhythmias, cardiac **DOI: 10.47391/JPMA.EGY-S4-20**

Introduction

Left ventricular hypertrophy is defined as an increase in the mass of the left ventricle, which can be secondary to an increase in wall thickness, an increase in cavity size, or both.[1] According to American Society of Echocardiography, LVH is defined as increased left ventricular mass (LVM) in males above 200 g and in females above 150g and both interventricular septal thickness and posterior wall thickness above 1.1 cm. The concentric ventricular remodelling Echocardiographic features show normal or small LV cavity size, usually increased LV wall thickness and normal LVM.[2] The prevalence of LVH rises with age, from 6% in those under 30 to 43% in those over 70 years of age.[3]

A significant proportion of individuals who undergo coronary artery bypass grafting (CABG) have preoperative LVH.[4] Increased mortality and morbidity due to cardiovascular disease are linked to LVH, which affects ventricular function, coronary artery circulation, and arrhythmogenesis.[5]

Hypertensive associated LVH has an elevated risk for cardiac events as it leads to progression of congestive heart failure and myocardial fibrosis, which causes LV diastolic dysfunction. During an acute myocardial infarction (AMI), the ventricular mass enlarges due to increased oxygen demands.[6]

In this study, the relationship between left ventricular hypertrophy (LVH) and coronary artery bypass grafting (CABG) procedure was evaluated, specially on the early outcome during the first 6 months following surgical intervention

Patients and methods

This prospective cohort study included 82 patients with coronary artery disease having undergone CABG (Coronary Artery Bypass Graft) and were being followed -up in cardiothoracic surgery departments in the faculty of medicine, Kafrelsheikh university hospitals in the period April 2019 till November 2021.The patients were selected by convenience sampling without having calculated the sample size.

The included patients were divided into two groups according to the presence or absence of left ventricular hypertrophy, Group I had 38 (46.34%) patients with LVH and Group II had 44 (53 .65%). patients without LVH. All the

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study participants provided informed consent for participating in the study and the approval of ethics committee of Kafr el sheikh university hospital was obtained vide the document number: MKSU 50- 6 – 13, dated:13. January 2019.

The including factors were patients in sinus rhythm with an ejection fraction greater than 50%, no previous history of cardiac surgery, patients with isolated coronary artery disease indicating isolated coronary artery bypass grafting (CABG) and with the knowledge that all procedures would be done on-pump with cardiac arrest

The exclusion criteria were, patients with impaired kidney and or liver function tests, congestive heart failure (CHF), chronic obstructive lung disease (COPD) or cerebrovascular accidents (CVA) valvular disease that required imminent surgery and infective endocarditis.

All patients were evaluated before the surgery by full clinical assessment and Laboratory investigations which included, complete blood count (C.B.C), Liver function test, Kidney function test, Coagulation profile and arterial blood gasses.

Also included were a resting Electrocardiogram (E.C.G.) and an Echocardiogram: Transthoracic echocardiographic evaluation was the cornerstone in the patient's evaluation. M-mode and 2D. Doppler echo was done for all patients preoperatively and in the early postoperative period (i.e.: first 6 months after hospital discharge).

Multiple views were recorded at a speed of 50 to 100 mm/s, with simultaneous recordings of electrocardiogram and phonocardiogram. The left ventricular end systolic [LVESD] and end diastolic dimensions [LVEDD], posterior [PWT] and septal wall thickness [SWT] were determined. The thickness of the Interventricular septum (IVST in mm) and left ventricular posterior wall (PWT, in mm) were measured at the level of the mitral valve leaflet tip according to the criteria of the American Society of Echocardiography (ASE) [7]. Interventricular septal thickness (I.V.S.T) and posterior wall thickness (P.W.T) were both noted to help differentiate cases with preoperative LVH from those lacking the pathology.

Chest X-ray and Cardiac catheterization was also performed.

The intraoperative part of the study: All procedures were done by using conventional on pump revascularization surgery using mammary and saphenous grafts. Total cardiopulmonary bypass (C.P.B) and ischaemic time was recorded The number of grafts were noted. Management of complications was recorded as:

Arrhythmias: managed with electrical defibrillation (DC) or amiodarone.

inotropes (type, number,) were recorded

Pacemaker or intra-aortic balloon (IABP) insertion was noted in the documents.

Procedure: Skin was sterilized with povidone iodine. Median sternotomy was performed through a standard median sternotomy incision in all patients.

Cannulation: Arterial cannulation was done via ascending aorta, double staged venous cannulation via right atrial appendage whereas venting of the left ventricle was achieved through a cardioplegia canula placed in the aorta.

Cardiopulmonary bypass was performed under moderate hypothermia of 30-34°C, haematocrit level (HCT) was maintained between 25 to 33 and flow was kept according to body surface flow chart. Myocardial protection was achieved by acquiring mild systemic hypothermia at 30-34°C and antegrade intermittent warm blood cardioplegia. After median sternotomy LMA and Great Saphenous Vein was harvested and distal and proximal anastomosis was done using the classical technique. After the anastomosis was completed, gradual weaning from bypass was performed and haemostasis was assured. Patients were then transferred to ICU and follow up was recorded daily and the number of ICU stay days were noted. When the patients were transferred to the ward, the follow up was also recorded. After discharge, patient was followed up in outpatient after 14 days and Echo was done after 5 to 6 months

Statistical analysis: All data were collected, tabulated and statistically analysed using SPSS version 22.0 for windows (IBM Corp., Armonk, NY, USA) and Microsoft Office Excel 2010 for windows (Microsoft Cor., Redmond, WA, USA). Continuous Quantitative variables were expressed as the mean ± SD & median (range), and categorical qualitative variables were expressed as absolute frequencies (number) & relative frequencies (percentage). Continuous data was checked for normality by using Shapiro Wilk test. Independent samples Student t-test was used to compare two groups of normally distributed data while Mann-Whitney U test was used for non-normally distributed data. Wilcoxon signed ranks test was used to compare between two dependent non-normally distributed data. Categorical data were compared using Chi-square test or Fisher's exact test when appropriate. Spearman's rank correlation coefficient was calculated to assess correlations between study parameters. The results considered (+) sign as indication for direct correlation and (-) sign as indication for inverse correlation. Values near to 1 were considered as strong correlation and values near 0 as weak correlation. A Univariate logistic regression (enter method) analysis was used to estimate the Odds Ratio with the dependent variable being the patient's outcome. All tests were two sided. p-value< 0.05 was considered statistically significant (S), p-value< 0.001 was considered highly statistically significant (HS), and p-value ≥ 0.05 was considered statistically insignificant (NS).

Results

The patients ages ranged from 40 to 65 years. The mean age of the patients in both groups was not significantly different (p=0.816). Male patients were 52(63.4%) and 30 (36.6%) were females. The group with LVH had 38 patients which consisted of 22 (57.9%) males and 16(42.1%) females (Table 1)

Smoking, although an important risk factor altering the course of coronary artery disease, was found to be statistically insignificant between LVH and non-LVH groups. (Table 1)

The ischaemic time and total bypass time showed no significance between both groups although the time to regain mechanical activity displayed high significance (p <0.001) of LVH patients, 5.76±1.82 minutes compared to 2.77±0.83 minutes in patients devoid of LVH which impedes the function of LV post bypass. (Table 2)

IABP was needed intraoperative in about 3 (7.9%) cases with LVH compared to 1(2.3%) case without LVH. (Table 2) LVH group had significant intraoperative inotropes in comparison to non LVH group (p = 0.017). (Table 2)

LVH group had a significantly longer period of mechanical ventilation and ICU stay compared to non LVH group (p<0.001) . With LVH, the mean ventilation time was 16.50±4.25 hours versus only 9.61±3.78 hours in the non LVH patients.Also the mean ICU duration of stay in the LVH versus the non LVH group was 3.81±1.20 days versus 2.56±0.81days respectively . (Table 2)

The ICU follow up revealed significant arrhythmias in the LVH group (p =0.022)and infection rates (p =0.005) compared to non LVH group. (Table 2)

A total of 28(73.7%) cases with LVH had wound infections with serous discharge, which was highly significant (p <0.001). (Table 2)

The ejection fraction (E.F) in both groups showed postoperative reduction after CABG. However, the comparison of values between both groups showed a significant reduction in the LVH group according to paired analysis (p <0.001). (Table 3)

During outpatient clinic follow up LVH was significantly associated with unfavourable outcomes (p = 0.177). Heart failure developed in 9(23.7%) cases and 2(4.5%) cases in patients without LVH. (Table 3)

Table-1: Demographic and pre operative data

Parameter	Groups		test	*p-value*
	Non LVH n=44	LVH n=38		
Gender				
Male	30 (68.2)%	22 (57.9)%	0.930 a	0.335
Female	14 (31.8)%	16 (42.1)%		
Mean Age (years)	57.43±5.35	56.68±6.14	-0.233b	0.816
Smoking				
Non-smoker	20 (45.5)%	23 (60.5)%	1.857 a	0.173
Smoker	24 (54.5)%	15 (39.5)%		
Mean Pre operative SBP (mmHg)	132.93±3.43	141.86±3.50	-7.232 b	-7.232b
Mean Pre operative DBP (mmHg)	82.88±3.03	90.23±2.44	-11.949 c	0.029
Pre operative echo finding				
Mean EF (%)	63.09±2.71	61.71±3.02	-2.189 b	0.029
Mean PWT	9.38±0.96	12.15±1.02	7.213 b	<0.001
Mean IVST	9.47±0.73	12.52±0.68	-7.919 b	<0.001
Mean LVEDd	51.04±3.03	49±3.93	-2.189 b	0.029
Mean LVESd	31.20±3.46	29.71±3.41	1.959 c	0.054

Abbreviations LVH left ventricular hypertrophy SBP systolic blood pressure DBP diastolic blood pressure EF ejection fraction PWT posterior wall thickness IVST interventricular septum thickness LVEDd left ventricular diastolic dimension LVESd left ventricular systolic dimension.(a : chi-square test) (b : Mann Whitney u test) (c independent sample)

Table-2: intraoperative and post-operative results

Parameter	Groups		test	*p-value*
	Non LVH n=44	LVH n=38		
Mean Total bypass time (min.)	110.13±27.87	110.07±25.76	0.010c	0.992
Mean Ischaemic time (min.)	60.02±15.24	60.10±14.74	-0.023b	0.981
Mean Time to Mechanical electrical activity	2.77±0.83	5.76±1.82	-6.897b	<0.001
Intraoperative inotropes				
No	9 (20.5)%	1 (2.6)%	6.049 a	0.017
Yes	35 (79.5)%	37 (97.4)%		
Need of IABP				
No	43 (97.7)%	35 (92.1)%	1.389 a	0.332
yes	1 (2.3)%	3 (7.9)%		
Need of DC				
No need	23 (52.3)%	7 (18.4)%	10.071 a	0.002
Used	21 (47.7)%	31 (81.6)%		
Post operative informative data				
Mean Ventilation time (hours)	9.61±3.78	16.50±4.25	-5.978 b	<0.001
Mean ICU duration (days)	2.56±0.81	3.81±1.20	-4.872 b	<0.001
Arrhythmia				
No	43 (97.7)%	31 (81.6)%	6.039 a	0.022

Continued on next page

Table-2: *continued from previous page*

Parameter	Groups		test	*p-value*
	Non LVH n=44	LVH n=38		
Yes	1 (2.3)%	7 (18.4)%		
Infection				
No	42 (95.5)%	28 (73.7)%	7.736 a	0.005
Yes	2 (4.5)%	10 (26.3)%		
Wound infection				
Absent	39 (88.6)%	10 (26.3)%	32.931 a	<0.001
Present	5 (11.4)%	28 (73.7)%		

Abbreviations IABP intra-aortic balloon pump, DC direct current , ICU intensive care unit LVH left ventricular hypertrophy.(a : chi-square test) (b : Mann Whitney u test) (c independent sample)

Table-3: outpatient clinic follow-up data

Parameter	Groups		test	*p-value*
	Non LVH n=44	LVH n=38		
Mean EF follow-up (%)	58.88±3.90	55.92±3.78	3.652 b	<0.001
Heart failure				
HF	2 (4.5)%	9 (23.7)%	6.430 a	0.011
Improved	42 (95.5)%	29 (76.3)%		
Sternal wound infection				
Absent	43 (97.7)%	34 (89.5)%	2.426 a	0.177
Present	1 (2.3)%	4 (10.5)%		
Wound sinus				
Absent	42 (95.5)%	36 (94.7)%	0.023 a	1.000
Present	2 (4.5)%	2 (5.3)%		

Abbreviations EF: ejection fraction HF: heart failure LVH: left ventricular hypertrophy .(a : chi-square test) (b : Mann Whitney u test)

Discussion

Intraoperatively, there was no significant difference in the ischaemia time between LVH and non-LVH patients, with a mean of 110 minutes. In contrast, Toumpoulis et al[8] observed that the total bypass time in the LVH group exceeded the non LVH group (a mean of 125 minutes versus 106 minutes respectively). Our study could have this difference due the non-significant difference in graft numbers between both groups. In our study, the time to regain mechanical activity was significantly longer in patients with LVH. IABP was non significantly required in the present study (p =0.332), where the LVH group showing 3 out of 38 cases had the device inserted whereas in the non-LVH group only 1 out of 44 cases required the device. Unfortunately, not so many studies regarding this issue are available, but the study by Claudius Diez et al,[9] documented that the overall actual mortality between patients with preoperative IABP insertion and patients without preoperative IABP did not differ significantly (P = 0.27)

Pengyun Yan et al,[10] compared the predictive mortality rate between patients with LVH and patients devoid of LVH, and patients with HF and reduced ejection fraction. The results showed that the group with LVH had a higher frequency of mortality (p =0.010). This is in contrast to our study which could be be due to no mortality in both groups due to preserved EF.

In a study conducted by Licker et al,[11], 94 patients with aortic stenosis and LVH with a PWT greater than 11mm and 84% having diastolic dysfunction, were placed for aortic valve replacement. During weaning from CPB, 38(40.4%) patients experienced LV dysfunction and required high dose of inotropes and 5 from 38 cases needed additional mechanical support with IABP. Our results show that the LVH group significantly required inotropic support during weaning from CPB (p =0.017). Most of our cases, (37 out of 38) belonging to the non-LVH group required inotropic support only with either adrenaline, noradrenaline or both. This result clearly consolidates the effect of LVH on myocardial recovery in both studies.

In our study the detrimental effect of LVH was observed as development of atrial fibrillation in 7 cases and infection in 10 cases. The study by Akdeniz B,[12] was similar to our study regarding the arrhythmogenic potential of LVH. The frequency of potentially malignant ventricular arrhythmia was significantly higher in hypertrophic groups (20.9%) compared to non hypertrophic groups (6.5%) ($p < 0.05$). Comparing this data with our study, 18.4% of LVH group had arrythmias while non-LVH group showed 9.8%(p=0.022). Similarly, Hashemzadeh et al,[13] in their study concluded that preoperative LVH was the strongest predictor of postoperative atrial fibrillation following open heart surgery, undeniably confirming LVH as an arrhythmogenic substrate.

Although arrhythmias are an important postoperative complication, stroke was not identified. Di Tullio et al, in their study[14] concluded that LVH was associated with increased stroke risk. Di Tullio's study comprehended that concentric pattern of hypertrophy carried the highest risk followed by eccentric hypertrophy without statistical difference between races. Concentric remodeling on the other hand lacked any association with increased stroke risk.

In contrast to Di Tullio's study,[14], our study failed to establish a link between LVH and stroke as a major complication. This could be attributed to the fact that we excluded all cases above 65 years of age with concomitant carotid artery atherosclerosis or stenosis as well as excluding all preoperative risk factors apart from hypertension.

Regarding myocardial infarction, in our study there was non-significant difference between the two groups. Toumpoulis et al.,[8] also did not establish this statistical significance. Kaplinsky,[15] however, managed to prove the existing inter-relationship between LVH and MI, where MI leads to compensatory myocardial growth with excessive fibrous tissue and a decreased capillary to cell size ratio. LVH, owing to excessive subendocardial fibrosis and decreased capillary to cell size ratio will definitely increase the frequency of recurrent MI. This factor was not significant in our study due to preserved contractility and EF in both groups

LVH, notorious for its side effects, delayed the recovery of patients from mechanical ventilation and increased their overall ICU stay. This can be noted with a mean ventilation time reaching 16.50±4.25 hours and ICU stay for 3.81±1.20 days both were highly significant (p<0.0010). In comparison, the non-LVH group demonstrated a mean ventilation time of only 9.61±3.78 hours and an ICU stay for 2.56±0.81 days. In contrast to our study, Saxena et al.[16] outlined the effect of left ventricular dysfunction on prolonging mechanical ventilation. Their study revealed that 31.9% cases with severely impaired LV ejection fraction had prolonged ventilation compared to only 12.7% of cases with normal EF (p <0.001). This emulates our study where the LVH group showed a mean ventilation time of 16 hours compared to just 9 hours in the non-LVH group. Saxena did not use LVH as a factor per se, but rather relied on its result in the form of ventricular dysfunction. They also included another risk factor in their study, aortic valve replacement. Our study was restricted to isolated CABG procedure.

Complications of LVH observed on 28 (73.7%) patients in the surgical ward were wound discharge (p <0.001) but none of them required ICU re-admission with no cases of deep wound infection. Both Saxena et al.[16] and Toumpoulis et al.,[8] similar to our study, found that ventricular dysfunction and LVH respectively were not statistically significant regarding deep sternal wound infection (p= 0.961).

The negative impact was also apparent in the postoperative Echo findings especially in the ejection fraction (E.F) with a significant reduction compared to preoperative values (p <0.001)

During the follow up period in our outpatient clinic, 9 (23.7%) cases from LVH group and 2 (95.5%) cases from the non-LVH group developed heart failure. This proves the dismal effect of LVH on the early outcome of CABG procedure. Both Saxena et al.[14] and Toumpoulis et al.,[8] failed to establish this statistical significance.

East et al[17] had a follow up duration of 3(+ or – 2) years. Survival rates at 1,3 and 5 years were 75%,56% and 42% respectively for those with LVH versus 88%, 76% and 67% respectively for those without LVH. They also noted these effects related to race and gender. In contrast, our study followed the patients only for six months after the surgical revascularization.

The study by Toumpoulis et al.,[8] showed that although LVH was not a risk factor for in-hospital mortality, it remained a risk factor for long term mortality after 3 years from the operation with an overall increase by 24%. Our study focused on early outcome with a follow up of 6 months duration as the objective was to determine LVH induced major significant complications without in-hospital mortality.

In contrast to our study, Zdravkovic et al,[18] analysed the preoperative risk factors in low risk patients exhibiting a EuroSCORE less than 2. Although recognizing smoking, old age, old myocardial infarction and poor ejection fraction, as major risk factors for increasing 5 year mortality, yet LVH was determined as non-significant in predicting mortality. This shares a common ground with our results where we failed to establish a relationship between LVH and mortality on the short term follow-up.

On the other hand, Sastry et als,[19] study focussed on the diastolic component of LV function. The study evaluated the left ventricular end- diastolic pressure (LVEDP) as a predictor of mortality risk (independent of left ventricular systolic dysfunction). It concluded that implementing end diastolic dysfunction on the EURO-Scoring system for better risk stratification was important.

Sastry et als,[19] study divided the patients into 4 groups: group 1) preserved systolic function, preserved diastolic function, group 2) poor systolic function, preserved diastolic function, group 3) preserved systolic function, poor diastolic function, group 4) poor systolic function, poor diastolic function. Group 3 patients with evidence of diastolic dysfunction in the presence of apparently preserved systolic function had higher mortality when compared with group 1(5.6% versus 1.5% respectively).

Comparing group 2 with group 4 in our study, showed the impact of diastolic dysfunction to be over and above impaired LV systolic function. This comparison indicates that LVEDP (as a measure of diastolic dysfunction) augments this effect especially with a LVEDP >20 mmHg. The mortality rates were 1.9% versus 7.4% respectively.

Conclusion

LVH has been associated with increased morbidity and worse outcome after CABG operation. LVH had its effect intraoperatively in the form of more time to regain mechanical activity, and the need of more inotropes during weaning from CPB.

Postoperatively, LVH group suffered longer ventilation time, longer ICU stay, increased arrhythmias and wound infection. LVH was associated with an unfavourable outcome.

Limitations: The sample size was not calculated for this study which could effect the power of the study.

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