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Patterns and Outcomes of Adult Cardiac Surgery in a Tertiary Hospital in Pakistan: A Seven-Year Single-Surgeon Retrospective Study

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ABSTRACT

Cardiovascular disease is a major health burden in Pakistan, where access to cardiac surgery is limited. Understanding disease patterns and cardiac surgical procedures in high-burden societies can guide resource allocation to improve patient outcomes. **Objectives:** To evaluate retrospectively the pattern of adult cardiac surgical procedures and their outcomes performed by a single surgeon at a tertiary hospital in Pakistan. **Methods:** This retrospective observational study included 1,404 consecutive adult patients operated on by a single surgeon at CPEIC, Multan. Data were collected from all consecutive adult patients (≥15 years), of either sex, who underwent surgery by a single cardiac surgeon between May 2018 and July 2025. The data were obtained from a prospectively maintained surgeon's database. Fisher's exact test was used for small group comparisons. **Results:** A total of 1,404 patients underwent cardiac surgery. Coronary artery bypass grafting comprised 70.0% (on-pump 55.9%, off-pump 11.3%), valvular surgery 21.6%, congenital repairs 2.3%, aortic root 1.0%, and post-MI VSR repair 1.5%. In isolated CABG, the internal mammary artery was used in 92.4%, with a mean of 2.96 ± 0.93 grafts. Complications occurred in 20.4%. Early mortality was 3.1%, with the lowest rates in CABG (1.9%) and the highest in VSR repair (23.8%). Ventilation time and hospital stay were significantly longer in aortic root and redo procedures ($p<0.05$). **Conclusions:** Over seven years, CABG and valvular procedures predominated, with overall mortality and complication rates comparable to regional benchmarks. On-pump CABG provided more complete revascularization, while complex surgeries carried a higher risk.

INTRODUCTION

Cardiovascular disease (CVD) is the leading cause of death worldwide. More than half a billion people around the world are affected by cardiac diseases [1, 2]. In South Asia, there is an increasing trend of mortality among patients with ischemic heart disease, resulting in 0.16 years of loss of healthy life expectancy [3]. In South Asia, including Pakistan, rheumatic heart disease is more prevalent than in developed countries, resulting in a significantly increased need for mitral and aortic valve procedures. [4] However, contemporary institutional data describing the full range of cardiac procedures and associated early outcomes in Pakistan remain limited, with most published studies focusing on isolated procedures or small cohorts. Pakistan has a massive cardiovascular disease burden, with both incidence and mortality exceeding global averages. The Global Burden of Disease 2019 estimated the age-standardized incidence of CVD at 918 per 100,000 and the mortality rate at 358 per 100,000, which is significantly higher than the worldwide rates [3]. A multicenter cohort reported a 34.9% prevalence of coronary artery disease (CAD), with hypertension, diabetes, obesity, and smoking as major risk factors. [5] Local case–control data from Nawabshah further highlight obesity, hyperlipidemia, diabetes, and smoking as strongly associated with CAD [6].

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Cardiac surgery in Pakistan began in the late 1950s with closed-heart procedures, followed by the country's first open-heart surgery in 1967–68 at United Christian Hospital, Lahore [7, 8]. Postoperative morbidity after cardiac surgery is a key determinant of survival and resource utilization. Reporting outcomes is crucial for enhancing care and informing policy in resource-constrained settings. This study hypothesized that, despite a diverse and high-risk population, early morbidity and mortality at our center would be comparable to international standards.

Despite the high burden of cardiovascular disease and the growing need for diverse cardiac procedures in Pakistan, comprehensive institutional data on the full spectrum of adult cardiac surgeries and their early outcomes remain limited. Most available studies focus on isolated procedures or small cohorts, highlighting the need for single-center, longitudinal data to inform clinical practice, resource allocation, and policy in resource-constrained settings.

METHODS

The retrospective observational study was conducted at the Department of Cardiac Surgery, Chaudhry Pervaiz Elahi Institute of Cardiology, Multan, Pakistan. Data included all consecutive adult patients (>15 years) of either sex operated on by a single cardiac surgeon between May 2018 and July 2025, and the study was conducted from July to oct 2025. Before data collection commenced, institutional ethical approval was obtained (No. 238). Cardiovascular procedures like coronary artery bypass grafting, cardiac valve replacement or repair, aortic surgery, surgery on the pericardium, and adult congenital repairs were included. Patients operated on by other surgeons and minor vascular or cardiac procedures, e.g., arterial embolectomy, carotid endarterectomy, and pericardial effusion drainage, were excluded from the study. The study utilized a prospectively maintained surgeon's database, in which data were recorded in Microsoft Excel. Patients' preoperative, intraoperative, and postoperative characteristics were recorded. All procedures were carried out by a single experienced cardiac surgeon following standardized institutional protocols for anesthesia, myocardial protection, and postoperative management. For coronary artery bypass grafting (CABG), a median sternotomy was performed with cardiopulmonary bypass (CPB) established via aortic and right atrial cannulation; myocardial protection was provided with cold blood cardioplegia. In off-pump cases, mechanical stabilizers and intracoronary shunts were used. The left internal mammary artery (LIMA) was the preferred conduit for the left anterior descending artery, with additional venous or radial grafts used as needed. Valvular surgeries were conducted under CPB with aortic cross-clamping, utilizing mechanical or bioprosthetic valves as appropriate, and repairs were attempted when feasible. Procedures involving the aortic root and ascending aorta employed Composite tube grafts, while pericardiectomy was performed via median sternotomy. Adult congenital defects such as ASD and VSD were repaired under CPB with patch closure. Early mortality was defined as death during the initial hospitalization or within 30 days post-surgery, whereas late mortality referred to any death occurring after discharge but within six months of the operation. The collected variables comprise age, sex, and comorbidities like diabetes, hypertension, and smoking. Preoperative assessment included echocardiography (left ventricular ejection fraction, chamber dimensions, valvular morphology and severity, and pulmonary pressures) and coronary angiography (extent and severity of coronary artery disease). Additional variables recorded were HbA1c, serum creatinine, severity of carotid disease on carotid Doppler, abdominal ultrasonographic findings, priority status, operative details including type of procedure, use of cardiopulmonary bypass (CPB), use of left internal mammary artery (LIMA), coronary endarterectomy, cross-clamp and bypass durations, need of intraaortic balloon, and conversions from off-pump to on-pump techniques. Postoperative outcomes assessed were early mortality, defined as death during the index hospitalization or within 30 days of surgery; The primary morbidity outcome was defined as "any postoperative complication," referring to the occurrence of at least one adverse event following surgery. This composite measure included perioperative myocardial infarction (postoperative peak CK-MB ≥5× baseline), atrial or other arrhythmias, stroke, renal dysfunction (a ≥2-fold rise in serum creatinine from preoperative levels), re-exploration for bleeding or tamponade, pleural effusion requiring intervention, prolonged mechanical ventilation, and extended hospital stay. Patients who experienced more than one complication were counted only once in this composite outcome. Patients' contact information was documented, and postoperative follow-up was advised. Written informed consent was taken. The initial follow-up visit occurred two weeks after discharge in the Surgical Outpatient Department, followed by subsequent monthly visits for ongoing evaluation for 6 months after discharge. Data were analyzed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were presented as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Comparisons between categorical variables were made using the Chi-square test or Fisher's Exact test, as appropriate, depending on expected cell frequencies.

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Where subgroup counts were small (<5), Fisher's Exact test Monte Carlo correction was applied.

RESULTS

Between May 2018 and July 2025, a total of 1,404 patients underwent cardiac surgery at Chaudhry Pervaiz Elahi Institute of Cardiology (CPEIC), Multan. The mean age was 49.2 ± 13.7 years (range 15–82), and 76.9% were male. Diabetes mellitus was present in 31.7%, hypertension in 37.2%, and smoking in 14.9% of the cohort. Carotid duplex revealed normal carotid arteries in 871 (62.0%) patients, mild disease in 495 (35.3%), moderate disease in 26 (1.9%), and Severe stenosis (≥50% internal carotid artery stenosis) in 12 (0.9%). Abdominal ultrasound was normal in 64% of cases, whereas 15.6% had fatty liver, 7.5% congested liver, 3.5% renal cysts, and 2.6% gallstones. The mean ejection fraction was 51.3 ± 9.6%, with corresponding mean left ventricular internal diameters of 48.1 ± 8.0 mm in diastole and 33.9 ± 7.0 mm in systole. Mean serum creatinine (n=1382) was 0.99 ± 0.29 mg/dL, and HbA1c (n=1278) was 6.58 ± 1.50%. Most operations were elective (91.6%), with 8.1% performed urgently and 0.3% emergently. Coronary artery bypass grafting (CABG) was the most commonly performed procedure (n=983, 70%). Isolated valvular heart disease constituted 21.0% of the operative workload, simple congenital surgery accounted for 2.9%, and ruptured sinus of Valsalva (RSOV) repair was performed in 7 cases (0.5%). Other operations included Aortic root surgery (n=15, 1.0%), post-MI VSR repair (n=21, 1.5%), minimally invasive cardiac surgery (n=8, 0.6%), left atrial myxoma excision (n=7, 0.5%), redo operations (n=6, 0.4%), and pericardiectomy (n=6, 0.4%) (Table1).

Table 1: Spectrum of Procedures Performed

Operations	Frequency (%)	Operations	Frequency (%)
OFF Pump CABG	158 (11.3%)	On Pump CABG	785 (55.9%)
On-Pump Beating	7 (0.5%)	AVR	63 (4.5%)
MVR	112 (8.0%)	DVR	50 (3.6%)
ASD Prim	1 (0.1%)	ASD Sec	23 1.6%)
ASD SV	7 (0.5%)	RSOV	6 (0.4%)
Redo Surgery	6 (0.4%)	VSR Repair	21 (1.5%)
Aortic Root Surgery	15 (1.1%)	MV Repair	3 (0.2%)
MICs	8 (0.6%)	LA Myxoma Excision	9 (0.6%)
Miscellaneous	6 (0.4%)	Pericardiectomy	6 (0.4%)
SAM	2 (0.1%)	RVOT	2 (0.1%)
CABG + MVR	7 (0.5%)	CABG + DVR	1 (0.1%)
CABG + ASD Repair	1 (0.1%)	TVR	1 (0.1%)
CABG + AVR	16 (1.1%)	MVR + TVR	52 (3.7%)
DVR + TVR	17 (1.2%)	ASD + MVR	4 (0.3%)
VSD	2 (0.1%)	AVR + VSD Repair	5 (0.4%)
CABG + Mv Repair	8 (0.6%)	–	–

Abbreviations: CABG, coronary artery bypass grafting; OPCAB, off-pump coronary artery bypass grafting; AVR, aortic valve replacement; MVR, mitral valve replacement; DVR, double valve replacement; TVR, tricuspid valve replacement; MV repair, mitral valve repair; ASD, atrial septal defect (Prim = primum type; Sec = secundum type; SV = sinus venosus type); VSD, ventricular septal defect; RSOV, ruptured sinus of Valsalva; VSR, ventricular septal rupture (post-myocardial infarction); MICs, minimally invasive cardiac surgery; LA Myxoma, left atrial myxoma excision; SAM, subaortic membrane resection; RVOT, right ventricular outflow tract repair.

The left internal mammary artery (LIMA) was utilized in 92.4% of isolated CABG cases. In 1.7% of patients (n=16), the LIMA was harvested after establishing cardiopulmonary bypass (CPB) because of hemodynamic instability. In 7.3% of CABG cases, IMA was not used—either it was damaged during harvesting, had inadequate flow, or was not harvested due to technical difficulties, a poor-quality LAD target vessel, and a dilated left ventricle with poor function. Coronary endarterectomy was required in 4.6% of CABG cases. Intra-aortic balloon pump (IABP) support was used in 10 patients (0.7%). Among 158 patients undergoing OPCAB, 6 (3.8%) required conversion to on-pump surgery due to hemodynamic instability or technical difficulty. Comparative analysis revealed no statistically significant differences between on-pump and off-pump CABG in terms of early mortality (1.8% vs 1.9%), overall complications (20.4% vs 19.8%), ventilation time (5.4 ± 1.9 vs 5.2 ± 1.8, p=0.27), and hospital stay (6.3 ± 7.1vs 6.1 ± 6.8, p=0.589). However, on-pump CABG was associated with a significantly greater mean graft per patient (3.21 ± 0.76 vs 2.14 ± 0.86, p<0.001). A total of 1,117 patients (79.6%) had an uneventful postoperative course, while 287 (20.4%) developed one or more complications. The most frequent were atrial fibrillation (3.5%), re-exploration (2.7%), rhythm disturbances (2.4%), and renal dysfunction (1.4%). When stratified by procedure type, the highest complication rates occurred in post-MI VSR repair (33.3%) and redo surgeries (16.7%), reflecting the greater complexity and hemodynamic instability in these patients. The association between operation type and occurrence of postoperative complications was analyzed using the Fisher–Freeman–Halton Exact Test with Monte Carlo simulation (10,000 sampled tables, 99% confidence interval). Given that over 90% of expected cell frequencies were less than 5, this approach was preferred over the Pearson Chi-square test. The result showed a statistically significant relationship between procedure type and complications (Monte Carlo p = 0.003, 99% CI: 0.001–0.004) (Table 2).

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Table 2: Distribution of Major Postoperative Complications According to Surgery Groups (%)

Complications	CABG Only	CABG +Concomitant Surgery	Valvular	Congenital	Aortic Root Surgery	Post-MI VSR	MICS	Redo
No Complication	79.8%	75.8%	80.0%	80.6%		66.7%	100.0%	83.3%
Re-exploration (Reopening)	2.6%	0.0%	3.0%	4.5%	7.1%	0.0%	0.0%	0.0%
Atrial Fibrillation	3.6%	6.1%	4.3%	0.0%	0.0%	0.0%	0.0%	0.0%
Raised Creatinine	1.7%	6.1%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%
Rhythm Disturbances	2.2%	0.0%	2.3%	4.5%	7.1%	4.8%	0.0%	0.0%
Pleural Effusion	0.7%	0.0%	0.3%	3.0%	0.0%	0.0%	0.0%	0.0%
Stroke	0.4%	0.0%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%
Overall Complication	20.2%	24.2%	20.0%	19.4%	35.7%	33.3%	0.0%	16.7%

FisherExact Test (Monte Carlo simulation based on 10,000 samples, 99% CI 0.001–0.004): p=0.003.

Early mortality occurred in 43 patients (3.1%), while 12 patients (0.9%) died later within 6 months after surgery. Conventional CABG had the lowest early mortality (1.8%), whereas post-MI VSR repair (23.8%), aortic root surgery (8.3%), and combined CABG + AVR (12.5%) had the highest rates of early mortality. The association between operation type and postoperative mortality was analyzed using the Fisher Exact Test with Monte Carlo simulation (10 000 iterations, 99 % confidence interval 0.000–0.000). Given that over 75 % of expected cell counts were < 5, this approach was preferred over the Pearson Chi-square test. The relationship remained statistically significant (p<0.001). Includes all operations with ≥1 death. Percentages are within each operation type (denominator = N for that operation) (Table 3).

Table 3: Procedures with Mortality: Early, Late, and Total by Operation

Operations	n	Early Deaths, n (%)	Late Deaths, n (%)	Total Deaths, n (%)	Survival, n (%)
OPCAB	158	3 (1.9%)	0 (0.0%)	3 (1.9%)	155 (98.1%)
CABG	785	14 (1.8%)	3 (0.4%)	17 (2.2%)	768 (97.8%)
On-Pump Beating	7	1 (14.3%)	0 (0.0%)	1 (14.3%)	6 (85.7%)
AVR	63	1 (1.6%)	3 (4.8%)	4 (6.3%)	59 (93.7%)
MVR	112	3 (2.7%)	1 (0.9%)	4 (3.6%)	109 (96.4%)
ASD Prim	1	0 (0.0%)	1 (100.0%)	1 (100.0%)	0 (0.0%)
Redo Surgery	6	2 (33.3%)	1 (16.7%)	3 (50.0%)	3 (50.0%)
VSR Repair	21	5 (23.8%)	2 (9.5%)	7 (33.3%)	14 (66.7%)
Aortic Root Surgery	15	3 (20.0%)	0 (0.0%)	3 (20.0%)	12 (80.0%)
Miscellaneous	6	1 (16.7%)	0 (0.0%)	1 (16.7%)	5 (83.3%)
Pericardiectomy	6	1 (16.7%)	0 (0.0%)	1 (16.7%)	5 (83.3%)
SAM	2	1 (50.0%)	0 (0.0%)	1 (50.0%)	1 (50.0%)
CABG + MVR	7	1 (14.3%)	0 (0.0%)	1 (14.3%)	6 (85.7%)
CABG + AVR	16	2 (12.5%)	0 (0.0%)	2 (12.5%)	14 (87.5%)
MVR + TVR	52	2 (3.8%)	0 (0.0%)	2 (3.8%)	50 (96.2%)
DVR + TVR	17	2 (11.8%)	0 (0.0%)	2 (11.8%)	15 (88.2%)
CABG + Mvr	8	0 (0.0%)	1 (12.5%)	1 (12.5%)	7 (87.5%)
AVR + VSD Repair	5	1 (20.0%)	0 (0.0%)	1 (20.0%)	4 (80.0%)

Fisher–Freeman–Halton Exact Test (Monte Carlo simulation based on 10,000 samples, 99 % CI 0.000–0.000): p<0.001.

The mean ventilation time was 6.4 ± 7.5 hours, and the mean hospital stay was 5.4 ± 1.9 days. Aortic surgery and DVR cases had the most extended CPB durations (p<0.001), and both ventilation time and hospital stay were significantly prolonged in Aortic Root surgery and redo surgeries (p<0.001 and p=0.032, respectively).

DISCUSSION

Over the past seven years at CPEIC in Multan, our results for coronary artery bypass grafting (CABG) align closely with both regional and global data. The in-hospital mortality for isolated CABG (1.8%) was slightly lower than the 2.5–4% reported in other Pakistani series, reflecting consistent surgical performance [9]. These results also align with large international registries, where early mortality typically ranges between 1–2% [10]. Patients who needed coronary endarterectomy (CE) during CABG surgery experienced higher perioperative complications, consistent with global literature [11]. However, in patients with diffuse coronary artery disease (CAD), CE remains a valuable operative strategy, particularly in settings where hybrid or advanced percutaneous interventions (e.g., rotational/orbital atherectomy or intravascular lithotripsy) are not widely available [12]. Current findings reinforce that CE is a safe technique to achieve complete revascularization in diffuse CAD. A notable point in our study cohort is the relatively young age of patients (mean 49 years) compared with Western populations, where CABG is typically performed in the sixth or seventh decade of life [13]. This age disparity reflects the earlier onset and rapid progression of CAD among South Asians, emphasizing the urgent need for primary prevention and early screening programs to reduce cardiovascular disease in the region. High-risk subgroups, including patients undergoing repair of post-myocardial infarction ventricular septal rupture (VSR) or aortic root surgery, demonstrated predictably higher operative mortality. This is consistent with global experience [14]. Conversely, the reasonable outcomes of our limited aortic root cases suggest growing institutional expertise in complex aortic surgery, which is encouraging for capacity development in resource-limited centers. When comparing on-pump and off-pump CABG in our series, the data showed that although both operative armamentaria are safe, more complete revascularization is achieved during on-pump

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CABG. These findings are comparable with large international trials [15]. The overall postoperative complication rate was 20.4%, which matches regional data reporting 18–25% complications after heart surgery [16]. Atrial fibrillation was the most common complication at 3.5%, consistent with international studies showing rates between 2% and 5% [17]. The significant link between the type of surgery and complication rates ($\chi^2 = 322.5$, $p<0.001$) shows that more complex procedures, like redo surgeries and VSR repair, carry higher risks. Valvular procedures accounted for over one-fifth of our total cardiac procedures. The 6-month mortality ranged from 3.6% for mitral valve replacement (MVR) to 6.3% for aortic valve replacement (AVR), and corresponded closely with both national reports [18] and international benchmarks (2–7%) [19]. The intra-aortic balloon pump (IABP) support was used in only 0.7% of cases—lower than the international average of 2–4%—which points to a low-risk patient population, stable intraoperative conditions, and effective heart protection [20]. The short ventilation time (mean 6.4 hours) and hospital stay (mean 5.4 days) compare favorably with other regional centers [21], reflecting efficient postoperative recovery protocols. Predictably, longer ventilation and hospital stays were observed among aortic root and redo cases, consistent with their higher complexity. Preoperative imaging showed that over 97% of patients had normal or only mild carotid artery disease. This likely explains the low rate of stroke during surgery (0.4%). While coronary artery bypass grafting and valve replacements predominated, the overall spectrum also revealed relatively few cases of total arterial revascularization, mitral valve repair, and minimally invasive cardiac surgery (MICS). This reflects both patient selection and institutional practice patterns in a developingcountry setting, where resource constraints, late presentation, and limited expertise in advanced techniques may restrict their wider adoption. The low frequency of mitral valve repair highlights the ongoing challenge of rheumatic pathology, which often necessitates replacement rather than repair. Similarly, the limited use of total arterial grafting and MICS underscores the need for training and capacity building to expand these approaches to align with international standards.

The study's observational design may be prone to selection bias, as patient allocation to on-pump vs off-pump or complex procedures was not randomized. Additionally, variations in surgeon experience and perioperative management protocols could have influenced outcomes, limiting the ability to attribute results solely to the surgical approach. Future multicenter prospective studies with extended follow-up are needed to evaluate long-term outcomes and optimize surgical strategies in South Asian populations.

CONCLUSIONS

This seven-year retrospective study from a tertiary hospital in Pakistan demonstrates that CABG and valve surgeries predominated, with outcomes comparable to regional benchmarks. On-pump CABG achieved more complete revascularization, while complex procedures carried higher morbidity and mortality. Very few patients underwent mitral valve repair, total arterial bypass grafting, or minimally invasive surgery, underscoring the need for specialized training and adoption of advanced surgical strategies to improve outcomes in these subgroups.

Authors' Contribution

Conceptualization: MSIM
Methodology: MSIM, MHC
Formal analysis: MSIM, MHC
Writing and Drafting: MSIM, MHC, KH
Review and Editing: MSIM, MHC, KH

All authors approved the final manuscript and take responsibility for the integrity of the work.

Conflicts of Interest

All the authors declare no conflict of interest.

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