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LOW FLOW IMA ITS RESPONSE TO TOPICAL VASODILATORS AND ITS EFFECT ON PATIENTS OUTCOME IN CABG SURGERY

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Contribution
MID did literature review and research design and also finalized the manuscript. AHD helped in collection and analysis of data. MA helped in final draft. All authors contributed significantly to the submitted manuscript.

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ABSTRACT

Objective: To determine the frequency of low flow IMA, the effect of topical vasodilators, its use on LAD and immediate post-operative outcome.

Methodology: This cross-sectional study was conducted at Dow University Health Sciences, Karachi, from 1st January 2012 to 31st December 2014. Data was collected of patients who underwent CABG. Free flow of IMA was measured immediately after harvesting with a syringe. Data was analysed on SPSS 15 with sample t test used for comparison. P-value of less than 0.05 was considered statistically significant

Results: Total of 158 consecutive patients were included. Males were 81.6%, with mean age of 52 years The mean flow was 11.6±9.6ml/30 seconds.About 40 patients had IMA flow less than 5ml/30seconds (25.3%). The low flow IMA did not showed a good response to topical vasodilators and its use on LAD showed significantly higher need of inotropic support(p=0.004), more LCOS(p=0.022), more use of IABP(p=0.028), and higher incidence of atrial fibrillation. The mortality and readmission were also high but not reached to significant levels.

Conclusion: Low flow IMA should be used cautiously on LAD. If low flow IMA after harvesting does not give good response to topical vasodilators it may be better to use the vein graft on LAD. If use of low flow IMA necessary than mechanical and pharmacological support should be consider early.

Key Words: CABG, Internal Mammary Artery, IMA Flow, LAD

INTRODUCTION

The left internal mammary artery is the most commonly used arterial graft for revascularization of myocardium. It has been shown superior over saphenous vein graft by its long term patency, excellent survival and very low chances of degeneration.[1-3] Hospital discharge data analysis across Canada showed a decrease in morality after CABG where internal mammary artery (IMA) was used.[4] IMA grafting is particularly important for patient with diabetes mellitus because survival is significantly better in patient with diabetes after coronary artery bypass grafting compared with percutaneous trans-luminal intervenstion.[5] Long term survival and freedom from myocardial infraction, recurrence of angina, percutaneous re-intervention and repeat operation may further be reduced by the use of bilateral IMAs.[6,7] Other advantages of IMA are its ability to dilate in response to increase myocardial blood flow demand.[8,9] Diameter of IMA also increases with chronically increased demand of blood supply.[10] IMA endothelium produces prostaglandin more than saphenous vein and therefore have better resistant to thrombosis.[11]

Although the other arterial grafts are better in patency then the saphenous graft but there patency is not equal to IMA and even the radial graft did not reach patency equal to IMA, and right gasteroepiplic artery also have inferior patency rate than IMA.[12-13] One study showed the patency of IMA is 97% at a mean time period of 12 years.[14]

IMA related with spasm as shown in many studies which may be due to handling or the use of diathermy, and therefore, different vasodilators were used to over-come the spasm.[15] We collected the data of our patients to see the incidence of low flow IMA , the effect of topical vasodilator after harvesting IMA and the outcome of patients in low flow IMA was used.

METHODOLOGY

This cross sectional, observational study was conducted at Dow University Health Sciences, Karachi, from 1st January 2012 to 31st December 2014. Patients who underwent primary, isolated and elective coronary artery bypass surgery (CABG) were included from a single institute and IMA was harvested by the single surgeon. Emergency surgery, urgent referral for operation, redo-coronary artery bypass surgery, off pump surgery and CABG with valve surgery were also excluded.

The data was collected on the standard forms and patient's informed consent was taken. The data was entered into SPSS version 15 for statistical analysis. Data presented as mean with standard deviation, the discrete variables were presented as frequencies. Comparison of the two groups was performed by the independent sample t-Test for continuous variable with 95% confidence level. P-value of less than 0.05 was considered statistically significant. Ethical committee approval was obtained from the University of Karachi.

RESULTS

A total of 158 patients were prospectively evaluated. About 129 (81.6%) were male, mean age was 52 ± 8 years, Diabetes mellitus [66 (41.8%)] , hypertension [116 (73.4%)] and history of smoking was present in 77 (48.7%) patients respectively. Obesity (body mass index > 30 kg/m2) was present in 47 (29.7%) patient. The CCSA(The Canadian Cardiovascular Society classification of angina) class II [35 (22.2%)] , Class III [102 (64.6%)] and Class IV was present in 21 (13.3%) patients respectively. NYHA CLASS (New York Heart Association)) Class I present in 6 (3.8%) patients, Class II in 117 (74.1%) patients, Class III in 29 (18.4%) and Class IV in 6 (3.8%) patients. Renal impairment (creatinin more than 2 mg/dl) was present in 9(5.7%) patients. Carotid bruit [2 (1.3%)], COPD [5 (3.2%)] and stroke was present in 5 (3.2%) patients respectively. Liver disease in 8 (5.1%) patients and history of tuberculosis was present in 3 (1.9%) patients while pre-operative myocardial infraction (MI) was present in 114 (72%) patients. Left ventricular function was normal (more than 60%) in 30 (19%) patents, moderate (30 to 60%) in 107(67.7%) patients and poor (less than 30%) in 21(13.3%) patients. Left main coronary artery lesion was present in 9(5.6%) of patients (Table 1).

Before observing the flow of IMA in 158 patients the heart rate was 83±17 per minutes, systolic blood pressure was 104±14 mm of Hg, diastolic blood pressure was 64±10 mm of Hg, mean arterial pressure was 76±12 mm of Hg, central venous pressure was 7±3 mm of Hg. The room temperature was also observed and found to be 31±5ºC at the time of first study. The blood volume expelled in 30 seconds was 11.6±9.7ml. The minimum was 0ml per 30 seconds to 63 ml within same period of time. About

Table 1: Preoperative Variables of Study Population (n=158)

Variables	Number of patients (n)	Percentage (%)
Age in years (Mean ± SD)	52 ± 8	
Male	129	81.6%
Female	29	18.4%
Diabetes mellitus	66	41.8%
Hypertension	116	73.4%
Obesity	47	29.7%
Renal impairment	9	5.7%
Liver disease	8	5.1%
Myocardial infraction	114	72%
COPD	5	3.2%
Stroke	5	3.2%
Tuberculosis	3	1.9%
Carotid bruit	2	1.3%
Left main involvement	9	5.6%

COPD: Chronic Obstructive Pulmonary Disease

forty (25%) patients have less than 5mls of blood expelled in 30 seconds, 5 to10mls per 30 seconds were present in 58 (37%) patients, 10 to 20 ml in 35 (22%) patients, 20 to 30mls in 17 (11%) patients and more than 30 ml in only 8(5%) patients (Table 2).

After checking the first free flow of IMA in 30ml syringe, the topical vasodilators applied for all IMAs.In 23 patients the second reading was checked just before putting the patient on by pass and in 17 patients it was not checked, because the patients dropped their blood pressure or ECG changes and needed to put on bypass on urgent basis. The effect of topical vasodilators in 15 patients did not showed any response to vasodilators. Only 8 patients showed significant improvement in their blood flow, with p value of 0.001(Figure 1).

IMA was used in most of the patient to LAD, only in thirteen patients (8.2%) where it was not used because its flow was very low (5±3ml per 30 seconds). About

Table 2: IMA Blood Flow in Study Population (n=158)

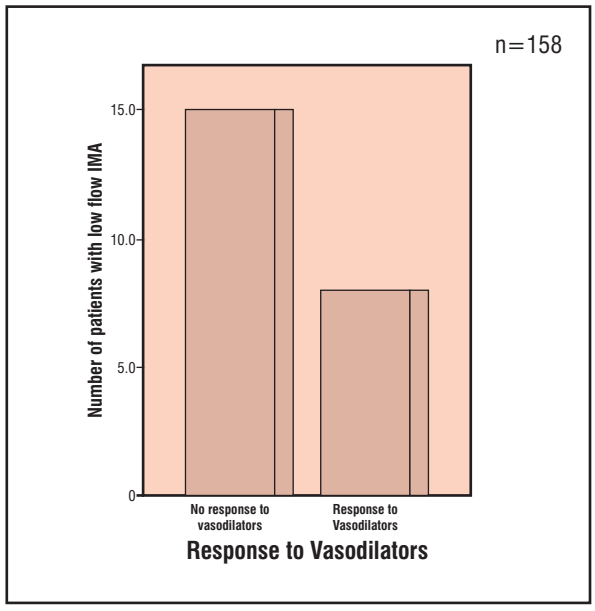
Variables	Number of patients (n)	Percentage (%)
IMA flow (mean ± SD)	11.6 ±9.7 ml	
<5 ml / 30 sec	40	25.%
5-10 ml /30 sec	58	37%
10-20ml / 30 sec	35	22%
20-30ml/30 sec	17	11%
>30ml/30 sec	8	5%

twenty seven IMAs with low flow initially gave response to topical vasodilators (3.3±1.2ml per 30 seconds improved to 10.4±4ml per 30 seconds) or at least had flow 10ml per 30 seconds at the time of anastomosis and was used for grafting to LAD.

The collected data showed that there was no significant difference in mean age, gender, smoking, hypertension, preoperative MI and renal impairment in patients with low flow IMA either to LAD or vein grafts use. Number of diabetic patients are more in LIMA as compared to LAD group Table 3.

Operative data in the patients who had very low flow IMA, reviled that, there was no significant difference in cardiopulmonary bypass time, aortic cross clamp time and number of grafts compared with all vein graft group. But despite the response to topical

Figure 1:
Low Flow IMA and its Response Topical Vasodilators



vasodilators, the low flow IMA group had significant higher number of patients with low cardiac output syndrome, needed more inotropic support, intra-aortic balloon pump and had atrial fibrillation compared to vein group Table 4. The post-operative data showed no significant difference in both groups in ICU stay, Intubation time and ward stay. One patient expired in LIMA to LAD group and two needed readmission with LAD group but there was no significant difference in both groups Table 4.

The overall mortality was 3.8% (6 out of 158). Low cardiac out-put syndrome developed in 10% (n=16),

Table: 3: Comparison of Low Flow IMA to for LAD or Only Vein Grafts

Variables	GSV used for LAD (n=13)	IMA used for LAD (n=27)	*P* value
Age (years)	54±8	52±7	NS
Female	4 (30%)	5 (18.5%)	NS
Smoker	7 (54%)	14 (52%)	NS
Diabetes mellitus	1 (8%)	11 (41%)	$p=0.001$
Hypertension	9 (69%)	17 (63%)	NS
Preop MI	9 (69%)	20 (74%)	NS
Renal impairment	0	0	NS

five (3%) patient needed intra-aortic balloon pump, 11 (7%) developed atrial fibrillation. Mean ICU stay was 2.3±.8 days, mean ward stay 4.±2.2 days and mean intubation time was 6±3.6 hours.About five (3%) patients were readmitted for different reasons, 6 (3.8%) needed reopening for bleeding, 4 (2.5%) developed chest wound infection. About three (1.9%) patient developed stroke after surgery, 2 (1.2%) developed post operative acute kidney injury which settle by conservative treatment. Endarterectomy was needed in 6 (3.8%) patients, while four patients needed to put urgently on bypass after harvesting the IMA because of the persistent low BP. About 2 patients needed chest tube insertion post operatively and needed to stay long in hospital, 3 patients developed mal-perfusion syndrome immediately after surgery and needed one extra vein graft to LAD only. One patient developed subclavin vein damage during harvesting IMA and rewiring of sternal wound.

Table: 4: Postoperative Data of study population

Variables	GSV used for LAD (n=13)	IMA used for LAD (n=27)	*P* value
CPB time in min	82±16	86±15	
AXC time in min	54±13	53±15	>0.05
No. of grafts	3.1±.6	3.2±.6	
Inotropic support	3	16	0.004
Low cardiac output syndrome	0	5	0.022
IABP used	0	2	0.028
ICU stay in days	2±.2	2.1±.4	
Ward stay in days	4.6±.4	4.3±.7	0.05
Intubation time in hours	5.9±1	5.6±2	
Atrial Fibrillation	0	3	0.007
Expired	0	1	
Readmission	1	2	>0.05

CBP: Cardiopulmonary bypass, AXC: Aortic cross clamp, IABP: Intra aortic balloon pump,

DISCUSSION

Left Internal mammary artery used for left anterior descending coronary artery is a routine part of elective coronary artery bypass grafting procedure due to its excellent long term patency. The excellent patency is related to the increased survival of CABG patients who have had a LIMA graft.[15] Several previous studies have evaluated the flow of IMA and the effect of vasodilator on it. Non of the studies looked for the effect of topical vasodilator on low flow IMA and its effect on outcome.

Many studies showed higher risk of coronary heart disease in South Asian population, but there, were not any difference in the out-come after CABG.[16-17] Caliber of coronary vessels has been shown in the studies which are smaller in south Asian populations but differences in caliber of IMA and its flow did not mention in any of the studies.[18]

Most of the international studies showed the mean blood flow in the IMA around 60ml/min.[19-21] In our study the IMA flow is low 11.6±9.7ml per 30 sec. which is less than half of the flow per minute compared to most of the international studies.

Low flow in IMA less than 5ml in 30 seconds were present in 40 patients. In this low flow group we used IMA in 27 patients and in rest of 13 patients, only vein graft was used for LAD. The findings showed, where we used IMA with low flow group the response of operation were not as good. In patient where IMA used

with low flow, there were significantly higher rate of IABP used (p=0.028), higher doses of inotropic drugs used (p=0.004), more number of low cardiac output syndrome (p=0.022) and more atrial fibrillations (p=.007). There were more deaths and more readmission after discharge where low flow IMA used but did not reached to significant levels.

The causes of low flow IMA are generally considered to be spasm or mechanical damage during surgical manipulation. The use of intraluminal maneuvers on low flow IMA results in intimal damage and ultimately results the string sign or late occlusion.[23] Although some recommend metallic cannula insertion, and balloon dilation to improve flow.[24] But most of the studies showed intimal damage as a result of such maneuvers and therefore, should be avoided.[25] Low flow IMA with pulsatile flow at the cut end is one of the marker, indicating without mechanical damage.[26,27] It is accepted generally that the flow in IMA when use for CABG should be more than 40 to 80 ml /min.[28,29] Another study recommended minimum flow of IMA must be 120ml/min for grafting.[24] Different world literature reported that the IMA is used only when the flow would be more than 20ml/min after relief of spasm.[30] Hata et al in their study showed the use of low flow IMA less than 20ml per one minute to LAD, without any early post-operative haemodynamic complications. They also showed better mid term results in their study.[23,26] In this study we found poorer response to topical vasodilators in very low flow IMA that is less than 10ml in one minute. Our study also showed the more complications were associated with low free flow IMA that is less than 10ml/min after harvesting. Our study also showed even the low free flow IMA give response to topical vasodilator, it is related with more haemodynamic instability immediately after operation. Therefore, should be use carefully.

CONCLUSIONS

Therefore, we concluded the low flow IMA should be used cautiously on LAD. Once we find the low flow IMA and it does not responds to topical vasodilator it may be better to use the Saphenous vein graft to LAD.If use of IMA is necessary by any mean in low flow case then early use of IABP, and other pharmacological support should be taken. Further study is warranted.

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