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THE EARLY PATENCY AND SURVIVAL RATE OF CORONARY GRAFTS IN ON-PUMP VS OFF-PUMP CABG

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ABSTRACT:

BACKGROUND: *A large number of patients with coronary artery disease (CAD) undergo surgical cardiopulmonary bypass [on-pump coronary artery bypass (ONCAB) or off-pump coronary artery bypass (OPCAB)]. Since two techniques have been commenced, the doubt of which one is more convincing and efficacious has always been discussed and is still controversial.*

AIMS & OBJECTIVE: *The purpose of this study was to determine the early patency and survival rate of coronary grafts after CABG in On-Pump vs Off-pump groups.*

MATERIAL & METHODS: *This retrospective cross sectional study was conducted in the Cardiac surgery department of Punjab Institute of Cardiology, Lahore in year 2020 using the data of previous surgeries done from 01-01-2009 to 01-03-2010 (14 months). Total 792 patients fulfilling inclusion criteria were included. The data consisted of two groups Group-A ONCAB (341) and Group B OPCAB (451), with total number of grafts (2333). Out of 792 patients only 315 were followed up the same year and in 2020, 135 were followed up for survival rate. The sampling technique used in this study was non probability sampling.*

RESULTS: *The mean age of the patients in Group A was 56.13 ±9.305 years and in Group B was 53.9 ± 9.382 years. In 315 followed up patients the number of grafts applied were 949. The mean number of grafts applied in Group A was 3.11±0.949 and in Group B was 2.95±0.959. There was no statistically significant difference seen between these groups. Out of 949 grafts 795 were patent from which 410 were applied in group A and 385 were applied in group B. 154 grafts were blocked out of which 67 were in group A and 87 were in group B. After 10 years, only 135 were followed for survival rate, out of which 22.22% had angioplasty done, 51.85% reported events of shortness of breath, 13.33% had another attack of myocardial infarction, 30.37% had angiography done and mortality rate was 14.07%. There were 85.4% patients still alive in Group A and 86.8% in Group B. The overall survival rate is 85.9%.*

CONCLUSION: *In overall comparison there is no significant difference in patency and occlusion rate. However, the survival rate is 85.9%. So we can say both groups are equally safe and no procedure is preferred over another, entailing an identical caliber of anastomosis.*

KEY WORDS: *Off-pump CABG, On-Pump CABG, Patent and Blocked grafts.*

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INTRODUCTION:

Yearly, a large number of patients with coronary artery disease (CAD) encounter surgical cardiopulmonary bypass (on-pump coronary artery bypass [ONCAB]) or off-pump coronary artery bypass [OPCAB]). Since the two techniques have been commenced, the doubt of which one is more convincing and efficacious has always been discussed and is still controversial. CABG yields outstanding results in the management of coronary artery disease; its long-term sequel is influenced by the non-fulfillment of the grafts. OPCAB is considered superior to ONCAB in selected cases (COPD, calcified aorta, severe renal impairment) because cardiopulmonary bypass, aortic cannulation and clamping is avoided; however, clinical trials and studies have reported that the former is inferior in terms of graft patency rate and number of distal anastomoses (incomplete revascularization).[1]

Short-term results are affected by early graft occlusions (before hospital discharge), they usually appear in 8 to 12 % of venous grafts. Early detection of acute graft blockage and rectification of the causative factors have a positive impact on CABG results.[2]

Off-pump surgery is more difficult, according to surgeons. Off-pump patients may have reduced graft patency due to several discrepancies between off-pump and on-pump surgery. On-pump surgery provides a bloodless, immobile field in which anastomoses has to perform, whereas OPCAB surgery is more technically complex. In addition, cardiopulmonary bypass causes hemodilution and platelet dysfunction, individuals who undergo OPCAB surgery may develop a hypercoagulable state. [3-5]

MATERIAL AND METHODS:

This retrospective study was carried out in cardiac surgery department of Punjab Institute of Cardiology, Lahore in year 2020 using the data of previously done surgeries from 01-01-2009 to 01-03-2010 (14 months). The study enrolled 792 patients fulfilling inclusion criteria. Preoperatively consent was taken. Demographic information (like name, age, sex, height, weight, address) was obtained. Mean ± SD was calculated for quantitative variables. Frequencies and percentages were given for qualitative variables. The data was consisted of two groups Group A ONCAB (341) and Group B OPCAB (451), total number of grafts (2333). Patients with symptomatic multi vessels coronary artery disease (each vessel has stenosis >50%), patients with stable angina and patients with preserved ventricular function were included in the study. Patients undergoing redo CABG, undergoing emergency CABG, ejection fraction <40% and unable to provide informed consent were excluded from the study. Follow-up graft study was done to see the patency of grafts. Data was entered in SPSS version 22. A p-value of ≤0.05 was considered significant.

Operational definition of graft patency:

The angiographic patency of the distal anastomoses was graded as:

1. Full patent graft with good antegrade flow.
2. Patent but with compromised flow.
3. Blocked / occluded.

Anastomotic stenosis was recorded. The "slender sign," which is defined as graft flow failure due to superior native artery flow, is often seen. The slender sign is indicated by quick dilution of the contrast media as it exits the graft and considerable retrograde graft filling following contrast agent injection into the native coronary artery. Reduced flow and the thin sign[6], as well as anastomotic stenosis of the graft, were coded in statistical analyses only when both readers approved.

RESULTS:

There was significant difference regarding demographic characteristics between two groups including age (p=0.002) and weight (p=0.049). The length of ICU stay was also significant (p=0.001).(Table-1)

Regarding immediate postoperative complications reopening occurred in 3(0.9) patients in group A and 7(1.5) patients in group B, pulmonary complications occurred in 24 (7.03) patients in group A and in 22 (4.87) patients in Group B, mortality occurred in 16(4.6%) patients in group A and 14(3.1)patients in Group B. the p-values of reopening, pulmonary complications and mortality were insignificant whereas p-values of AMI (0.011) Arrhythmia (0.008) and Renal Failure(0.026) were significant showing difference in complications between Group A and Group B. (Table-1)

Vessel Distribution: The comparison of vessel distribution in Group A N (%) for double vessel was 68(19.94%), triple vessel 146 (42.81%), four vessels 91 (26.68%) and for five vessels 22 (6.4%). In Group B N% for double vessel was 140 (31.04%), triple vessel 170 (37.69%), four vessels 97 (21.50%) and for five vessels 11 (2.4%). The p-values of triple (0.1451) and four vessels (0.089) were significant.

Pre and post op Ejection Fraction (EF): In group-A, the mean of pre op EF was 47.52±1.12%

and of post op EF was 47.85±1.02% with p-value (0.739). Similarly, for group B the mean of pre-op EF was 46.27±1.26% and of post op EF 47.09±1.30% with p-value (0.386). Hence there was no difference in both groups.

Number of Grafts: The total number of grafts applied in both groups was 2333. The mean number of pre op graft assessment showed grafts required for group A was 3.30 ±0.918 and for group B 3.29±0.94 with an insignificant p-value (0.881) and mean number of per op graft applied in Group A was 3.11±0.949 and in Group B was 2.95±0.959. There was a significant difference between the groups with p-value (0.019).

Table 2 shows from the total of 2333 grafts in Group A 341 were anastomosed to LAD, 116 to D1, 13 to D2, 48 to R1, 209 to OM1, 48 to OM2, 33 to CX, 8 to PLV, 76 to PDA and 72 to RCA. In Group B 451 grafts were anastomosed to LAD, 132 to D1, 20 to D2, 73 to R1, 227 to OM1, 46 to OM2, 26 to CX, 10 to PLV, 92 to PDA and 192 to RCA. The p values of D1(0.1579), D2(0.6748), R1(0.4162), OM2(0.1349), PLV (0.9250) and PDA (0.5173) were insignificant, showing no difference between group A and B.

Follow Up: During our study out of 792 patients only 315 were followed up for early graft patency. Out of which 153 belonged to group A and 162 belonged to group B. The total number of grafts applied for these 315 patients were 949.

Patent grafts: Out of 949 grafts,795 were patent in which 410 were applied in group A and 385 were applied in group B.

Blocked grafts: Out of 949 grafts 154 were blocked in which 67 were in group A and 87 were in group B as shown below in Table 3.

Table 3 shows that p-value of OM2(0.021) for patent grafts is significant in both Groups for blocked grafts the p values of OM1(0.021) and RI (0.004) are significant while all other values are insignificant.

Survival Rate after 10 years: Out of 315 patients only 135 were followed up for survival rate after 10 years. Out of which 22.22% had angioplasty done, 51.85% reported events of shortness of breath, 13.33% had another attack of myocardial infarction, 30.37% had angiography done and 14.07% died. (Table-4)

Table 1: Comparison of demographic variables and operational outcomes between Group A and Group B.

Variables	GROUP-A (ON-PUMP) Mean ± S.D	GROUP-B (OFF-PUMP) Mean ± S.D	P value
N	341	451	
Age	56.13± 9.305	53.9 ± 9.382	0.002
Height	165.64±13.07	166.46± 11.057	0.317
Weight	73.86±12.573	75.64 ± 11.176	0.049
Hemoglobin	13.82± 8.818	14.91 ± 15.366	0.254
Creatinine	1.01 ± 0.441	1.05 ± 0.636	0.339
Blood Sugar	135.75±67.67	136.35 ± 57.67	0.901
ICU Stay	5.15 ± 3.409	4.32 ±2.01	0.001
Hospital stay	12.73 ± 0.42	11.84 ±0.33	0.887
Post-Op complications	N (%)	N (%)	
Reopening	3 (0.9)	7 (1.5)	0.224
Mortality	16 (4.6)	14 (3.1)	0.271
Respiratory	24(7.03)	22 (4.87)	0.197
Neurological	3(1.5)	0(0.00)	>0.05
AMI	11(4.18)	19(8.71)	0.011
Arrhythmia	33(9.67)	22(4.85)	0.008
Renal Failure	39(11.4)	19(4.19)	0.026

Table 2: Graft Distribution			
Variable	**Group A N (%) 341**	**Group B N (%) 451**	**p-value**
LAD	**341 (100)**	**451 (100)**	**----**
D1	**116 (34.0)**	**132 (29.3)**	**0.1579**
D2	**13 (3.8)**	**20 (4.4)**	**0.6748**
RI	**48 (14.1)**	**73 (16.2)**	**0.4162**
OM1	**209 (59.8)**	**227 (48.8)**	**0.0021***
OM2	**48 (14.1)**	**46 (10.6)**	**0.1349**
CX	**33 (9.7)**	**26 (5.8)**	**0.0388***
PLV	**8 (2.3)**	**10 (2.2)**	**0.9250**
PDA	**76 (22.3)**	**92 (20.4)**	**0.5173**
RCA	**172 (50.4)**	**192 (42.6)**	**0.0290***

Table 3: Comparison of patent and blocked grafts in group A and B; N (315)						
	Patent grafts			**Blocked grafts**		
VESSEL	**Group-A (153) N (%)**	**Group-B (162) N (%)**	**p-value**	**Group-A (153) N (%)**	**Group-B (162) N (%)**	**p-value**
	410	**385**		**67**	**87**	
LAD	146 (95.4)	154 (95.1)	0.900	7 (4.6)	8 (4.9)	0.900
D1	40 (26.1)	33 (20.4)	0.230	16 (10.5)	19 (11.7)	0.734
D2	2 (1.3)	4 (2.5)	0.437	2 (1.3)	1 (0.6)	0.519
RCA	74 (48.4)	62 (38.3)	0.070	10 (6.5)	19 (11.7)	0.070
OM1	73 (47.7)	72 (44.4)	0.557	20 (13.1)	9 (5.6)	0.021*
OM2	20 (13.1)	9 (5.6)	0.021*	5 (3.3)	6 (3.7)	0.847
Distal LCx	9 (5.9)	10 (6.2)	0.911	1 (0.7)	3 (1.9)	0.350
PDA	24 (15.7)	21 (13.0)	0.494	4 (2.6)	10 (6.2)	0.050
PLV	3 (2.0)	3 (1.9)	0.948	1 (0.7)	1 (0.6)	0.912
RI	19 (12.4)	17 (10.5)	0.596	1 (0.7)	11 (6.8)	0.004*

Table 4: Factors affecting mortality after 10 years of follow up	
Factors affecting mortality	**Frequency %**
Angioplasty	30 (22.22%)
Shortness of breath	70(51.85%)
Post CABG MI	18(13.33%)
Need for angiography	41(30.37%)
Mortality	19(14.07%)

DISCUSSION:

According to the findings, OPCAB is a suitable approach for coronary artery revascularization, particularly in the case of multiple vessel dysfunction. Because anastomosis in ONCAB is performed on an arrested heart, some degree of cardiac ischemia is unavoidable.[7]

Many studies found no difference in the mortality between both groups. In a study conducted by Houlind et al 2014 in Six months after surgery, mortality was 21 (4.7%) in the ONCAB group and 19 (4.2%) in the OPCAB group.[8] In another study by Angelini et al 2009, 28 patients died in the OPCAB group (14%) and 24 in the ONCAB group (12%).[9] Similarly, in our study the mortality rate was 16 (4.6%) and 14(3.1%) in ONCAB and

OPCAB respectively.

Acute renal failure was the most frequent complication, with an occurrence rate of 9% in the total population: in ONCAB it was almost double that in OPCAB patients. Kumada et al 2017 reported 10.2% vs 5.5% respectively with a p-value 0.21.[10] In CORONARY trial by Daniel Fudulu et al 2016 respiratory complications in ONCAB vs OPCAB occurred in 7.5% vs 5.9% with a p-value 0.03.[11] In another study by John D. Puskas, 2004, Chronic obstructive pulmonary disease occurred in 17.2% vs 9.2%.[12] Hussain.G reported pulmonary complications in 4.7% patients in ONCAB group and in 2.7% in OPCAB group with a p-value 0.36. [13] Similarly, in our study respiratory complications occurred in 7.03% vs 4.87% respectively with p-value 0.197 as p value >0.05 so we can say that there is no difference in post-op pulmonary complications between the both groups.

Cerebrovascular stroke is one of a major complication after coronary artery bypass grafting that enhances mortality, morbidity and cost.[14] Neurologic complications were a bit high in on-pump CABG group but this difference was not statistically significant, Hussain G reported stroke in 0.7% patients in ONCAB and 0.0% in OPCAB with p-value 0.62.[13] In a study by Tatsuya Seki 2017, Stroke occurred in 5% patients of ONCAB group and 0% patients of OPCAB group with a p-value of 0.08.[7] Similarly in our study stroke occurred in 1.5% vs 0% patients of ONCAB vs OPCAB with an insignificant p-value.

In a study by Daniel Fudulu et al 2016 Renal failure in ONCAB vs OPCAB occurred in 32.1%vs 28.0%, with p-value 0.01. [11] In another study by John D. Puskas, 2004 renal failure occurred in 2.0% vs 1.0%.[12] Similarly, in our study renal failure occurred in 11.4% vs 4.19% respectively with a p-value 0.026.

Reoperation due to bleeding or sepsis is a common complication. In a study by Daniel Fudulu et al 2016 reoperation occurred in 2.4% vs 1.4%. with p-value 0.02.[11] John D. Puskas, 2004 reported reoperation in 2.0% vs 1.0. [12] In a study by Tatsuya Seki 2017 reoperation for bleeding occurred in 2% patients in ONCAB and 2% in OPCAB group with a p-value 1.00.[7] Similarly, in our study patients who underwent reoperation were 0.9% vs 1.5% in ONCAB vs OPCAB with a p-value 0.224.

Studies showed high rates of ICU stay in ONCAB vs OPCAB Groups. According to Kumada al 2017 the length of ICU stay was 2.7±8 vs 1.4±0.8 days respectively.[10] Similarly, in our study the length of ICU stay was 5.15±3.409 vs 4.32±2.01 days respectively.

In a propensity score matched study, there was no significant difference in graft patency rates between the ONCAB and the OPCAB groups observed. Second, there was no difference between the two groups in terms of the number of distal anastomosis. With a p-value of 0.21, the OPCAB group had a lower all-graft patency rate (72.6%) than the ONCAB group (45.2%), but this difference was not significant.[7] In Early graft patency was assessed by angiography within 3 weeks of the operation in the JOCRI experiment. The average number of grafts performed per patient was 3.5 ± 1.0 for OPCAB and 3.6 ± 0.9 for ONCAB, with no differences in early patency rates. The off-pump group had somewhat inferior early graft patency without stenosis (93%) than the on-pump group (96%) (P-0.093).[15] Puskas et al discovered that off-pump and on-pump coronary artery bypass grafting were associated to virtually equivalent early and late graft patency, as well as a similar number of grafts per patient (3.39 OPCAB versus 3.40 ONCAB). Graft patency was similar in both groups (76 % OPCAB vs. 83.5 % ONCAB; p = 0.44). [16]

Similarly, in our study the numbers of grafts applied were3.31±0.91 for ONCAB vs 3.25±0.96 for OPCAB per patient. The patency rate was 51.57% and 48.43% in ONCAB vs OPCAB group with a p-value of 0.516 this difference was not statistically significant so it can be neglected. In some randomized controlled trials at a single center and with a single experienced surgeon. [16-18] A significant difference between ONCAB and OPCAB was not seen. Likewise, in our study surgeons experience provide no difference in both groups in terms of post-op complications and graft patency.

In a retrospective study from the Feiring Heart Clinic database of survival followed up to 16 years, the analysis demonstrated a consistent and highly significant results in favor of CABG with almost equal survival rates in the two treatment strategies after that time period[19]. Similar results were seen in our study showing no difference of survival rates in both groups, i.e., 85.4% in On-Pump and 86.8% in off-pump.

CONCLUSION:

In overall comparison there is no significant difference in patency and occlusion rate. However, the survival rate is 85.9%. So we can say both groups are equally safe and no procedure is

preferred over another, entailing an identical caliber of anastomosis. However, further research is recommended in future.

Limitation: It was a retrospective study that relied on observational data from a single institution. Throughout the trial, we did not account for differences in surgical expertise. It is a significant aspect since surgeon preferences influenced the decision to conduct off-pump versus on-pump CABG.

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