INCIDENCE OF PERIOPERATIVE MYOCARDIAL INFARCTION FOLLOWING CORONARY ARTERY BYPASS GRAFTING (CABG)

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Abstract

Introduction: Myocardial infarction after coronary artery bypass grafting is a serious complication and one of the most common causes of perioperative morbidity and mortality.

Aim of the study: To determine the incidence of perioperative myocardial infarction and to detect predictors ,in hospital and 30 days clinical outcome related to perioperative myocardial infarction by using hs-TnI and evaluated the utility of adding to the troponin criteria new Q-waves or imaging evidence of new wall motion abnormality as suggested in the Universal Definition of MI.

Methods: The study enrolled 250 consecutive patients undergone isolated CABG at the National Heart Institute,Cairo,Egypt and Benha University hospital ,Benha,Egypt in the period from November 2013 to May 2014 (6 months). Threshold of 700 ng/l (10-times 99th percentile upper reference limit) of hs-TnI was prescribed plus ECG and or Echocrdiographic evidence of new wall motion abnormality.

Results: Perioperative MI was reported in 11% of patients after CABG with worse in hospital and 30 days clinical outcome. The study showed that, Body mass index, prior heart failure , EuroScore , Left main coronary artery stenosis> 50% , lesion type,% diameter stenosis and length , Aortic cross clamping time and Extracorporeal circulatory time were significant independent predictor of perioperativeMI,p <0.05.Perioperative MI was associated with increased risk of arrhythmias,heart failure and death.

Conclusion: perioperative myocardial infarction is an important adverse event with worse clinical outcome after CABG.

Keywords: Coronary artery bypass surgery, high-sensitivity troponin, myocardial infarction, Universal Definition, heart failure

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Introduction

Coronary artery bypass grafting (CABG) is of considerable benefit for those in need of revascularization, however, it may be associated with significant perioperative and post operative myocardial damage and necrosis, which may occur in varying degrees, however multiple mechanisms have been proposed to explain myocardial injury after CABG, intraoperative injury may result from cardiac manipulation, inadequate myocardial protection, and intraoperative defibrillation, while postoperative myocardial injury may be associated with acute loss of bypass grafts.[1]

The 2012 Third Universal Definition defined MI (type 5) after CABG as requiring two criteria: (1) cardiac biomarkers (with troponins preferred) rise >10-times 99% upper reference limit (URL) from a normal preoperative level; and (2) new pathological Q-waves or new left bundle branch block (LBBB) and/or imaging or angiographic evidence of new occlusion of native vessels or grafts, new regional wall motion abnormality, or loss of viable myocardium. [2]

Patients and methods

Patient selection and data collection

Ethical approval of this study was obtained from our ethics review committee. Patients undergoing isolated CABG without other concomitant cardiac surgery from November 2013 to May 2014 (6 months) were identified prospectively from the cardiothoracic surgical unit. Additive EuroScore, which predicts operative risk, was calculated. warm blood Sant Thomas cardioplegia and cold potassium crystalloid cardioplegia was used for on-pump CABG.

Electrocardiograms (ECGs) were performed multiple times until discharge. Transthoracic echocardiograms were performed as indicated clinically. New Q-waves or LBBB on the ECG or new regional wall motion abnormality on echocardiography were independently interpreted by authors blinded to outcomes.

Biomarker assay

Siemens Dimension RxL troponin I assay with 99th percentile URL of 70 ng/l.Patients routinely had hs-TnI measured 12–24 hours before and after surgery.[3]

The cut point for the hs-TnI rise to detect perioperative MI was prespecified: >10-times 99th percentile URL (i.e. 700 ng/l); For patients with stable baseline troponins. In patients with elevated stable baseline troponins, a significant hs-TnI rise required the postoperative hs-TnI to be above the cut point, and also a 20% rise from the preoperative level. [4]

Study groups

Based on perioperative myocardial infarction(POMI),patients were classified into two groups:

Group (1) : Those who had POMI.

Group (2) : Those without POMI.

Results

Statistical methods

Data are presented as mean+ SD for continous data and as number (%) for categorial data.Between groups comparison was done using student t-test for continous data and by Chi-square test (or Fischer exact test) for qualitative data. Level of evidence was detected to be significant at P value <0.05. Logistic regression was used to determine Independent predictors of perioperative MI. Data were collected and analyzed by SPSS (version 17).

Study population

The mean age was 57 ± 6 years (58±6 years versus 55 ±7 years in group 1,2 respectively, P=0.013),84% were males (75% versus 85% in group 1,2 respectively, P=0.192),53% had diabetes (57% versus 53% in group 1,2 respectively P=0.657), 68% had hypertention (64 %versus 68% in group 1,2 respectively P=0.639), the mean body mass index was 31±8 Kg/m2 (33 ± 8 Kg/m2 versus 30 ± 8 Kg/m2 in group 1,2 respectively P=0.022), 33 % had hyperlipidemia (46 % versus 31% in group 1,2 respectively P=0.111), 60 % were smokers(57% versus 61% in group 1,2 respectively P=0.709), 14% had positive family history of CAD (11% versus 14 % in group 1,2 respectively P=0.627).11 % had prior MI (21% versus 9 % in group 1,2 respectively P=0.036), 64% had history of prior heart failure (79% versus 63 % in group 1, 2 respectively P =0.014) , 2% had history of prior stroke (7% versus 1 % in group 1, 2 respectively P =0.093).The mean EuroScore was 2 ±1 (3 ± 2 versus 1 ± 1 in group 1,2 respectively P=0.001). Between groups comparison showed statistical significant difference between group 1 and group 2 regarding age ,body mass index,prior MI ,prior heart failure and EuroScore while no statistically significant difference was found between them regarding other baseline characteristics.

Coronary angiography before procedure

Single vessel disease was reported in 13 % of patients (7 % versus 14 % in group 1,2 respectively,P=0.281) , while two vessel disease in 24 % of patients (11 % versus 26 % in group 1,2 respectively,P=0.591),three vessel disease in 42% of patients (46 % versus 41 % in group 1,2 respectively,P=0.037) and left main disease was in 20 % of patients (36% versus 18 % in group 1,2respecyively,P=0.045).
Type A lesion was reported in 37% of patients (0.0 % versus 42% in group 1,2 respectively,P=0.019), type B lesion was reported in 18% of patients (21 % versus 18 % in group 1,2 respectively,P=0.019), type C lesion was reported in 45% of patients (79 % versus 41 % in group 1,2 respectively,P=0.019),the mean % diameter stenosis was 90±10% (95±5% versus 85±15 % in group 1,2 respectively,P=0.014),the mean lesions length was 26±7 mm (28±10 mm versus 24±4 mm in group 1,2 respectively,P= 0.05).

Procedural data

The mean aortic cross clamp time was 78 ±28 minutes (84 ± 25 min versus72 ± 31 min in group 1,2 respectively,P=0.048), the mean extracorporeal circulatory time was 118 ± 37 min (133 ± 36 min versus 103 ± 37 min in group 1,2 respecively,P= 0.001),86% of patients received warm blood Sant Thomas cardioplegia ,4% received cold potassium crystalloid cardioplegia while the remaining 10 % did not received cardioplegia as they were operated by off pump

technique (82% versus 87% for warm cardioplegia and 18% versus 3 % for cold cardioplegia in both group 1,2 repectively,P=0.219),90% of patients were operated by on pump technique while the other 10% were done by off pump technique (100% versus 89 % for on pump technique and 0.0% versus 11% for off pump technique in group 1,2 respecively,P=0.014).The number of grafts implanted was one graft in 13% of patients (7% versus 14% in group 1,2 respecively,P=0.013),two grafts in 24 % of patients (29% versus 24% in group 1,2 respecively,P=0.013) ,three grafts in 46% of patients (64% versus 44% in group 1,2 respecively,P=0.013),four grafts in 16% of patients (0% versus 18 % in group 1,2 respecively,P=0.013) and five grafts in 0.4% of patients (0.0% versus 0.4% in group 1,2 respecively,P=0.013).LIMA was used in 97 % of patients (86 % versus 99 % in group 1,2 respectively,P=0.003),Saphenous vein grafts were used in 86 % of patients (96 % versus 84 % in group 1,2 respectively,P=0.046). Between groups comparison showed statistical significant difference between group (I) and group (2) regarding aortic cross clamp time,Extracorporeal circulatory time,on pump technique,number and type of grafts implanted while no statistically significant difference was found between them regarding type of cardiolplegia, Table(1) Figure(1).

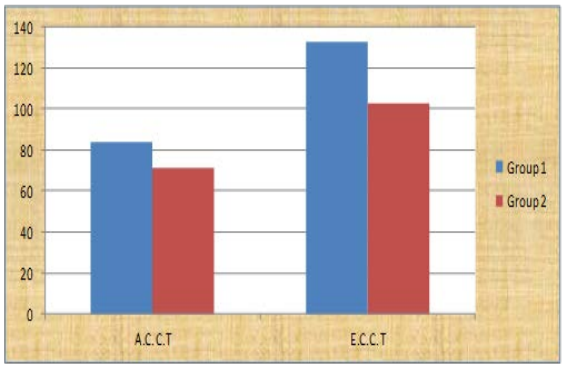


Figure (1) The mean aortic clamp time and extracorporeal time.

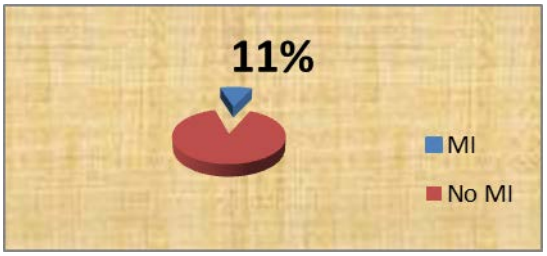
Incidence of perioperative MI

Twenty eight patients (11%) developed perioperative myocardial infarction according to the diagnostic criteria for MI after CABG.Table(2) ,Figure(2)

Sensitivity and specificity of ECG for detecting perioperative MI in group 1,is very high with only two false negative cases and no false positive results,also all cases who developed peroperative MI in group 1, were detected by Echo with no false positive or false negative cases were recorded so sensitivity and specificity of Echo for detecting perioperative MI was 100% (P=0.001).

Table(2) Incidence of MI (CTnI>700 ng/L plus ECG and/ or Echo)

ECG and/ or Echo		CT nI ng/l		
		<700 ng/l	>700 ng/l	Total
Negative	N	38	184	222
	%	15	73.6	88.60
Positive	N	0	28	28
	%	0.0	11*	11*
Total	N	38	212	250
	%	15.20	84.8	100.00



Figure(2) Incidence of MI following CABG.

Cardiac biomarkers

The mean cardiac troponin I (CTnI) at baseline was 96 ± 32 ng/l (105 ± 34 ng/l versus 87± 30 ng/l in group 1,2 respectively,P=0.766), the mean postoperative cardiac troponin I (CTnI) was 1094 ± 471 ng/l (1214 ± 596 ng/l versus 975 ± 345 ng/l in group 1,2 respectively,P=002).

Postoperative ECG

Post operative ST segment elevation was in 10% of patients (86% versus 0% in group 1,2 respectively,P=0.003), ST segment depression was in 1% of patients (7 % versus 0% in group 1,2 respectively,P=0.002), pathological Q wave was in 10% of patients (93% versus 0% in group 1,2 respectively,P=0.001),arrhythmias was reported in 19% of patients (46% versus 15% in group 1,2 respectively,P=0.022).

Post operative Echocardiography

The mean LVEF % at baseline was 56 ± 9 % (57±9 % versus 56 ± 9 % in group 1,2 respectively,P=0.516). Postoperative LVEF% was 49 ± 9% of patients (41 ± 9 % versus 56 ±8 % in group 1,2 respectively,P=0.001),the mean wall motion score index (WMSI) was 1.35±0.25 (1.5±0.3 versus 1.2±0.2 in group 1,2 respectively,P=0.04) ,the mean left ventricular end systolic volume was 33 ± 10 mm (29 ± 9 mm versus 37 ± 11 mm in group 1,2 respectively,P=0.034) ,the mean left ventricular end diastolic volume was 94±17 mm (92±18 mm 96±16 versus in group 1,2 respectively,P= 0.642) .

Postprocedural data

Insertion of intra-aortic balloon was needed in 3% of patients (21% versus 1 % in group 1,2 respectively,P=0.001). 7% of patients needed mechanical ventilation time more than 24 hrs (29 % versus 5% in group 1,2 respectively,P=001).

Predictors of POMI

Logestic regression analysis was to identify independent predictors of POMI showed that BMI, prior heart failure , EuroScore , LM stenosis> 50% , lesion type,% diameter stenosis and lesion length , ACCT and ECCT were significant independent predictor of perioperative MI.Table (2)

Postoperative outcome

A. In hospital outcome

Atrial fibrillation was reported in 16% of patients (36% versus 14% in group 1,2 respectively,P=0.001) ,ventricular tachycardia was reported in 2 % of patients (4 % versus 1% in group 1,2 respectively, P =0.001), ventricular fibrillation was reported in 1% of patients (7 % versus 0% in group 1,2 respectively, P =0.0.001) , heart failure occurred in 13% of patients (79% versus 5 % in group 1,2 respectively, P =0.001),cardiogenic shock was evident in 8 patients, all in group1 but not in group2 (P=0.0001) ,death occurred in 7% of patients (21% versus 5% in group 1,2 respectively, P=0.004), Table (3).

30 days outcome

All cause mortality occurred in 9 % of patients (29% versus 7% in group 1,2 respectively, P =0.001). There were six mortalities (21%) among patients with perioperative MI during in hospital stay , all deaths were cardiac-related (11% died due to cardiogenic shock, 7 % died because of ventricular fibrillation and 4% due to ventricular tachycardia).However we reported 2 cases of suden cardiac death during 30 days follow up.

Table (3) Procedural data

	All patients N = 250	Group 1 No = 28	Group 2 No = 222	P value
ACCT time /min Mean ± SD	78±28	84± 25	72 ± 31	0.048
ECCT time/min Mean ± SD	118 ±37	133 ± 36	103 ±37	0.001
Type of cardioplegia				
Warm	215(86%)	23(82%)	192(87%)	
Cold	11(4%)	5(18%)	6(3%)	0.219
No	24(10%)	0(0.00%)	24(11%)	
Technique				
On pump	226 (90%)	28(100%)	198 (89%)	0.014
Off pump	24 (10%)	0 (0.00%)	24 (11%)	
Number of grafts				
1	33(13%)	2(7%)	31 (14%)	
2	61(24%)	8(29%)	53 (24%)	
3	116(46%)	18(64%)	98 (44%)	0.013
4	39(16%)	0(0.00%)	39 (18%)	
5	1(0.45%)	0(0.00%)	1 (0.4%)	
Type of graft				
LIMA	243(97%)	24(86%)	219(99%)	0.003
SVG	214(86%)	27(96%)	187(84%)	0.046

ACCT: Aortic cross clamp time.
ECCT: Extracorporeal circulatory time
LIMA: Left internal mammary artery.
SVG: Saphenous vein graft

Table (4) Predictors of POMI by logistic regression analysis

Independent variables	95% Confidence Interval		P value
	Lower Bound	Upper Bound	
Age	0.614	1.141	0.315
Sex	0.778	5.035	0.152
BMI	1.007	1.113	0.025*
Prior HF	1.298	1.461	0.035
UA	0.716	6.045	0.178
Prior MI	0.908	6.769	0.076
DM	0.541	2.646	0.658
HTN	0.364	1.888	0.655
Hyperlipedemia	0.868	4.257	0.107
Smoking	0.388	1.904	0.709
Prior stroke	0.896	5.174	0.065
FH	0.211	2.597	0.638
Euroscore	1.368	2.199	0.001**
LM	1.054	5.704	0.037*
1 VD	0.107	2.098	0.325
2 VD	0.099	1.166	0.086
3 VD	0.546	2.646	0.647
Lesion type	2.481	8.885	0.001**
% diameter Stenosis	1.169	1.383	0.001**
Lesion length	1.110	1.323	0.001**
No graft	0.581	1.369	0.602
LIMA	0.017	0.389	0.002**
SVG	0.642	7.145	0.126
ACCT	1.000	1.024	0.050*
ECCT	1.009	1.030	0.001**
Cardioplegia	1.324	2.682	0.314
On pump	000	-	0.995
Off pump	000	-	0.995
Pre EF	0.974	1.061	0.461
Pre CTnI	0.999	1.001	0.766

VD :Vessel disease **FH**:Family history
EF:Ejection Fraction **UA**:Unstable Angina
DM:Diabetes Mellitus **HTN**:Hypertension
ACCT:Aortic cross clamp time.
ECCT:Extracorporeal circulatory time.

Table (5) In-hospital outcome

	All patients N = 250	Group 1 No = 28	Group 2 No = 222	P value
Infarction	28 (11%)	28 (100%)	0 (0%)	0.001
Arrhythmia	47(19%)	13 (46%)	34(15%)	0.022
AF	41(16%)	10(36%)	31(14%)	
VT	4(2%)	1(4%)	3(1%)	0.001
VF	2(1%)	2(7%)	0(0.00%)	
Heart failure	32 (13%)	22 (79%)	10(5%)	0.001
Cardiogenic shock	8 (3%)	8 (29%)	0 (0%)	0.0001
Death	17 (7%)	6 (21%)	11 (5%)	0.004

AF: Atrial fibrillation **VT:**Ventricular tachcardia **VF:**Ventricular fibrillation

Discussion

Perioperative MI was reported in 11% of patients after CABG with worse in hospital and 30 days clinical outcome compared to those who had not POMI

We reported prior heart failure was independent predictor of perioperative MI,P=0.035. This was in agreement with Tom Wang et al., 2013 study,818 patients undergone CABG,found heart failure (CCS class 4) was independent predictor of perioperative MI , p =0.017.[4]

We reported a mean body mass index 31±8 kg/m2 with significant difference between two groups, it was a strong predictor of POMI ,(p= 0.022). This was in agreement with Prasad et al.,1991 study, compared 250 obese patients undergoing CABG with 250 age and sex matched controls of normal BMI, obesity was independent predictor for myocardial infarction, p <0.02.[5]This was disconcodant to Wang et al et al.,2014 study, 4,916 chinese patients underwent CABG ,found that different BMI groups were not significantly associated with 5-years mortality and MACE,different study populations explain this difference.[6]

In our study the EuroScore was strong predictor of POMI (3 ± 2 versus 1 ± 1 in group 1,2 respectively P=0.001). This results is concordant to a study done by Onorati et al.,2005, study

included 776 patients ,found that Euroscore was independent predictor of myocardial damage.[7] In another study by Bordalo et al.,2011, 694 patients, undergone isolated CABG,found that non significant increase in logistic Euroscore among group A with perioperative MI versus group B without perioperative MI (5.6% versus 5.9% respectively).[8] The difference between two study is that we use additive Euroscore rather than logistic Euroscore.

In the present study, aortic cross clamp time and extracorporeal circulatory time was independent predictor of perioperative MI ,p<0.05. Onorati et al.,2005 study,776 patients undergoing CABG , found that aortic cross clamping time greater than 90 min and cardiopulmonary bypass time greater than 180 min were independent predictor of myocardial damage at multivariate analysis[7].In contrast, Nouhi et al.,2009 study, 424 patients underwent CABG; found that pump time was not significantly associated with perioperative myocardial infarction p-value>0.05.[9]

The difference between the two studies is that Noohi study was done on patients underwent combined surgery; CABG and valve surgery.

We reported arrhythmias in 19% of patients (46% versus 15 % in group 1.2 respectively,P=0.022). This was in agreement with Bordalo et al.,2011 study, 694 patients with isolated CABG there was significant increase in dysrhythmic profile in patients with perioperative MI compared to patients without such complication(4 % versus 1%) , p-value <0.025.[8]Koletsis et al.,2011 study, 157 patients presenting AF after CABG (groupA) and 191 patients without AF (group B), found that perioperative myocardial infarction have significant correlation with postoperative AF with p <0.001.[10]

We reported heart failure in 13% of patients (79% versus 5% in group 2 respecively,p=0.001).This was in agreement with Steur et al., 2005 study, 7,493 patients who underwent CABG ,found that 114 patients (20%) had perioperative myocardial infarction developed heart failure.[11]

In our study there was significant difference between group (1) and group (2) in mortality during hospital stay and 30 days follow up,P=0.004. Our study findings are in agreement with Bordalo et al.,2011 study 694 patients with isolated CABG,found that in hospital mortality among perioperative MI group A compared to group B without perioperative MI (9.6% versus 2.1%) ,P-value <0.001.[8]Our study findings are also in agreement with Jarvinen et al.,2014 study, 501 patients undergo CABG surgery ,found that 30-day mortality was adversely affected by perioperative MI (6.3% in PMI group vs. 1.0% in non-MI group ,p-value=0.001).[12]

Recommendations

All previously mentioned predictors of POMI must be avoided to minimize the risk of POMI and to improve clinical outcome after CABG.

Study limitations

- The small sample size.
- Two center study.
- Short follow up time.

Conclusions

Perioperative MI is associated with worse outcome after CABG.

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