The European Research Journal

http://www.eurj.org

Original Article

e-ISSN: 2149-3189

DOI: 10.18621/eurj.2016.5000190033

Impact of previous percutaneous coronary intervention on postoperative outcomes of coronary artery bypass grafting

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ABSTRACT

Objectives. The widespread use of percutaneous coronary intervention (PCI) has resulted in an increasing number of patients who have undergone prior PCI being referred for coronary artery bypass graft grafting (CABG). The aim of this study was to determine the association between previous PCI and early and midterm outcomes after CABG. ***Methods.*** A total of 54 patients undergoing elective CABG (group 1) between January 2008 and January 2009 were compared to 46 patients who had a history of bare metal stent implantation before CABG (group 2). Mean follow-up was 12 months. ***Results.*** The average time interval to CABG following initial PCI was 18.5 months. There was no significant difference in demographic features and risk factors between the two groups (p>0.05). There were also no significant differences in intraoperative and postoperative data, and no significant differences for in-hospital mortality, cardiac mortality and total mortality and in the number of rehospitalizations for cardiac or for all-cause reasons (p>0.05). ***Conclusions.*** In this study, previous PCI did not significantly influence the outcomes of CABG in a 12-month follow-up period.

Eur Res J 2016;2(3):170-176

Keywords: Coronary artery bypass grafting; percutaneous coronary intervention; coronary artery disease; postoperative outcomes

Introduction

In the last 15 years, the number of percutaneous coronary intervention (PCI) has been continuously increasing [1]. Widely use of PCI has already caused that a great number of PCI-applied patients become part of the patient group to have coronary artery bypass grafting (CABG). Due to PCI failure (10-30% intra-stent stenosis) or the progression of disease, CABG has to be performed for patients who previously had PCI [2]. The relationship between CABG and previous PCI history is a subject that should be discussed. The results of the studies that compare the relationship between CABG and PCI are controversial. Some authors report that initial PCI may increase postoperative morbidity and mortality, others

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Received: April 21, 2016; Accepted: June 23, 2016; Published Online: August 09, 2016

report the opposite [2, 3].

The aim of this study was to examine short and medium term postoperative outcomes of patients who had successful PCI prior to CABG due to recurrent symptoms and to compare these results with those of patients who had undergone CABG alone.

Methods

A total of 100 patients were included in this retrospective study between January 2008 and January 2009 at Bursa Yuksek Ihtisas Training and Research Hospital. Patients were divided into two groups as to whether they had PCI history or not. Fifty-four patients having elective CABG were determined as control group (Group 1: 42 males,12 females, average of age 59.43±10.04) and 46 patients previously having PCI and then CABG were determined as study group (Group 2: 37 males, 9 females, average of age 56±9.50). Patients have been operated on consecutively. Patients having CABG history, patients requiring concomitant surgery, patients requiring emergency surgery, patients having renal dysfunction and patients whose ejection fraction (EF) was <30% were excluded from the study. Demographic characteristics, cardiac histories and perioperative data of patients were obtained from hospital records. Institutional Review Board approved the study protocol, and informed consent was obtained from each patient undergoing the surgical procedure described herein.

Preoperative Data Analyzed

1) Basic patient characteristics: Age, gender, New York Heart Association (NYHA) classification, EF. 2) Risk factors for ischemic heart disease: Diabetes mellitus (DM), hypertension (HT), hyperlipidemia (HL), obesity, smoking history. 3) Coexisting diseases: Recent myocardial infarction (MI), cerebrovascular disease, chronic obstructive pulmonary disease, peripheral arterial disease, renal failure history were questioned. 4) Euro SCORE was calculated. Previous coronary intervention type and time passing from PCI to CABG were determined for the study group.

Surgical Technique

In all patients, standard incision and median sternotomy were performed. Cardiopulmonary bypass (CPB) was applied by the cannulation of ascending aorta and right atrium appendix. Left internal mammary artery graft was anastomosed to left anterior descending coronary artery in all of the patients. During operation, moderate hypothermia (28°C-30°C) was applied. Roller pump and membrane oxygenators were used. Myocardial protection was achieved by antegrade cardioplegia by the cardioplegia cannula. It was ensured that pump flow was 2.2–2.4 l/min/m^2 and non-pulsatile and mean artery pressure remained at 50–60 mmHg level during cross clamp. Hematocrit was kept between 20-25% during CPB. After proper blood pressure and cardiovascular stability were ensured, CPB was ended. Patients were followed by taking into intensive care unit during postoperative period. Patients whose clinical course was normal were taken into service.

Intraoperative Evaluation

Aortic cross clamp time (minute), cardiopulmonary bypass time (minute), total number of veins bypassed, the veins bypassed, whether perioperative MI and arrhythmia were developed, whether there was an intra-aortic balloon pump (IABP) support or not, whether positive inotropic support was required or not were evaluated.

Postoperative Evaluation

Postoperative MI and arrhythmia, mechanic ventilation time (hour), total drainage amount (mL), duration of intensive care stay (day), duration of hospital stay (day), complication, re-hospitalization reasons and death were evaluated. All patients were followed during postoperative 12 months.

Statistical Analysis

When evaluating all data obtained from the study, SPSS 16.0 program was used. Data were given as mean±standard deviation. Data were statistically evaluated by Fisher's Exact Test, Pearson Chi Square Test and Independent Samples Test. $p<0.05$ value was accepted as statistically significant.

Results

Mean age of patients was 59.43±10.04 in group 1 and 56±9.50 in group 2. When considering the distribution by genders, female/male rate was 12/42 in group 1 and 9/32 in group 2 (Table 1). There is no significant difference between both groups with

Table 1. Patient characteristics

	Group 1 (n=54)	Group 2 (n=46)	*p*
Age	59.43±10.04	56±9.50	0.175
Female gender	12 (22%)	9 (20%)	0.745
DM	18 (33%)	15 (33%)	0.939
HT	28 (52%)	23 (50%)	0.854
HL	26 (48%)	19 (41%)	0.493
Obesity	18 (33%)	12 (26%)	0.431
Smoking	26(48%)	24(52%)	0.688
Previous TIA	3(6%)	2(4%)	1.000
COPD	5 (9%)	2 (4%)	0.447
PAD	6 (11%)	3 (7%)	0.501
Previous MI in 90 days	9 (17%)	12 (26%)	0.249
NYHA	2.22±0.46	2.41±0.50	0.050
EF%	48.17±9.62	46.78±9.93	0.481
Euro SCORE	2.65±1.96	2.52±1.97	0.750
Ventricle scoring	8.93±2.80	9.20±1.97	0.585

Data are shown as mean±standard deviation or number (%). Group 1=having elective CABG, Group 2=having previous PCI and then elective CABG, COPD=chronic obstructive pulmonary disease, DM=diabetes mellitus, EF=ejection fraction, HL=hyperlipidemia, HT=hypertension, MI=myocard infarction, NYHA=New York Heart Association, PAD=peripheral arterial disease, TIA=transient ischemic attack

regards to demographic characteristics and risk factors (p>0.05). Preoperative patient characteristics, coexisting diseases, mean NYHA, EF %, Euro SCORE and ventricular scoring values are shown (Table 1). The average time interval between stent implantation and CABG was 18.5 months (1 month-3 years) in group 2. In group 2, 22 patients had stenting of the LAD artery, 14 of the circumflex artery and 18 of the right coronary artery before the CABG. Three patients had stenting LAD and circumflex artery, 2 patients had stenting circumflex and right coronary artery, 2 patients had stenting LAD and right coronary artery and1 patient had stenting LAD, circumflex and right coronary artery before the CABG.

Considering the intraoperative patient data, although the number of distal anastomosis in the group having PCI was lower (3.00±0.87) and the cross clamp time and pump time were shorter (71.54±26.90 min. 90.91±29.56 min. respectively), it was seen that there was no statistically significant difference (p>0.05) (Table 2). All the patients in both groups had anastomoses to the LAD. 35 had anastomoses to the circumflex artery and 19 patients did not have anastomoses to the circumflex artery in group 1 while 32 had anastomoses to the circumflex artery and 14 patients did not have anastomoses to the circumflex artery and in group 2. All the patients in group 1 had anastomoses to the right coronary artery. Twenty-six had anastomoses to the right coronary artery, 20 patients did not have anastomoses to the right coronary artery in group 2. Inotrope was used for 9 patients in group 1 and for 10 patients in group 2, IABP was used for 7 patients in group 1 and for 5 patients in group 2. Twenty-four-hour drainage amounts were 424.53±233.21 cc in group 1 and 440.22±264.29 cc in group 2. While atrial fibrillation developed in 21 patients in group 1, it developed in 14 patients in group 2. Mean EF in control ECHO was 47.42±11.36% in group 1 and 45.09±10.42 % in group 2 (Table 3). When comparing both groups with regards to these

Table 2. Operative data

	Group 1	Group 2	*p*
Number of grafts	3.28±0.86	3.00±0.87	0.112
X klemp (minute)	79.31±27.71	71.54±26.90	0.160
CPB (minute)	98.80±32.61	90.91±29.56	0.212

Data are shown as mean±standard deviation. Group 1=having elective CABG, Group 2=having previous PCI and then elective CABG

Table 3. Postoperative data

	Group 1	Group 2	*p*
Inotropic agents	9 (17%)	10 (22%)	0.519
IABP	7 (13%)	5 (11%)	0.748
Bleeding (cc)	424.53±233.21	440.22±264.29	0.754
AF	21 (39%)	14 (30%)	0.377
EF % (Postop. 2. month)	47.42±11.36	45.09±10.42	0.303

Data are shown as mean±standard deviation or number (%). Group 1=having elective CABG, Group 2=having previous PCI and then elective CABG, AF=atrial fibrillation, EF=ejection fraction, IABP=intra-aortic balloon pump, Postop=postoperative

data, it was seen that there was no statistically significant difference ($p>0.05$).

In both groups, it was seen that there was no significant difference in intra-hospital mortality, cardiac related mortality and total mortality ($p>0.05$). In both groups, there was 1 intra-hospital mortality (2%). Cardiac related mortality was 2 patients (4%) in group 1 and 3 patients (7%) in group 2. Cardiac related deaths were the ones occurred due to MI, cardiac arrhythmia, resistant low cardiac output. Total mortality was 3 patients (6%) in group 1 and 4 patients (9%) in group 2 (Table 4).

Cardiac related hospitalization and total hospitalization rates in postoperative 1st month were 1/2 in group 1 and 1/2 in group 2. At the end of 1 year which was the follow-up time, cardiac related hospitalization and total hospitalization rate were 2/5 in group 1 and 3/6 in group 2 (Table 5). When comparing both groups, it was seen that there was no statistically significant difference between these data ($p>0.05$).

Discussion

Nowadays, the number of cases undergoing to CABG increased in parallel with the increase in frequency of ischemic CAD and evolution of PCI treatment. Therefore, many patients already having PCI become a part of cardiac surgery. Restenosis is the main restrictor of PCI. In the treatment of cases in which post-stent restenosis develops, re-stent, drug eluting stent, brachytherapy, cutting balloon, coronary bypass surgery are the main ones of preferred methods. In the studies, post-stent revascularization rates were reported as 14-30%. While 22% of these

Table 4. Mortality data

	Group 1	Group 2	*p*
In-hospital mortality	1 (2%)	1 (2%)	1.000
Cardiac mortality in 1 year	2 (4%)	3 (7%)	0.659
Total mortality in 1 year	3 (6%)	4 (9%)	0.700

Data are shown as number (%). Group 1=having elective CABG, Group 2=having previous PCI and then elective CABG

Table 5. Rehospitalization data

	Group 1	Group 2	*p*
Cardiac reasons			
Postop. 1. month	1 (2%)	1 (2%)	1.000
Postop. 1. year	2 (4%)	3 (7%)	0.659
All reasons			
Postop 1. month	2 (4%)	2 (5%)	1.000
Post. 1. year	5 (10%)	6 (14%)	0.538

Data are shown as number (%). Group 1=having elective CABG, Group 2=having previous PCI and then elective CABG, Postop=postoperative

patients are referred to CABG, 78% of whom have recurrent PCI [4, 5]. Most of these interventions are generally applied to the same coronary artery. Studies made on bare metal stents (BMS) have showed that CABG is applied to 6-13% of patients within 1 year after PCI and to 13-26% of patients within 10 years [6]. There is an increasing tendency to CABG in case of failure of PCI in early period or for patients in whom PCI is inadequate in long period. Post-PCI CABG is applied for about 12 months [7]. In our study, post-PCI CABG was applied average of 18.5 months.

There are publications reporting the poor results after non-cardiac surgery following PCI [7]. Moreover, there are studies on the fact that PCI affects adversely the results in recurrent PCIs [9]. Considering the post-PCI bypass results, there are lots of mechanisms affecting the results of post-PCI CABG. These mechanisms include; 1) PCI may limit the number of bypass. If stent is placed to distal in patients having occluded stent, it is technically difficult to place graft to distal. Moreover, graft is not placed to the veins having patent stent if there is not a stenosis in stent distal; because graft patency rates, especially arterial ones reduce for lack of significant stenosis. However, veins left only with patent stent without placing the graft may cause postoperative MI due to postoperative pro-thrombotic case and perioperative stopping of antiplatelet treatment. 2) Also PCI affects the patency rates of previous grafts. The first one in-stent restenosis was associated with early venous graft failure [10]. The second one stent presence causes the placement of grafts to more distal. Due to stents which are adjacent or overlapping, coronary obstruction or occlusion occurs, this affects the coronary run-off and bypass graft patency and endangers collateral blood flow. It is not possible to displace the stent intraoperatively and the graft anastomosis has to be made to thinner distal part of target vein and the run-off and patency rate are affected adversely. 3) Drug-eluting stents (DES) generally affect coronary endothelial function [11]. Although it is well-known that DESs cause endothelial dysfunction, it is likely that BMSs endanger endothelial function with changes in inflammation and coagulation status. Pathophysiological response to intravascular foreign body may affect adversely the results after surgery. 4) Patients having post-PCI CABG form the patient group having more aggressive atherosclerosis [12]. In fact, as the reason of poor results of post-stent surgery, it is discussed that this is not caused by previous stent application but by more aggressive course of atherosclerotic disease in patients requiring an intervention again [10].

There are many studies showing the poor results. Massoudy *et al.* [13] examined the results of 29,928 patients underwent CABG in a multicenter analysis. They compared 3 group patients (no PCI, having one PCI and having two or more PCI) with regard to intra-hospital mortality and intra-hospital major cardiac event (MCE) (MI, low cardiac output syndrome, cardiac death). In their conclusion, it was found that single PCI application did not affect the results, but multiple PCI history increased intra-hospital mortality and MCE incidence following the CABG. In our study, single stent was applied to 40 (87%) patients and 2 and more stents were applied to 6 (13%) patients. It was found that there was no statistically significant difference between them with regards to mortality and major cardiac event. Tran *et al.* [14] compared 1,537 patients having diabetes and not having PCI before CABG and 221 patients having PCI with regards to surgical and major perioperative complications. In their conclusion, patients having DM and having PCI during 2-year follow-up were found as having increased risk for operative death, perioperative complications. Likewise, Bonaros *et al.* [15] compared 306 patients having elective PCI in recent 24 months before CABG and 452 patients not having elective PCI with regards to 30-day mortality, MCE and perioperative complications. They reported that patients having PCI had poorer results than those not having PCI. Hassan *et al.* [16] compared the CABG results of 919 patients having PCI and 5,113 patients not having. Although there was less serious CAD and less comorbidity in the group having PCI, it was defined that previous PCI was an independent risk factor on hospital mortality. In our study, intra-hospital mortality was similar (2%) in both groups.

Thielman *et al.* [17, 18] have two publications on this subject. In the first publication, they compared the results of 2,626 patient firstly having CABG but not having PCI, 360 patients having PCI for once and 289 patients having multiple PCI. In the other study, they compared 621 patients having diabetes and three vascular diseases with 128 patients. In both studies, they found that PCI applied before CABG in patients increased independently intra-hospital deaths and MCE [17, 18]. Some of the authors also reported that CABG patients with previous stent implantation have a poorer quality of life and a higher rate of unstable angina and re-intervention compared to the patients

underwent CABG only [19, 20].

Mannacio *et al.* [21] grouped and examined 7,855 patients and reported that previous PCI increased operation mortality and perioperative complications and reduced survival during 5-year follow-up. Songur *et al.* [22] reported that prior PCI can adversely affect graft patency after surgery.

In a study on 162 patients having PCI and 149 patients not having PCI, Gaszewska-Zurek *et al.* [23] reported that previous PCI did not significantly affect the CABG results but angina-related symptoms were observed frequently in patients having PCI during 3-year follow-up.

Velicki *et al.* [24] examined 950 patients during 18-month period and published that PCI did not affect the morbidity and mortality in low risk group. Additionally, in a multicenter comprehensive study in which medium term results of more than 13,000 patients were researched, Yap *et al.* [25] followed 11,727 patients not having PCI and 1,457 patients having PCI during 3.3±2.1 years on average. In their conclusion, it was reported that previous PCI did not increase short and medium term post-CABG mortality and good results could be obtained in this patient population.

In a study in which Barakate *et al.* [2] compared 361 patients having PCI and 11,909 patients not having PCI and in a study in which Judith *et al.* [26] compared 113 patients having PCI and 1,141 patients having isolated CABG, successful PCI did not affect the post-CABG results negatively. In the first meta-analysis made by Ueki *et al.* [27] in which 174,777 patients and 23 comparative studies were examined, it was shown that PCI increased intra-hospital mortality.

There is no current information on the reason why PCI increases the risk of CABG. There is a possibility that stent implantation causes a prolonged inflammatory response [28] and it adversely affects the anastomosis site of the graft. New types of stents (Polymer-coated drug eluting stents and nitric oxide-coated bioactive stents) are developed for preventing neo-intimal hyperplasia and reducing the rates of restenosis. Studies about efficacy and effectivity of nitric oxide-coated bioactive stents are still ongoing [29].

In our study, there was BMS use in all our patients. Even if poor results were published in post-stent CABG, this negative effect of stent on short and medium term surgery results could be not shown in our study.

The Limitations of the Study

The retrospective nature and low number of patients in our study are its most important limitations. However, these results may result from our patient selection. Event free surgical results may be correlated with low Euro SCORE of patients included in the study (about 2.5). This study is also a study including patients preferring the stent type only as BMS. Our results may be affected by our treatment methods. It is a single-centered study in which patient number is low in a selected patient group having post-PCI CABG. Therefore, the results cannot be generalized. It examined the operations and results made by different surgeon groups. This complicates the standardization. Our patients were followed during 12 months; therefore we have no available data for the following periods. We have no sufficient data on the number of patients who died after PCI and so could not have CABG. Multicenter studies especially with DESs are required in order to confirm the short and long term effects of pre-CABG PCI.

Conclusions

In our study, we showed that PCI was not a predictor for mortality or MCE and did not affect adversely survival in 12-month follow-up. It was found that there was no correlation between previous PCI and mortality. It was also found that there was no statistically significant different between both groups with regards to short and long term re-hospitalization and postoperative major complications. If recurrent angina develops in patients having successful PCI, CABG is a good choice.

Conflict of interest

The authors disclosed no conflict of interest during the preparation or publication of this manuscript.

Financing

The authors disclosed that they did not receive any grant during conduction or writing of this study.

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