

A retrospective observational study of risk factors, angiographic patterns, short-term mortality and their correlations between on-pump and off-pump coronary artery bypass surgery

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Abstract

Objective: The decision to perform on-pump or off-pump coronary bypass surgery (CABG) depends on various parameters such as myocardial contractility, thickness of the myocardium and overall surgeon preference. There are very few studies analyzing the same. Hence, the aim of the study is to investigate the distribution of different risk factors, angiographic patterns and short-term mortality in patients undergoing between on-pump CABG and off-pump CABG groups and compare short-term outcomes among different subgroups of patients with coronary artery disease.

Methods: The present study is a retrospective observational study with data from August 2016 to December 2021 undertaken in government general hospital Kurnool, India. A total of 108 patients were taken of whom 36 constituted on-pump CABG group and 72 – off-pump CABG group, were present eligible as per inclusion criteria and exclusion criteria. The data considered includes the age, risk factors, echocardiographic reports, angiographic data, surgery details and post-surgery status.

Results: The mean age of patients was 56.21 (10.2) years with maximum age of 85 years and minimum age of 35 years. The distribution of population by sex: male - 90 (83.3%) and female - 18 (16.7%). The smoking as a risk factor was found in 60 (55.6%) patients, alcohol - 36 (33.3%) patients, diabetes - 28 (25.9%) patients, and hypertension - 19 (17.6%) patients. Some of them have more than one risk factor. The mean ejection fraction (EF) of the patients was 43.66 (6.2%) with the highest EF noted 63% and lowest 30%. The patients with single-vessel disease were 26 (24.1%), double-vessel disease - 35 (32.4%), triple vessel disease - 47 (43.5%). Of all patients, 36 undergone on pump CABG of whom 12 patients (33.3%) died and 72 patients undergone off pump CABG, of whom 6 (8.3%) succumbed after the surgery ($p < 0.05$).

Conclusion: The on-pump group had significantly more often mortality rate than off-pump group. Increasing age group above 60 years, reduced EF, involvement of left main coronary artery, smoking and alcoholism were associated with morbidity and mortality in on-pump CABG than off-pump CABG.

Key words: surgical procedures, coronary bypass surgery, on-pump, off-pump, coronary artery disease, risk factors, mortality

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Introduction

Coronary artery bypass graft surgery (CABG) has become recognized as one of the principle therapies to prolong survival and improve the quality of life of patients suffering from coronary artery disease (CAD) (1).

There are two basic ways of performing CABG: on-pump CABG and off-pump CABG. They both begin with the surgeon harvesting blood vessels from the leg, chest, or the arm and gaining access to the heart using midline sternotomy.

In on-pump CABG, the heart is stopped with the body's blood supply being maintained by the cardiopulmonary bypass (CPB) machine. While the heart is stopped the surgeon performs the graft procedure by sewing one end of a section

of a blood vessel over a tiny opening made in the aorta and the other end over a tiny opening made in the blocked coronary vessel, distal to its blockage. With the grafting complete, the body is removed from the cardiopulmonary bypass machine and the heart is restarted (1).

In off-pump CABG, the area around the stenosed coronary artery is stabilized while the surgeon grafts the blood vessel on the pumping heart. Off-pump CABG is relatively a newer procedure to on-pump CABG and doesn't require the use of the CPB (1).

Many studies, observational and randomized controlled trials (RCTs) alike, have compared outcomes after off- and on pump CABG, with results ranging from equivalent outcomes to favoring off-pump or on-pump CABG (2-4).

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Though data on mortality is still controversial (4-7). The present study is an effort to investigate the distribution of different risk factors, angiographic patterns and short-term mortality in patients undergoing on-pump CABG and off-pump CABG groups and compare short-term outcomes among different subgroups of patients with coronary artery disease.

Methods

Study design and population

The present study is a retrospective observational study undertaken in government general hospital Kurnool, India. This retrospective study was conducted by case record selection of cases admitted between August 2016 to December 2021. A total of 108 patients were present eligible as per inclusion criteria and exclusion criteria.

Inclusion criteria were: age >20 years, patients with angiographically established coronary artery disease (CAD) with or without reduced ejection fraction (EF). Exclusion criteria were as following: age < 20 years, pregnant women, mentally incompetent person, previous CAD with history of CABG.

Of 108 patients, 36 were assigned to the on-pump CABG group and 72 patients constituted the off-pump CABG group.

The informed consent of patients was taken before all procedures and institutional Ethics committee clearance was sought.

Data collection

The data considered includes the age, sex, risk factors of CAD, echocardiographic and angiographic data, peri- and intraoperative data, post-surgery status, and short-term mortality.

From the analysis, the choice for on-pump and off-pump CABG in the study population was based on:

1. Low EF
2. Surgeon preference
3. Patient preference
4. Target vessel less than 1.25 mm in calibre
5. Diffuse coronary plaque
6. Associated ischemic mitral regurgitation

Statistical analysis

Data were analyzed using statistical package SPSS (IBM, New York, USA). The difference between categorical variables was assessed using Chi-square test. A p value <0.05 was considered as significant.

Results

The study included total 108 patients undergone CABG. Overall, 36 (33.3%) patients underwent on-pump CABG surgery and 72 (66.7%) - off-pump CABG. The mean age of patients was 56.21 (10.2) years with maximum age of 85 years and minimum age of 35 years. The male population constituted 83.3% and female - 16.7%.

Smoking as risk factor was recorded in 55.6%, alcohol - 33.3%, diabetes - 25.9% and hypertension - 17.6%, with smoking being as more frequently encountered risk factor in our study population.

There were 26 (24.1%) patients with single-vessel disease, 35 (32.4%) - double-vessel disease, and 47 (43.5%) - triple-vessel disease.

Ejection fraction

The mean EF of the patients were 43.66 (6.2)% with the greatest value of 63% and the lowest of 30%. Most of patients (98) had EF lower than 50% (Fig. 1).

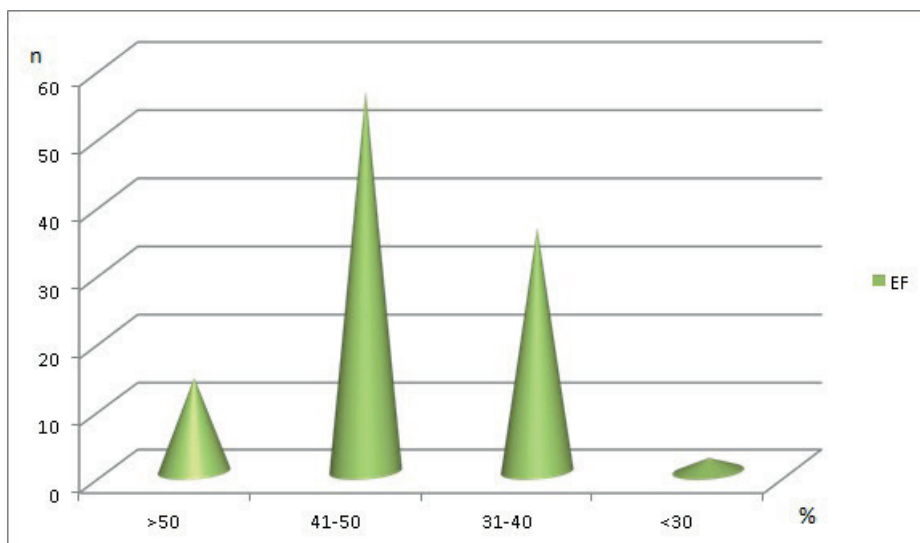


Figure 1. Distribution of patients by ejection fraction subgroups

Mortality

Of the 36 patients who underwent on-pump CABG -12 patients (33.3%) died and of the 72 patients who underwent off- pump CABG 6 (8.3%) patients died ($p<0.05$) (Fig. 2).

Among patients with EF< 30% - 1(50%) patient in on-pump CABG group died. Among patients with EF 31-40% - 6(16.6%) patients of on- pump CABG group and 3(8.3%) cases of off- pump CABG group died. Among patients with 41-49% EF - 3(5.3%) patients in on-pump CABG group died. Among patients with 50-59% EF, 2(14.2%) of on- pump and 3(21.4%) of off- pump CABG groups patients died.

Among patients with smoking as risk factor - 5 (55.5%) of patients of on-pump and 4(44.5%) of patients of off-pump CABG group. Among patients with alcohol as risk factor, 5 patients died, of whom 4 (80%) underwent on-pump and 1(20%) – off- pump CABG. Five patients with diabetes as risk factor died, among them 3 (60%) belong to on- pump and 2 (40%) - to off- pump CABG groups. Among patients with hypertension as risk factor, 1(33.3%) underwent on- pump and 2(66.7%) -off- pump CABG.

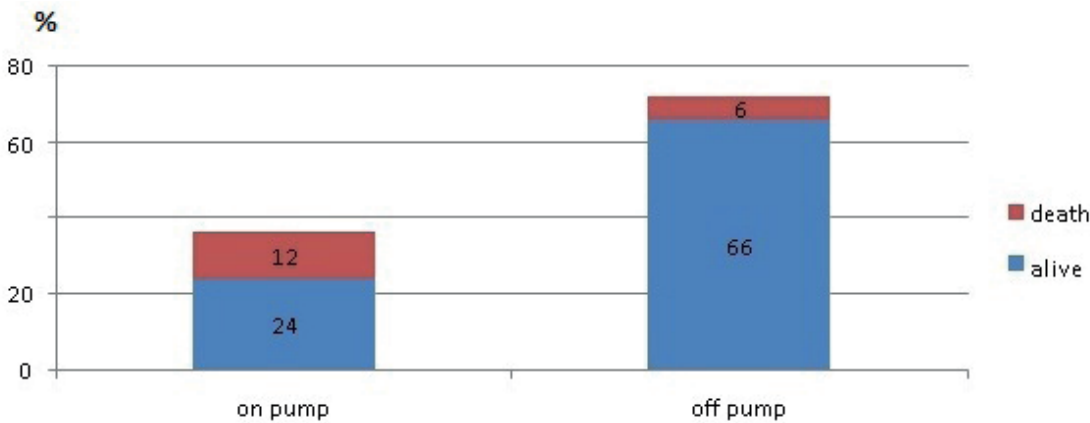


Figure 2. Comparison of on- pump vs off-pump CABG mortality (differences are significant $p<0.05$)
 CABG – coronary bypass surgery

Age-dependent mortality

Of 36 patients who underwent on- pump CABG, 12 patients died: of them 2 (16.6%) patients belong to the age group of 40 – 49 years, 5 (41.7%) patients belong to the age group of 50-59 years and 5 (41.7%) patients belong to the age group of 60-69 years.

Of 72 patients who underwent off-pump CABG procedure 6 patients died: of them 5 (83.3%) patients belong to 50 to 59 years age group and 1(16.7%) patient belong to 60-69 years age group ($p<0.05$)(Fig. 3).

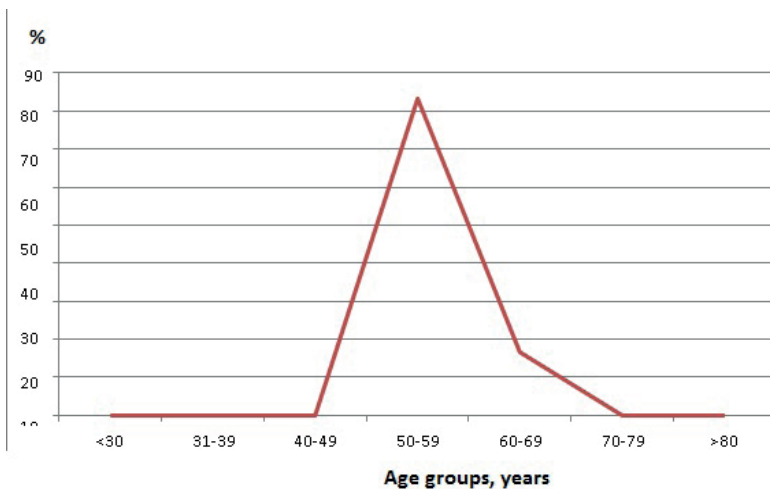


Figure 3. Age-dependent mortality in off- pump CABG group (differences are significant $p<0.05$)
 CABG – coronary bypass surgery

Extent and severity of CAD dependent mortality

Among 18 patients who died 1 (5.5%) had single- vessel disease (SVD), 8(44.5%) cases had double- vessel disease (DVD), and 9 (50%) cases had triple-vessels disease.

Among the patients with SVD - 1(3.8%) patient underwent on-pump CABG and 25(96.2%) cases - off -pump CABG, of whom 1(4%) off- pump CABG patient died. Among those with DVD,

9(25.7%) patients underwent on- pump CABG and 26(74.3%) patients - off pump CABG, of whom 5(55.5%) patients in on-pump group died and 3(11.5%) patients in off- pump group died. Among patients with TVD, 26(55.3%) patients underwent on-pump CABG and 21(44.7%) - off - pump CABG, of whom 6(23%) of on-pump group patients died and 3(14.2%) of off-pump group died (p<0.05)(Fig. 4).

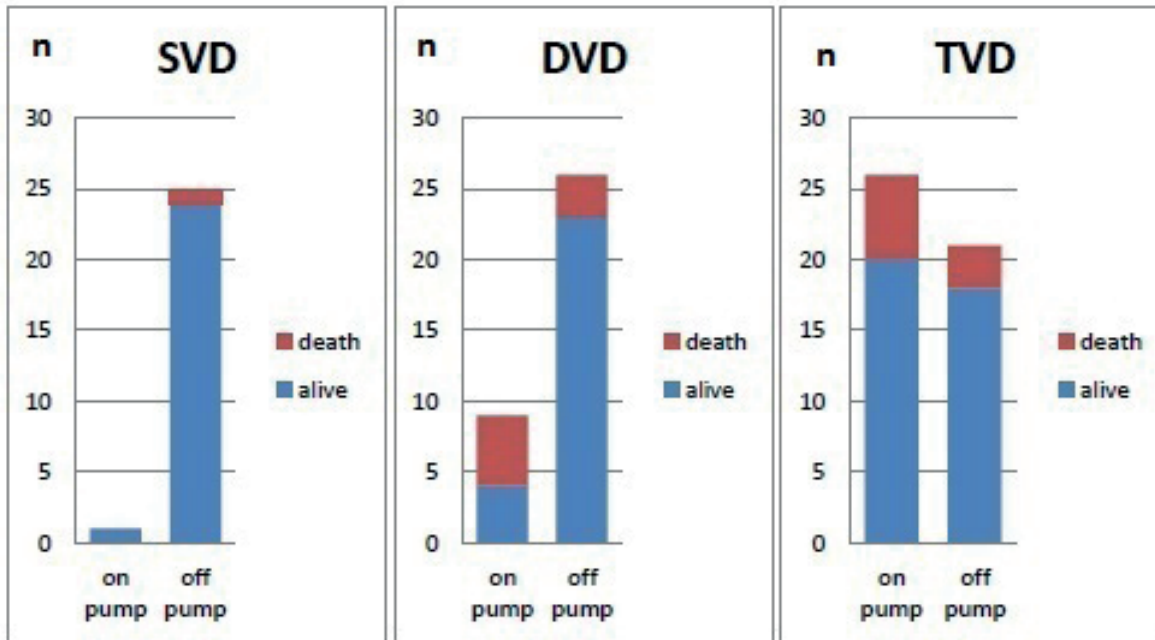


Figure 4. Mortality in on-pump vs off-pump groups among the various categories of CAD extent (differences are significant p<0.05)

CABG – coronary bypass surgery, CAD –coronary artery disease

Among 26 patients of SVD group, 3(11.5%) patients had associated left main coronary artery (LMCA) disease involvement. Out of the 3 patients with LMCA diseases, 1(33.3%) patient underwent on- pump CABG and 2 patients (66.7%) underwent off-pump surgery, of whom 1 patient with off - pump CABG group died.

Of the 35 patients in DVD group, 12 (34.2%) patients had LMCA involvement. Out of these 12 cases, 5 (41.6%) underwent on-pump CABG and 7(58.4%) patients underwent off- pump CABG, of whom - 4 (80%) patients in on -pump CABG died and 1 (14.2%) of off-pump CABG died.

Of the 47 patients with TVD, 4 patients have LMCA involvement. Out of 4 patients 3(75%) underwent on- pump CABG and 1(25%) - underwent off -pump CABG, of whom 2(66.7%) patients in on -pump group died and no one in off-pump group died.

Discussion

The mean age of presentation of the CABG groups of our study is 56.21 (10.2) years, which is far less than in other studies (2, 3).

The male population in the CABG groups of our study constituted 83.3% and female population is 16.7%. In comparison to Sattartaber et al. study (2) that included 73.6% males and 26.4% females, our population was represented by higher male and less female patients. While in comparison to Cornwell et al. (3) study, where males largely dominated (99%) over females (1%), our male population was less and female population was higher.

Analysis of CAD risk factors showed that majority of our patients (55.6%) were smokers, alcohol was used by 33.3% of patients, diabetes was present in 25.9% and hypertension - 17.6% of patients, with smoking being as more frequently encountered risk factor in the present study. Different results are presented in other studies (2, 3), that might be related to population included. Sattartaber et al. (2) demonstrated hypertension as major risk factor and Cornwell et al. (3) revealed diabetics as the most common risk factor in patients undergoing CABG.

In the present study, 24.1% of patients had SVD, 32.4% -DVD and 43.5% -TVD, the latter was the most frequent angiographically documented extent of CAD. Our results are similar to those reported by Sattartaber et al. (2) and Cornwell et al. (3). When taking vessels with LMCA involvement, 33.3% have associated LMCA, that was comparatively lower than non-LMCA involvement (66.7%). Sattartaber et al. (2) and Cornwell et al. (3) showed similar incidence of LMCA involvement as in our study.

In the present study the percentage of patients with EF < 31% are around 10 %, which is like in other studies (2, 3). This is an important risk factor in our and other studies to make the decision between on-pump and off-pump surgery.

It was found that the short-term mortality was higher in on-pump CABG group (33.3%) than in off-pump (8.3%) group but more on- pump patients to be needed to equate. Our present data on mortality is in accordance with Kowalewski et al. (4) and Giovanni et al. (5) studies. However, Raja et al. (6) and Daniel et al. (7) studies did not find significant differences in short-term mortality between on -pump and off -pump CABG patients.

The short-term mortality in our study, was the highest among age group of 50-69 years in on -pump CABG patients and among 50 to 59 years for off -pump CABG in the present study. This is contradictory to the findings of the study by Nicolini et al. (8), which showed the highest mortality among 70-89 years followed by 60 to 69 years which can be explained as less number of patients above 70 years have undergone procedure in present study.

The short-term mortality was the highest among on-pump group of patients with EF less than 40 than off- pump group in the present study. These findings are in agreement with Zhiyuan et al. (9), but 3 cases of off -pump group who died had EF more than 50%, but these patients had also risk factor as higher age > 70 years that may be a possible reason for mortality.

The short-term mortality was higher among patients with multivessel disease but when mortality was compared among on- pump and off -pump the latter has higher rate. However, this is not in agreement with some studies like Zubarevich et al. (10), which showed no significant difference. Other studies support our results (4, 5).

Even though there is number of differences between the on- pump group and off- pump groups, this study as a whole shows more short -term mortality among DVD than TVD (5 out of 9 cases vs 6 out of 26 cases). It was found that the patients died in DVD group had more often LMCA disease than the patients died due to TVD. Therefore, we found in this study that the LMCA involvement in multivessel disease had some contribution to the mortality. This confirms results of Benedetto et al. (11) study.

The off-pump group had higher short-term mortality among hypertension group in the remaining risk factor group on-

pump group had higher short-term mortality. In subgroup analysis of on- pump and off-pump groups had higher mortality among smokers and alcoholics.

Study limitations

The limitation of the present study is first this study is conducted in a single centered. Second, there is no significant number of on-pump CABG group patients to compare effectively. Third lower EF group of patients and higher age group of patients are comparatively less in number.

Conclusion

The present study concludes that:

- The on-pump CABG group had higher mortality than off- pump CABG group
- Older age group above 60 years are having higher mortality in on-pump CABG group
- The patients with lower EF had higher mortality among on- pump CABG than off- pump CABG
- The patients with LMCA involvement with other vessels had higher mortality among on- pump group in addition to those with TVD
- Smoking and alcohol are more contributing for mortality in on -both groups being higher in on- pump CABG group. Hypertension contributes more to off- pump CABG mortality.

Ethics: Informed consent was obtained from patients before all procedures. Institution Ethics committee approval was obtained.

Peer-review: External and internal

Conflict of interest: None to declare

Authorship: C.P.R. and C.S.S.V. equally contributed to the study and preparation of manuscript and fulfilled authorship criteria

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