


# From First Cases to Program Expansion: Coronary Artery Bypass Grafting in Senegal

—A Single-Center Study of 55 Patients

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**How to cite this paper:** Diagne, P.A., Ba, E.B., Diop, M.S., Coulibaly, B.D., Sow, N.F., Ba, P.O., Diop, M.S., Mbaye, M.S., Dione, J.C.N., Mbengue, A.L., Camara, M., Thiaw, A.A., Diallo, A.K., Sall, A.M., Faye, C.A.F., Minghou, J.S., Dioum, M., Ba, P.S. and Ciss, A.G. (2026) From First Cases to Program Expansion: Coronary Artery Bypass Grafting in Senegal. *World Journal of Cardiovascular Surgery*, **16**, 93-108.

<https://doi.org/10.4236/wjcs.2026.165010>

**Received:** April 27, 2026

**Accepted:** May 19, 2026

**Published:** May 22, 2026

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## Abstract

**Background:** Coronary artery disease is increasing in Senegal as a result of epidemiological transition and the growing burden of cardiovascular risk factors. Since 2019, coronary artery bypass grafting (CABG) has been progressively structured within the local surgical team. Following the first Senegalese series reporting 10 cases performed between 2019 and 2022, surgical activity has significantly expanded between 2023 and 2025. **Objective:** To describe the current status, early outcomes, and development perspectives of CABG in Senegal based on an expanded institutional experience. **Methods:** This study is based on a combined analysis of historical series, recent operative records, and institutional registries, including a total of 55 patients who underwent CABG between 2019 and 2025. **Results:** A total of 55 CABG procedures were performed, providing for the first time a sufficient operative volume for robust epidemiological and technical analysis. The patient profile was dominated by advanced multivessel coronary artery disease, with triple-vessel involvement observed in approximately 65% - 70% of cases. Cardiovascular risk factors were highly prevalent, including hypertension (60% - 70%), diabetes (30% - 40%), dyslipidemia (≈30%), and smoking in nearly half of the patients. Left ventricular systolic function was generally preserved, with a mean ejection fraction ranging from 50% to 60%, although segmental wall motion abnormalities were present in 30% - 40% of cases. Surgically, the left internal mammary artery was used in more than 90% of procedures, associated or not with

saphenous vein grafts. The recent period has been marked by the introduction of off-pump CABG, performed in 5 patients (9.1%), reflecting the initial adoption and progressive diversification of surgical techniques. Conclusion: CABG in Senegal has entered a phase of expansion and consolidation, with encouraging early results. This study provides a comprehensive national overview based on the integration of published data, prospective registry analysis, and recent operative experience. Continued development of surgical expertise, infrastructure, and access to care is essential to meet the growing burden of coronary artery disease in this setting.

## Keywords

Coronary Bypass Surgery, Off-Pump, Coronary Lesions, Cardiac Surgery, Senegal

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## 1. Introduction

Cardiovascular diseases (CVDs) remain the leading cause of mortality worldwide, accounting for approximately 17.5 million deaths each year. The burden is particularly pronounced in low- and middle-income countries, where nearly 80% of these deaths occur, reflecting the ongoing epidemiological transition and the rapid increase in cardiovascular risk factors [1].

Despite this growing burden, access to cardiac surgical care remains highly limited. It is estimated that nearly 75% of the global population lacks access to safe and timely cardiac surgery due to insufficient infrastructure, shortage of trained personnel, and limited financial coverage [2]. This disparity is further illustrated by the extremely low density of cardiac surgeons in low-income settings, estimated at 0.04 adult cardiac surgeons per million inhabitants compared to 7.15 per million in high-income countries [2].

In this context, coronary artery bypass grafting (CABG) has become a key therapeutic strategy, particularly in patients with multivessel coronary artery disease. CABG is associated with improved survival and better clinical outcomes in high-risk patients, especially those with triple-vessel disease, and remains a cornerstone of myocardial revascularization. As the prevalence of advanced coronary disease increases, the demand for surgical revascularization continues to rise globally.

In Senegal, the development of coronary surgery has followed a delayed but progressive trajectory. Historically, management of complex coronary artery disease relied largely on medical evacuations abroad or short-term humanitarian missions, with the first CABG procedures performed in 2009 under external support. A major shift occurred from 2018 onward, with the strategic development of a national coronary revascularization program and the progressive acquisition of technical expertise and infrastructure.

The period between 2019 and 2022 marked a foundational stage, with the first locally performed series of 10 CABG cases establishing the feasibility of coronary

surgery within the country [3]. Since then, surgical activity has significantly increased, with a substantial rise in operative volume by 2025, accompanied by the introduction of off-pump coronary artery bypass techniques [4], reflecting a new phase in the maturation and diversification of surgical approaches.

In a context where demand for coronary surgery is rapidly increasing while local capacity remains recent and evolving, it is essential to assess the current state of CABG practice.

The present study aims to provide a comprehensive overview of coronary artery bypass grafting in Senegal, focusing on its current status, early outcomes, and future development perspectives based on an expanded institutional experience.

## 2. Materials and Methods

This single-center observational study was conducted at the Department of Thoracic and Cardiovascular Surgery of Fann University Hospital in Dakar, Senegal, and includes both retrospective and prospective data collected between January 2019 and December 2025 as part of the progressive development of a national coronary revascularization program. The study cohort was assembled from multiple institutional data sources, including operative reports, patients' medical records, and the institutional surgical registry. The final data-lock date for the analysis was December 31, 2025. The initial series of 10 patients (2019-2022), previously published, was re-identified using operative records and unique patient identifiers and integrated into the present cohort. These cases were included only once and merged with subsequent cases (2023-2025) after cross-verification to ensure the absence of duplication. The final dataset therefore represents the complete and consecutive institutional experience.

All consecutive patients who underwent coronary artery bypass grafting (CABG) during the study period were included. Patients undergoing concomitant procedures, such as mitral valve surgery or hybrid revascularization, were also considered when CABG constituted the primary surgical indication. This resulted in a total cohort of 55 patients, representing the entire institutional experience, including an initial phase (2019-2022) previously reported with the first 10 cases and a subsequent expansion phase (2023-2025). Patients were referred for surgical management from multiple cardiology centers across the country, including the cardiology departments of Fann University Hospital, the Principal Hospital of Dakar, Idrissa Pouye General Hospital, Cheikhoul Khadim Hospital in Touba, Dalal Jamm National Hospital, the Dakar Cardiology Clinic, and the university hospitals of Saint-Louis and Thiès. Patients undergoing combined procedures or with incomplete medical records were excluded. Preoperative assessment was standardized and included clinical evaluation, cardiovascular risk stratification, electrocardiogram, transthoracic echocardiography to assess left ventricular function and regional wall motion abnormalities, coronary angiography confirming surgical indication, Doppler ultrasound of supra-aortic trunks, pulmonary function testing when indicated, and routine laboratory investigations, along with system-

atic screening for infectious foci. Surgical risk was evaluated using the EuroSCORE II. The indication for CABG was established based on clinical presentation, coronary anatomy, and current guideline recommendations. Most patients presented with multivessel coronary artery disease. In selected cases of single-vessel disease, surgical revascularization was indicated in the presence of complex proximal left anterior descending artery lesions, unfavorable anatomy for percutaneous coronary intervention, or persistent symptoms despite optimal medical therapy. All treatment decisions were discussed within a multidisciplinary Heart Team involving cardiologists, cardiac surgeons, and anesthesiologists, with consideration of anatomical complexity, comorbidities, and overall surgical risk.

All procedures were performed via median sternotomy under general anesthesia. In most cases, CABG was carried out under cardiopulmonary bypass with aortic and venous cannulation and myocardial protection using cardioplegia. The left internal mammary artery was preferentially used for grafting the left anterior descending artery, with additional use of the right internal mammary artery and/or great saphenous vein depending on coronary anatomy and surgical strategy.

In the most recent period, off-pump coronary artery bypass (OPCAB) was introduced and performed on the beating heart using mechanical stabilizers and intracoronary shunts, with the aim of reducing cardiopulmonary bypass-related morbidity. The revascularization strategy aimed to achieve complete myocardial revascularization whenever anatomically feasible. Sternal closure was completed with the placement of pericardial and retrosternal drains, along with pleural drains when required. Postoperatively, all patients were admitted to the intensive care unit and underwent continuous hemodynamic monitoring, arterial blood gas analysis, lactate measurement, and cardiac enzyme assessment (troponin). Early extubation was targeted from the second postoperative hour in hemodynamically stable patients. Antiplatelet therapy with acetylsalicylic acid (aspirin) was initiated six hours after surgery, followed by the gradual reintroduction of guideline-directed medical therapy, including angiotensin-converting enzyme inhibitors, statins, beta-blockers, antiarrhythmic agents, and antihypertensive medications as indicated. A control transthoracic echocardiogram was systematically performed on the day of surgery. Since the last three years, all patients have been systematically enrolled in a structured cardiac rehabilitation program following surgery. Early mortality was defined as in-hospital or 30-day mortality, while late mortality referred to any death occurring beyond 30 days during follow-up. The follow-up schedule included systematic clinical evaluation at postoperative day 15, and at 1 month and 6 months, with transthoracic echocardiographic assessment. Follow-up completeness was ensured through scheduled outpatient visits and review of institutional medical records. Data were collected from medical records, operative reports, and institutional registries, including demographic characteristics, cardiovascular risk factors, clinical presentation, angiographic findings, operative details, and postoperative outcomes. Primary endpoints were early postoperative mortality and major complications, including infectious, neurological, and car-

diac events, while secondary endpoints included duration of mechanical ventilation, length of intensive care unit stay, and total hospital stay. Statistical analysis was descriptive, with continuous variables expressed as mean  $\pm$  standard deviation or median with ranges, and categorical variables as frequencies and percentages. Ethical approval was obtained from the institutional ethics committee of Fann University Hospital, Dakar, Senegal. Given the retrospective nature of part of the study, the requirement for informed consent was waived for previously collected data. For prospectively included patients, informed consent was obtained when applicable. All data were anonymized prior to analysis.

### 3. Results

A total of 55 patients underwent coronary artery bypass grafting during the study period. Patients were referred for surgical management of stable angina, unstable angina, or post-acute coronary syndrome. The mean age was 62 years (44 - 78), with a predominance of patients in the 55 - 75-year age group, and a marked male predominance (40 men and 15 women; sex ratio 2.67). At admission, the clinical presentation was dominated by exertional angina and/or unstable angina, frequently associated with exertional dyspnea and typical or atypical chest pain. In most cases, symptoms had been evolving for several months prior to referral to specialized care. Cardiovascular risk factors were highly prevalent, with hypertension in 65% of patients, diabetes in 35%, dyslipidemia in approximately one-third, and active or former smoking in about half of the cohort. A history of acute coronary syndrome or myocardial infarction was frequently noted, and most patients had at least two cardiovascular risk factors. The mean body weight was 76.8 kg (41 - 109 kg), and the mean body mass index was 25.16 kg/m<sup>2</sup> (15 - 34 kg), with a predominance of overweight or obese patients. On physical examination, most patients were hemodynamically stable, without signs of advanced heart failure, although arterial hypertension at admission was frequently observed. Electrocardiographic findings included sequelae of myocardial necrosis, ischemic repolarization abnormalities, and rhythm disturbances such as extrasystoles, atrial fibrillation, and atrioventricular block. Coronary angiography revealed advanced coronary artery disease, with triple-vessel disease in approximately 73% of cases, double-vessel disease in 22%, and single-vessel disease in 5%. The left anterior descending artery was involved in all patients, the left main coronary artery in approximately 50%, the circumflex artery or one of its branches in 80%, and the right coronary artery in 85% of cases. Transthoracic echocardiography showed a mean left ventricular ejection fraction of 56% (29 - 76), with approximately one-fifth of patients presenting with a reduced ejection fraction (<50%). The mean TAPSE was 21 mm (range 18 - 33), reflecting generally preserved right ventricular function. Segmental wall motion abnormalities were common, predominantly affecting the anterior and septal territories (60% - 70%), followed by the inferior (50% - 55%) and lateral territories (25% - 30%). Additional findings included right ventricular pressure overload and associated valvular lesions. The mean EuroSCORE

II was 2.39% (range 1% - 5.6%), indicating an overall low-to-intermediate surgical risk profile. Patient characteristics are shown in **Table 1**.

**Table 1.** Patients' characteristics.

Variable	Value
<b>Demographic characteristics</b>	
Age, mean (range), years	62 (44 - 78)
Male sex, n (%)	40 (72.7%)
Body mass index, mean (range), kg/m <sup>2</sup>	25.16 (15 - 34)
<b>Cardiovascular risk factors</b>	
Hypertension	65%
Diabetes mellitus	35%
Dyslipidemia	≈33%
Smoking (current or former)	≈50%
History of ACS or MI, n (%)	12 (22%)
≥2 cardiovascular risk factors, n (%)	39 (71%)
<b>Clinical presentation</b>	
Stable angina, n (%)	31 (56%)
Unstable angina, n (%)	16 (29%)
Exertional dyspnea, n (%)	33 (60%)
Duration of symptoms, (months)	≈ 22 month
Hemodynamic status at admission, n (%)	46 (83%)
<b>Electrocardiographic findings</b>	
Necrosis sequelae, n (%)	19 (34%)
Ischemic repolarization abnormalities, n (%)	33 (60%)
Arrhythmias (AF, extrasystoles, AV block), n (%)	15 (27%)
<b>Coronary angiography</b>	
Triple-vessel disease	73%
Double-vessel disease	22%
Single-vessel disease	5%
LAD involvement	100%
Left main involvement	≈50%
Circumflex involvement	≈80%
Right coronary artery involvement	≈85%
<b>Echocardiography</b>	
LVEF, mean (range), %	56 (29 - 76)

**Continued**

LVEF < 50%	≈20%
TAPSE, mean (range), mm	21 (18 - 33)
Segmental wall motion abnormalities	Frequent
Associated valvular lesions	Present
<b>Surgical risk</b>	
EuroSCORE II, mean (range), %	2.39 (1 - 5.6)

From a surgical standpoint (**Table 2**), the left internal mammary artery was used in approximately 90% of cases, while the right and left great saphenous veins were used in about 29% and 18% of cases, respectively. Bilateral internal mammary artery grafting was performed in approximately 24% of patients, and combined arterial and venous grafting in a smaller proportion. The distribution of the number of grafts was as follows: one graft in 12% of patients, two grafts in 50%, three grafts in 30%, and four or more grafts in 8%, with a mean of 2.2 grafts per patient. The left anterior descending artery was revascularized in all patients (100%), followed by the circumflex or marginal branches (65%), the right coronary artery (50%), and diagonal or bisector branches (20%). The mean cardiopulmonary bypass time was 140 minutes (46 - 275), and the mean aortic cross-clamp time was 104 minutes (37 - 232). Associated procedures were performed in a limited number of cases, including mitral valve repair (1 case), mitral valve replacement (2 cases), and hybrid procedures (2 cases). Off-pump coronary artery bypass was performed in 5 patients, reflecting the initial adoption of this technique. The mean time to extubation was 6 hours (0 - 33), and the median postoperative troponin level was 3.1 ng/mL (0.73 - 4000). Electrocardiographic monitoring in the intensive care unit most often showed normalization or stability compared to preoperative findings, with transient rhythm disturbances and rare signs of residual ischemia. The mean length of stay in the intensive care unit was 7 days (2 - 17), while the overall hospital stay averaged 10 days.

Postoperative morbidity was significant and multifactorial in 18 patients (32%). Four patients developed a single complication, 11 experienced two or more complications, and 3 patients presented with four or more complications. Infectious complications were the most frequent, observed in 9 patients (16.3%), including surgical site infections, pneumonia, and infections without a clearly identified focus. Neurological complications occurred in 7 patients (12.7%) and included agitation, confusion, hemiparesis, and delirium. Hemodynamic complications were reported in 6 patients (42.9%), including hypotension, circulatory collapse, ventricular tachycardia, and atrial fibrillation. Respiratory complications were also observed in 6 patients (42.9%), including hypoxia, respiratory distress, and acute pulmonary edema. Anemia requiring management was noted in 6 patients (10.9%). Renal complications, including acute kidney injury and oliguria, occurred in 5 patients (10%). Pleural or pericardial effusions were reported in 3

**Table 2.** Surgical characteristics.

Variable	Value
<b>Surgical approach</b>	
Median sternotomy	100%
On-pump CABG (with CPB)	Majority
Off-pump CABG (OPCAB), n (%)	5 (≈9.1%)
<b>Cardiopulmonary bypass parameters</b>	
CPB time, mean (range), min	140 (46 - 275)
Aortic cross-clamp time, mean (range), min	104 (37 - 232)
<b>Graft types used</b>	
Left internal mammary artery (LIMA)	≈90%
Right saphenous vein graft	≈29%
Left saphenous vein graft	≈18%
Bilateral internal mammary arteries (BIMA)	≈24%
Combined arterial and venous grafts	Present
<b>Number of grafts per patient</b>	
1 graft	12%
2 grafts	50%
3 grafts	30%
≥4 grafts	8%
Mean number of grafts per patient	2.2
<b>Target vessels revascularized</b>	
Left anterior descending artery (LAD)	100%
Circumflex artery/marginal branches	65%
Right coronary artery (RCA)	50%
Diagonal/bisector branches	20%
<b>Associated procedures</b>	
Mitral valve repair	1 case
Mitral valve replacement	2 cases
Hybrid procedures	2 cases

patients (5.4%). Postoperative complications are detailed in **Table 3**.

Early mortality was 8% (4 deaths), corresponding to in-hospital mortality. One additional death occurred during follow-up at 3 months (related to a hypertensive crisis), resulting in an overall mortality of 9%. After the initial series of 10 patients, mortality over the last three years was 2 out of 45 patients, corresponding to 4.44%. The characteristics of deceased patients are summarized in **Table 4**. These

patients exhibited a high-risk profile, with a mean age of approximately 71 years, frequent diabetes (4 out of 5 patients), severe bi- or triple-vessel coronary disease, and impaired or borderline left ventricular function. Contributing factors included prolonged cardiopulmonary bypass duration, intraoperative complications such as arrhythmias and bleeding, as well as postoperative sepsis and low cardiac output syndrome.

**Table 3.** Morbidities.

Type of complication	n (%)
Infectious complications (surgical site infection, pneumonia, sepsis)	9 (16.3%)
Neurological complications (agitation, confusion, hemiparesis, delirium)	7 (12.7%)
Hemodynamic complications (hypotension, shock, ventricular arrhythmia, atrial fibrillation)	6 (10.9%)
Respiratory complications (hypoxia, respiratory distress, pulmonary edema)	6 (10.9%)
Anemia	6 (10.9%)
Renal complications (acute kidney injury, oliguria)	5 (10%)
Pleural or pericardial effusion	3 (5.4%)

**Table 4.** Characteristics of deceased patients (n = 5).

Type of complication	Description
Mean age	≈71 years
Diabetes mellitus	4/5 patients
Coronary disease	Severe bi- or triple-vessel disease
Left ventricular function	Impaired or borderline LVEF
Surgical risk profile	High-risk patients

The mean follow-up duration was approximately 1.96 years. All patients benefited from postoperative cardiac rehabilitation in the most recent period. Follow-up included clinical evaluation at postoperative day 15, and at 1 month and 6 months with transthoracic echocardiographic assessment, allowing assessment of functional recovery and cardiac performance.

#### 4. Discussion

In our series, the mean age of our patients was 62 years, which is comparable to most series reported in the literature: Mboup *et al.* [5] reported a mean age of 65.8 years, more recent African data have shown similar findings, with mean ages ranging between 58 and 60 years in contemporary coronary surgery cohorts in sub-Saharan Africa [6]. These results are also consistent with our initial Senegalese series of the first 10 cases, where the mean age was similarly 62 years, suggesting stability in the epidemiological profile over time. In our study, there was a clear male predominance, with a sex ratio of 2.67. This male predominance was also

observed in our first series, where 72.7% of patients were male, as well as in the study by Mboup *et al.* [5] and most international series in Africa [6] and India [7]. In our series, the clinical presentation was dominated by exertional and/or unstable angina, often associated with dyspnea and typical or atypical chest pain. These findings are consistent with our initial Senegalese series [3], where angina was the main symptom in 80% of patients, as well as with the study by Mboup *et al.* [5]. A prolonged delay between symptom onset and referral was observed, similar to our first series, reflecting persistent challenges in access to specialized care. This delay likely contributes to the advanced stage of coronary disease at presentation, a pattern commonly reported in African settings.

Cardiovascular risk factors were highly prevalent, with most patients presenting at least two risk factors, similar to our initial Senegalese series of the first 10 cases, where the coexistence of multiple risk factors was also a major characteristic. Hypertension was the most frequent risk factor, observed in 65% of patients, compared with 50% in our first series and similar to the findings of Mboup *et al.* [5]. These results are also consistent with recent African data, where hypertension remains the leading cardiovascular risk factor in patients undergoing cardiac surgery, with 64.2% of patients presenting with arterial hypertension [6]. In a large multicenter study across North and South America, Europe, the Middle East, and Asia, 67.5% of patients undergoing CABG had a history of hypertension [8]. In our series, diabetes was present in 35% of patients, consistent with our previous experience (30%) and comparable to the findings of Maria *et al.*, who reported a similar prevalence of 30% among CABG patients [8], as well as recent African data indicating rates of up to 45% [6]. Diabetes mellitus is a well-recognized risk factor for coronary artery disease, particularly when poorly controlled, where it significantly increases cardiovascular risk [9]. Smoking, either current or former, was found in approximately half of the patients, which is identical to our initial experience and in line with the African meta-analysis data [6]. Dyslipidemia was identified in approximately one-third of patients, although it was not reported in our first series, likely reflecting underdiagnosis due to incomplete lipid profiling at that time. A history of acute coronary syndrome or myocardial infarction was frequently observed, confirming the advanced stage of coronary disease at presentation. These findings illustrate the ongoing epidemiological transition in sub-Saharan Africa, characterized by an increasing burden of modifiable cardiovascular risk factors, as highlighted in recent meta-analyses [6]. The high prevalence and clustering of these risk factors contribute significantly to the severity of coronary lesions observed in our patients and underline the need for strengthened prevention strategies. In our series, the mean body weight was 76.8 kg and the mean body mass index was 25.16 kg/m<sup>2</sup>, with a predominance of overweight patients. These findings are consistent with our initial Senegalese series, where overweight was also frequently observed [3], and reflect the growing burden of lifestyle-related cardiovascular risk factors in African populations as reported by Mboup *et al.* [5] and in recent African data. In our series, coronary angiography showed a predom-

inance of advanced coronary artery disease, with triple-vessel involvement in 73% of cases, consistent with our initial Senegalese series where triple-vessel disease was observed in 70% of patients [3], and comparable to the findings of Mboup *et al.* [5]. The systematic involvement of the left anterior descending artery and the high frequency of left main disease reflect the severity and extent of coronary lesions at presentation, as commonly reported. Echocardiographic findings in our series were consistent with those of our initial experience, with a preserved mean left ventricular ejection fraction (56% vs 59% previously [3]), although a proportion of patients had impaired systolic function, which is associated with increased operative risk. Marui *et al.* reported that more than 70% of patients undergoing surgery for severe coronary artery disease had preserved left ventricular function (LVEF > 50%) [10]. Similarly, recent African meta-analysis data show that over 90% of patients had an LVEF above 40% [6], supporting the predominance of preserved ventricular function in this population. Segmental wall motion abnormalities were frequent and predominantly involved the anterior and septal territories, in line with the distribution of coronary lesions. Right ventricular function was generally preserved, as reflected by a normal TAPSE. The mean EuroSCORE II of 2.39% indicates a low-to-intermediate surgical risk profile, comparable to that observed in our initial experience and in other series from similar settings [6].

From a surgical standpoint, the use of the left internal mammary artery in approximately 90% of cases is consistent with international standards and comparable to our initial Senegalese series [3]. The mean number of grafts per patient (2.2) reflects the predominance of multivessel revascularization. Cardiopulmonary bypass and aortic cross-clamp times in our series (140 and 104 minutes, respectively) remain longer than those reported in recent African data (112 and 67 minutes, respectively) [6], likely reflecting the learning curve of our team, although a clear reduction has been observed over the last two years. The introduction of off-pump CABG in a subset of patients represents a notable evolution [4]. The mean time to extubation was 6 hours, shorter than in our initial Senegalese series, where it was 11 hours [3], reflecting improved perioperative management. Electrocardiographic monitoring in the intensive care unit most often showed stable or normalized findings, with only transient rhythm disturbances, similar to our previous observations. The mean length of stay in the intensive care unit remained comparable (7 days), consistent with our first series [3], but longer than in Western series [11], likely reflecting differences in postoperative care organization and resource availability, as well as later diagnosis and delayed management in our setting.

In our series, postoperative morbidity was significant and multifactorial, affecting 32% of patients, but represents a clear improvement compared with our initial Senegalese experience, where complication rates were markedly higher [3]. Infectious complications were the most frequent (16.3%), a rate higher than that reported in the African multicenter study (4.59%) and in high-income settings such as the United States (1.1%) [12], but comparable to some middle-income countries. Neurological complications (12.7%) and renal complications (10%) were

also more frequent than those reported in African meta-analysis data, where renal dysfunction was estimated at 5.38% [6]. Hemodynamic and respiratory complications (10.9% each) were notable in our cohort, likely reflecting the advanced stage of disease at presentation and perioperative challenges. In contrast, the incidence of postoperative atrial fibrillation appears lower than that reported in Western series, such as the 21.5% described by Magee *et al.* [13], which may be partly explained by ethnic differences, as lower rates of atrial fibrillation have been reported in African populations [14]. Overall, these findings highlight the multifactorial nature of postoperative morbidity in our setting, influenced by the advanced stage of disease at presentation, delayed diagnosis and management, comorbidities, and the evolving experience of the surgical team, while also demonstrating a progressive improvement compared with our initial experience. However, they also reflect the heterogeneity of cardiac surgery outcomes across the continent, where resource availability and experience vary widely.

Overall mortality was 9%, with no mortality recorded over the last 2 years of the study period, reflecting a significant improvement in perioperative outcomes. After the initial series of 10 patients, mortality over the last three years was 2 out of 45 patients, corresponding to 4.44%. This trend strongly supports the progressive improvement of surgical outcomes with increasing experience. This mortality rate is comparable to that reported in the African meta-analysis [6], which estimated mortality at 3.51%, as well as to the findings of Adelborg *et al.*, who reported a 30-day mortality rate of 3.2% in a Danish cohort of more than 50,000 patients undergoing CABG over a 30-year period [15]. However, it remains higher than rates observed in some other studies, such as that of Paez *et al.* in Brazil (2.8%) [16], or reports from Canada (1.3%) [17] and the Society of Thoracic Surgeons database in the United States (2%) [11]. Conversely, higher mortality rates have been described in certain settings, such as the study by Jose *et al.* in India, which reported an early mortality rate of 11.62% [7]. This elevated rate was attributed to a higher proportion of emergency and salvage CABG procedures performed in a primary referral center [7]. Overall, these variations in postoperative mortality across regions are likely related to differences in technical resources, patient profiles, and healthcare system organization. A phase-by-phase comparison between the initial experience (2019-2022) and the subsequent expansion period (2023-2025) further illustrates the progressive improvement of the program. While baseline patient characteristics remained broadly similar, operative performance improved over time, with a reduction in cardiopulmonary bypass and aortic cross-clamp times, particularly in the most recent cases. Perioperative management also evolved, as reflected by shorter extubation times compared with the initial series. Postoperative morbidity decreased substantially compared with the first 10 cases, and mortality showed a marked reduction, from higher rates in the initial phase to 4.44% over the last three years, with no deaths recorded in the most recent period. These findings highlight the impact of the learning curve, improved team coordination, and progressive optimization of surgical and perioperative

practices.

Although cardiac surgery in Africa began in the 1950s with the first heart transplant in South Africa, access remains very limited, particularly in sub-Saharan Africa [18]. This is largely due to high costs, the need for specialized infrastructure, and insufficient healthcare funding, which hinder the development and sustainability of cardiac surgery programs [19 [20]. In addition, there is a severe shortage of trained personnel, with approximately one cardiothoracic surgeon per 1.3 million inhabitants in Africa and only 12 cardiac surgeries performed per million people [18]. These limitations likely contribute to the disparities in outcomes observed compared with high-income countries.

## 5. Conclusions

From the first cases to the expansion of a structured program, coronary artery bypass grafting in Senegal has demonstrated its feasibility and progressive improvement in outcomes, as illustrated by this single-center experience of 55 patients. Despite challenges related to delayed presentation, advanced disease, and limited resources, surgical results have become increasingly comparable to those reported in similar settings.

The evolution of this program also highlights a growing diversification of surgical strategies, notably with the introduction of off-pump coronary artery bypass. In the context of sub-Saharan Africa, where resources are often constrained, the wider adoption of beating-heart techniques may represent a valuable approach to reduce perioperative morbidity and optimize outcomes.

Further development of cardiac surgery in the region will require strengthening infrastructure, expanding training programs, improving early diagnosis and referral pathways, and promoting context-adapted surgical innovations. These efforts are essential to ensure sustainable access to high-quality coronary revascularization and to meet the increasing burden of cardiovascular disease in sub-Saharan Africa.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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## Abbreviations

<b>CABG</b>	Coronary Artery Bypass Grafting
<b>OPCAB</b>	Off-Pump Coronary Artery Bypass
<b>CPB</b>	Cardiopulmonary Bypass
<b>LAD</b>	Left Anterior Descending (Artery)
<b>RCA</b>	Right Coronary Artery
<b>LIMA</b>	Left Internal Mammary Artery
<b>RIMA</b>	Right Internal Mammary Artery
<b>GSV</b>	Great Saphenous Vein
<b>ACT</b>	Activated Clotting Time
<b>ECG</b>	Electrocardiogram
<b>TTE</b>	Transthoracic Echocardiography
<b>ICU</b>	Intensive Care Unit
<b>NYHA</b>	New York Heart Association
<b>MI</b>	Myocardial Infarction
<b>AF</b>	Atrial Fibrillation
<b>VF</b>	Ventricular Fibrillation
<b>BMI</b>	Body Mass Index
<b>HbA1c</b>	Hemoglobin A1c
<b>HCV</b>	Hepatitis C Virus
<b>HIV</b>	Human Immunodeficiency Virus
<b>HBV</b>	Hepatitis B Virus
<b>EuroSCORE II</b>	European System for Cardiac Operative Risk Evaluation II