

Heart surgery by the locals in resource-limited settings: The experience from Ethiopia



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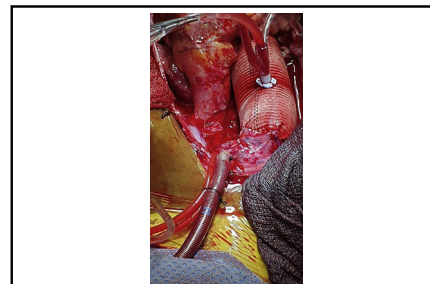
ABSTRACT

Background: In developing countries, despite its demand is high, heart surgery is not always accessible to the neediest patients. We aimed to describe the early outcomes of heart surgeries that were performed by a local cardiac surgical team in Addis Ababa, Ethiopia.

Methods: Data were collected through chart abstraction of patients who underwent heart surgery from the period of June 2017 to July 2021 by the same local cardiac surgical team at 3 centers in Addis Ababa, Ethiopia. Data were analyzed using the Statistical Package for the Social Sciences for Windows version 20.0.

Results: A total of 290 patients who underwent heart surgery during the specified period were included in the study. Of the total, 192 patients underwent valve surgery (177 were patients with rheumatic valvular disease and 15 were valve surgeries with other causes) with a 30-day mortality rate of 9 (4.7%), 33 patients underwent coronary artery bypass graft with a 30-day mortality rate of 3 (9.1%), 58 patients underwent repair for congenital heart diseases with no 30-day mortality. Specifically, button Bentall was done for 1 patient; maze procedure was done for 2 patients along with mitral valve surgery, and a total of 7 out of 290 (2.4%) underwent redo heart surgery. The overall procedure-related mortality was 4.1%.

Conclusions: In addition to operating on a large number of cardiac patients, the local cardiac surgical team was able to do complex surgical procedures such as button Bentall, left maze procedure, redo valve surgeries, and coronary artery bypass graft surgery in a resource-limited setup. The overall patient outcome was comparable to reports from other centers. (JTCVS Open 2022;9:98-105)



Aspects of the first successful button Bentall procedure performed by the local team.

CENTRAL MESSAGE

Our local team was able to do procedures such as button Bentall, left maze, redo valve surgeries, and coronary artery graft surgery in a resource-limited setup with good outcomes.

PERSPECTIVE

Four years since the commencement of open-heart surgery by the complete local team in a resource limited set up. We believed the achievement and the performance status would help as a reference for future as well as for the region to compare outcome of open-heart surgery.

▶ Video clip is available online.

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The outcome of heart surgery was daunting during the early period from 1960 to the 1970s. The operative mortality of heart surgery for those older than age 65 years at Mayo clinic from 1968 to 1973 was: aortic valve replacement (AVR) 10.6%, mitral valve replacement (MVR) 20%, and multiple valve surgery 42%.¹ With improvement in diagnostic technologies, refinement in extracorporeal circulation, myocardial protection techniques, and advanced postoperative care, the outcome of heart surgery has improved tremendously.

According to the Society of Thoracic Surgeons National Cardiac Surgery Database, from 1994 to 1997 the operative mortality of AVR and MVR was 4.0% and 6.04%, respectively, drawn from a 49,073-population study.² According to a 2009 Veterans Affairs Medical Centers report on 2203 patients undergoing coronary artery bypass grafting

Abbreviations and Acronyms

AVR	= aortic valve replacement
CABG	= coronary artery bypass graft
MVR	= mitral valve replacement
RHD	= rheumatic heart disease

(CABG), the outcome of composite of death or complications within 30 days of surgery was 5.6% for on-pump CABG and 7% for off-pump CABG.³

In-hospital mortality among children younger than age 18 years after surgery for congenital heart disease, based on a designated risk score called Risk Adjustment for Congenital Heart Surgery 1, which was based on the categorization of several surgical procedures (palliative or corrective) showed variable in-hospital mortality rates according to risk. For the Pediatric Cardiac Care Consortium data, mortality rates were 0.4% in category 1%, 3.8% in category 2%, 8.5% in category 3%, 19.4% in category 4%, and 47.7% in category 6.⁴

With an estimated population of 1 billion persons in Sub-Saharan Africa from Maghreb to South Africa, there are reports that some countries in this region started doing heart surgery in the 1970s. The Rwandan 10-year experience by missionaries showed 4.7% operative mortality of valve surgery⁵; the 35-year cardiac surgery experience report from Cote d'Ivoire showed 6.7% operative mortality of rheumatic heart disease (RHD) valve surgery.⁶ A 5-year experience report from Tanzania on 85 CABG surgeries showed 7.1% mortality during the 30-day period postsurgery.

Established in 2009, the Cardiac Center of Ethiopia was providing heart surgery service free of charge with the help of overseas voluntary missionary cardiac teams who were coming mainly from Europe and the United States.⁷ However, 4 years back, the local cardiac team, which was trained in India, was able to overtake the responsibility and it is providing heart surgeries at the Center. Moreover, in addition to providing the service at the Cardiac Center of Ethiopia, the local cardiac team is also expanding the heart surgeries at 2 different private, for-profit hospitals in Addis Ababa.

A complete local cardiac surgical team commenced heart surgery during mid-2017.⁸ In this article, we aim to present the spectrum, scope, and early patient outcomes of heart surgery performed by the same local team at 3 hospitals during the 4-year period from June 2017 to June 2021.

METHODS

The study was conducted at 3 centers in Addis Ababa (Cardiac Center of Ethiopia, Elozouir Cardiac Center, and Tazma Cardiac Center) that are conducting heart surgery. Over the past 4 years, in these 3 centers, the same local cardiac surgical team has performed the heart surgery. Local team is defined in this study as when the lead cardiac surgeon, cardiologist,

cardiac anesthesiologist, intensive care unit lead doctor, perfusionists, and operative scrub nurses are from the local personnel. Operative mortality is defined as death within 30 days of the index surgery.

All patients who underwent heart surgery during the period from June 2017 to July 2021 that was performed by the local cardiac team in the 3 centers were included in the study. Data were collected through chart abstraction and structured questionnaire was used to collect data. Demographic characteristics (age and sex), the specific preoperative cardiac lesion, the type of heart surgery, presence of comorbid conditions, duration of hospital stay, and patient outcome within the first 30 days of the postsurgery period were collected. SPSS version 20.0 for Windows (IBM-SPSS Inc) was used to analyze data. The Institutional Review Board of St Paul's Hospital Millennium Medical College approved the study on April 13, 2021, with registration No. PM23/656.

SURGICAL TECHNIQUE**CABG Surgery**

Three of the CABG surgeries done were on a beating heart (ie, off-pump CABG). All 3 were single-vessel grafts that were done by using left internal thoracic artery to left anterior descending artery. The rest 30 were done on-pump using aortic and right atrial 2-stage cannulation and a cold St Thomas antegrade cardioplegia was administered every 20 minutes. The surgeon wore a 3.5 × telescope loop and used 7 to 0 Prolene for all distal anastomoses. All proximal anastomoses were done on a beating heart using 6 to 0 Prolene.

Valve Surgery

After midline sternotomy and pericardium was tucked to the sternum, aortic and 2-stage right atrial cannulation with vent placed in the right upper pulmonary vein for isolated AVR. Aortic and selective bicaval cannulation was established for the rest of the valve surgeries. St Thomas antegrade cardioplegia was administered every 20 minutes until crossclamp was released.

Congenital Heart Surgery and Cardiac Mass

After midline sternotomy and pericardium was tucked to the sternum, aortic, and 2-stage right atrial cannulation for isolated subaortic membrane excision and vent placed in the right upper pulmonary vein. Aortic and selective bicaval cannulation was established for the rest of congenital heart surgeries. St Thomas antegrade cardioplegia was administered every 20 minutes until crossclamp was released.

Four patients with tetralogy of Fallot underwent intracardiac repair with transannular patch using untreated autologous pericardial patch. The ventricular septal defect was closed transatrially through the tricuspid valve using glutaraldehyde-treated autologous pericardial patches. One patient with tetralogy of Fallot underwent only transatrial right ventricular outflow tract relief and transannular patch was not needed. Using 2-patch technique repair, 1 patient underwent complete atrioventricular septal defect closure.

Bentall Procedure

Button Bentall procedure was done using the same cannulation and vent technique as the AVR. The buttons of the coronary ostia were anastomosed to the conduit using 6 to 0 Prolene. The distal conduit anastomosis to the aorta was done using 4 to 0 Prolene.

Left Maze Procedure

In addition to the procedure on the mitral valve, the components of left maze procedure were 4: left atrial appendage excision and sewing in 2 layers using 4 to 0 Prolene, all 4 pulmonary veins were isolated using cut-and sew technique, left atrial reduction, and a connection cut-and-sew line from the left atrial appendage to mitral annulus.

Redo Surgery

There were 7 redo surgeries with a redo sternotomy approach. The reasons for the 7 redo surgeries were as follows:

- Redo sternotomy for infected lead removal. The patient was a 47-year-old man who previously underwent permanent pacemaker implantation after he developed third-degree heart block following AVR surgery. He developed infective endocarditis (pacemaker lead infection) and required redo sternotomy to remove the infected lead.
- Redo-AVR and redo sternotomy was done for severe aortic valve insufficiency 15 years after AVR was done for chronic RHD.
- Redo MVR plus redo tricuspid valve repair was done for a 10-year-old boy after the patient developed severe hemolytic anemia following MVR and tricuspid valve repair that was done for severe mitral and tricuspid valve regurgitation due to RHD.
- Redo MVR and redo sternotomy was done for a 32-year-old woman after she developed stuck mitral mechanical valve 10 years after double valve replacement was done for chronic RHD.
- Redo MVR and redo sternotomy was done for 3 patients who underwent tissue valve replacement at 7, 8, 10 years after the initial cardiac surgery after presenting with degenerative change of the prosthetic valve causing severe stenosis of the mitral valve.

Patient Selection

The local cardiac surgical team conducts a weekly Joint Clinical Committee meeting to discuss patients who will be selected for surgery. The team comprises cardiac surgeons, cardiologists, cardiac anesthesiologists, and cardiac intensivists. Patients will undergo operation only if the team reaches consensus that the patient will benefit from the planned surgery.

Postoperative Patient Management

The Center has a 10-bed intensive care unit equipped with mechanical ventilators and patient monitors. However,

there is lack of important intensive care unit drugs such as milrinone and vasopressors. Also, in times of difficulty to wean from cardiopulmonary bypass there is no back up of important machines such as intra-aortic balloon pump and extracorporeal membrane oxygenation machine. There is also a shortage of full-time cardiac intensivists to care for critically sick postoperative patients.

RESULTS

Preoperative Characteristics

A total of 290 patients underwent heart surgery during the 4-year period. Of the total, 192 (66.2%) underwent operation for valve lesions (RHD or non-RHD etiology), 33 were operated on for coronary artery disease, and 58 for congenital heart disease. Four patients underwent intracardiac mass excision and the remaining 3 were operated on for other types of cardiac lesions (Table 1).

Among the 192 valve surgeries 177 (92.2%) were underwent operation for RHD etiology valve surgery. The mean age for RHD surgery patients was 31.3 years, with an age range from 7 to 72 years. Male patients constituted 83 (47%), whereas female patients constituted 93 (53%). From the 192 total valve surgeries, 15 (7.8%) were non-RHD etiology. The mean age for valve surgery due to non-RHD etiology was 54.9 years, with a range of 14 to 74 years. Nine (60%) of the patients were men in this group of valve surgery. All of this non-RHD etiology valve surgery was isolated AVR. In 1 young patient, who was operated on for isolated severe aortic regurgitation, pathology later confirmed connective tissue disease and no Aschoff bodies. Twelve out of 15 (80%) of the AVR procedures done were due to degenerative severe aortic stenosis. The remaining 2 AVR procedures were done due to congenital bicuspid aortic valve causing severe aortic stenosis.

There was 1 isolated tricuspid valve replacement done for a 40-year-old woman after she presented with New York Heart Association class IV heart failure due to severe tricuspid regurgitation.

Congenital heart surgery constituted 20% of the total heart surgeries performed in this study. The mean age for congenital surgery was 15 years with the range of 1.2 to 57 years. Female patients made up 36 (62%) of the congenital heart disease surgery group. Of the 58 patients who had congenital heart disease, 26 (44.8%) of them had isolated secundum atrial septal defect.

The mean age for CABG surgery, which made up 11.4% of the heart surgeries performed in this study, was 63.3 years with an age range of 42 to 90 years. The majority of patients were men, making up 28 (84.8%) of the total. Of the 33 patients who underwent CABG surgery, 32 of them had a preoperative comorbid medical illness. Of the 32 patients who had a preoperative comorbid illness, 28 had either diabetes or hypertension or a combination of these 2 disease conditions. Also, preoperatively, 16 out of 32 patients with

TABLE 1. List of the diagnoses and the corresponding cardiac surgical procedures performed, 2021

Diagnosis	Type of procedure	No. of procedures
Rheumatic valvular heart disease	Double valve replacement surgery	18
	Double valve replacement with tricuspid valve repair surgery	12
	Isolated RHD aortic valve replacement surgery	14
	Isolated mitral valve repair surgery	13
	Isolated mitral valve replacement surgery	51
	Mitral valve replacement and tricuspid valve repair surgery	48
	Aortic valve replacement and mitral valve repair	4
	Aortic valve replacement and open heart mitral valve commissurotomy	5
	Mitral valve repair and tricuspid valve repair surgery	4
	Tissue mitral valve replacement and left maze	2
	Redo mitral valve replacement surgery	5
Redo aortic valve replacement	1	
Total RHD surgery		177
Degenerative aortic valve disease	Aortic valve replacement	12
Tricuspid valve replacement for non tissue mass on septal leaflet	Tricuspid valve replacement	1
Bicuspid aortic valve with severe stenosis	Aortic valve replacement	2
Total non RHD etiology valve surgery		15
Total valve surgery		192
CABG + Valve surgery		1
CABG surgery		32
Total CABG surgery		33
TOF	Intracardiac repair with TAP	5
VSD	VSD patch closure	6
Secundum ASD	Autologous pericardial patch closure of ASD	26
Secundum ASD and PDA\$	Autologous pericardial patch closure of ASD and PDA ligation	1
Ostium primum ASD	ASD closure	1
PDA device emboli to RPA	Device delivery and PDA ligation	1
ASD device emboli	Device delivery and ASD closure	1
Secundum ASD and pulmonary stenosis	Autologous pericardial patch ASD closure and RVOTO relief	1
Subaortic membrane	Subaortic membrane excision	8
Subaortic membrane and PDA	Subaortic membrane excision and PDA ligation	2
Partial anomalous pulmonary venous drainage	Rerouting 2 patch technique	3
Complete AVSD	2-patch technique AVSD closure	1
Partial AVSD and cor triatriatum	Cor triatriatum membrane excision and AVSD repair	1
Secundum ASD and cor triatriatum sinistrum	Membrane excision and ASD closure	1
Total congenital surgery		58
Left atrial myxoma	Excision of the myxoma	1
Right atrial myxoma	Excision of the myxoma	2
Mature cystic teratoma inside the right ventricle	Excision of the mass	1
Total intracardiac mass excision		4
Aortic root aneurysm and severe aortic regurgitation	Button Bentall procedure	1
Infected pacemaker lead	Redo sternotomy and lead removal	1
Hypertrophic obstructive cardiomyopathy	Septal myomectomy	1
Miscellaneous cardiac surgery		3
Total heart surgeries		290

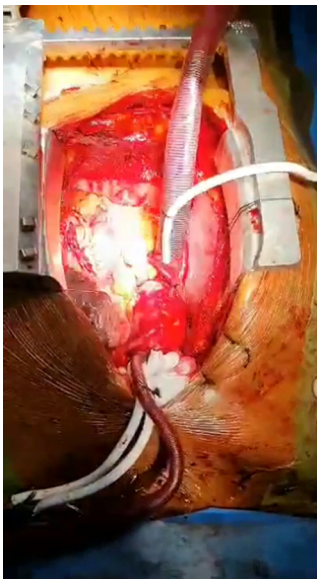
RHD, Rheumatic heart disease; CABG, coronary artery bypass grafting; TOF, tetralogy of Fallot; VSD, ventricular septal defect; ASD, atrial septal defect; PDA, patent ductus arteriosus; RVOTO, right ventricular outflow tract obstruction; AVSD, atrioventricular septal defect.

coronary artery disease were diagnosed with left bundle branch block. The local team performing a 3-vessel CABG surgery is provided in [Video 1](#).

Four patients (1.4%) of the total heart surgeries, were operated on for an intracardiac mass. These patients had a mean age of 34.3 years and 50% of them were women. Three (1%) of the total heart surgeries were miscellaneous surgeries. The first was a button Bentall procedure for a 23-year-old man for a 90-mm maximum dilatation of the aortic root and ascending aorta with severe aortic regurgitation. The patient had classic clinical features of Marfan syndrome ([Figure 1](#)). The second surgery was septal myectomy for a 30-year-old man diagnosed with hypertrophic obstructive cardiomyopathy. The third surgery was redo sternotomy for an infected pacemaker lead removal for a 50-year-old man after recurrent admission for infective endocarditis. The pacemaker was inserted for a third-degree complete heart block after AVR 5 years ago.

Postoperative Outcomes

Of the total 290 patients who underwent heart surgery, 12 (4.1%) died within 30 days of the surgery. Nine (75%) of the deaths happened among patients who underwent valve surgery, making the mortality rate among valve surgery 4.7%. However, procedure-related mortality was higher among patients who were operated on for CABG surgery compared with valve surgery (9.1% vs 4.7%). All the deaths among valve surgery patients occurred for RHD etiology valve surgery. This makes the 30-day mortality



VIDEO 1. Video showing the local team after completing a 3-graft coronary artery bypass graft procedure on a 71-year-old hypertensive, nondiabetic patient just before starting to wean from a cardiopulmonary bypass machine. Video available at: [https://www.jtcvs.org/article/S2666-2736\(22\)00011-0/fulltext](https://www.jtcvs.org/article/S2666-2736(22)00011-0/fulltext).

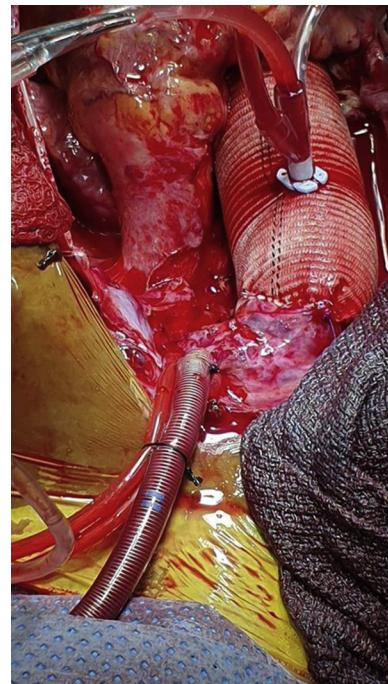


FIGURE 1. The first successful button Bentall procedure performed by the local team, showing a 36 mm polyethylene terephthalate composite conduit replacing the whole ascending aorta. The aortic cannula and the de-airing aortic root needle in situ just before coming off bypass.

among RHD etiology valve surgery patients in this study 9 out of 177 (5.1%). Nine patients of the total 290 developed tamponade physiology requiring surgical intervention and all of them occurred among RHD etiology valve surgery patients ([Table 2](#)).

There was no 30-day mortality among the 58 congenital heart surgeries performed by the team. Postoperative stroke was observed in 3 out of 290 (1%) patients. Renal failure requiring dialysis occurred in 3 out of 290 (1%) patients. [Figure 2](#) shows the overall performance of the local team.

DISCUSSION

This study aimed to describe the early mortality, the range of heart surgeries, and patient outcomes of heart surgeries performed by the local cardiac surgical team in a resource-limited setting. The heart surgeries performed include valve surgeries, CABG surgery, surgery of shunt lesions, tetralogy of Fallot repair, intracardiac mass excision, aortic root repair (ie, button Bentall), redo heart surgeries, and maze procedures. Inherently, heart surgery is a resource-intensive surgical procedure that also requires a team of qualified health professionals. Patient outcome is highly dependent on the availability of the needed medical equipment as well as technology both during the surgical procedure and during the postoperative period. Resource

TABLE 2. Morbidity and mortality in the first 30 days following heart surgery, 2021

Procedure	No. of surgeries	Re-exploration for bleeding	Tamponade physiology requiring drainage	Complete atrio-ventricular block requiring PPM	Renal Failure Requiring Dialysis	Stroke with focal neurologic loss	Deaths
RHD valve surgery	177	6	9	1	1	1	9
AVR for degenerative and bicuspid	–	–	–	–	1	–	–
CABG	33	–	–	–	1	–	3
Congenital surgery	58	–	–	–	–	2	–
Intracardiac mass excision	4	–	–	–	–	–	–
Miscellaneous cardiac surgery	3	–	–	–	–	–	–
Total	289	6	9	1	3	3	12

RHD, Rheumatic heart disease; AVR, aortic valve replacement; CABG, coronary artery bypass grafting.

scarcity is almost always a challenge of providing health care services in developing countries, particularly heart surgery. The local cardiac team performed the mentioned heart surgeries in the midst of those challenges.

From 2009 to 2017, the voluntary cardiac teams from Europe and the United States were doing heart surgery at the Cardiac Center of Ethiopia. During this period, the voluntary teams played a significant role not only in transferring knowledge and skill to the local cardiac team, but also introducing a good work culture in the Center. In addition, because each voluntary team was coming to the Center with all the consumables and skilled manpower needed to conduct the surgeries that were planned during the visit, patients were getting the service free of charge and affordability was not an issue.

In 2017, an Ethiopian cardiac surgical team returned home after completing training in India. Because the voluntary teams had already laid important groundwork, it was not a hard landing for the local cardiac team to keep the Center running after returning from abroad training. However, it was not without challenge that the local team is able to keep the Center functioning. The Center provides the service free of charge and its source of income is philanthropic organizations. As a result, its income is neither adequate nor predictable and sometimes the Center is forced to function below its capacity due to lack of consumables. That means patients who would have benefitted from early intervention are forced to wait until consumables are available. Such delayed intervention would affect patient outcome even if intervention was done at a later time.

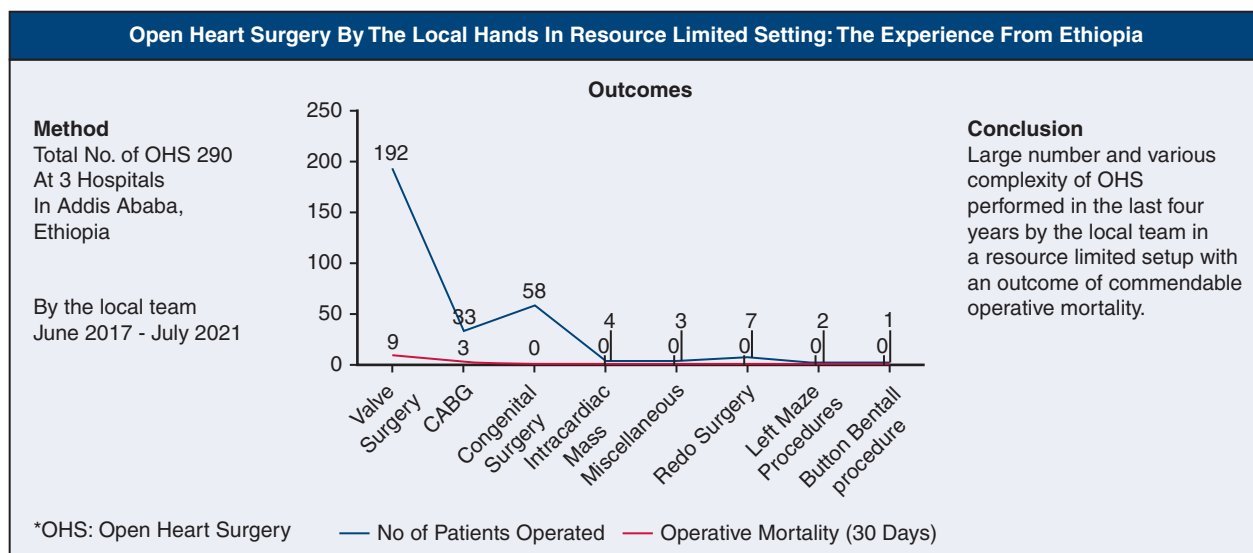


FIGURE 2. The performance of the local team in Ethiopia after launching conventional heart surgery for the first time. OHS, Open heart surgery.

In addition to shortage of consumables, the lack of well-trained nurses and cardiac professionals capable of providing perioperative care for babies weighing <10 kg is also a challenge in our setting. Moreover, our cardiac intensive care unit is not well equipped and staffed, which has direct influence on patient outcomes and also forces surgeon to be selective of the patients to be operated on.

The team performed a total of 33 CABG surgeries in which 3 of the bypass procedures were performed off-pump and the remaining were done while patients were on-pump. One patient received CABG plus AVR by the local team. In addition, the team performed 4-vessel CABG surgeries and we believe that this procedure was the first of its kind in the nation of Ethiopia. The overall in-hospital mortality rate of the CABG procedure was 9.1%, which is higher than the 2.0% mortality rate reported by Lazar and colleagues.⁹ The higher mortality rate in our setting can be explained by the late presentation of patients coupled with poor resource availability that was needed for the surgical procedure. Of the 3 deaths following CABG surgery in our case series, 1 had 15% preoperative left ventricular ejection fraction, indicating late patient presentation. The second death was a 76-year-old patient who had diffuse triple-vessel disease in the setting of acute myocardial infarction and grafting of the left anterior descending coronary artery was difficult due to thrombosis of the vessel. The third death was a patient who had a preoperative left ventricular ejection fraction of 35% and acute kidney injury with a creatinine level of 2.7 mg/dL and hemoglobin level of 10 g/dL.

In 9 hours, the local team performed successfully the first button Bentall procedure without complication. Button Bentall procedure is said to be superior in its outcome versus the classic Bentall procedure and the Carbol modification Bentall procedure with only 4% operative mortality.¹⁰ Bleeding is the feared complication of the procedure and it did not happen in the postoperative course of our patient and the patient was fully conscious with full motor and cognitive function the next day after the procedure. Next to atherosclerosis, connective tissue disorder is the most common cause of aortic root aneurysm,^{11,12} and that was the likely cause of aortic root dilatation in our patient.

Of the total 12 postoperative deaths that occurred among the 290 patients who underwent heart surgery, 9 were patients who were operated on for RHD. The overall postoperative mortality rate of RHD surgery was 5.1%, which is higher than the 2.43%, 3.85%, and 7.25% mortality for aortic, mitral, and tricuspid valve surgeries, respectively, that was reported by Meija and colleagues.¹³ The higher postoperative mortality among patients who underwent RHD surgery in our setting can be explained by the late presentation of patients (mean age, 31.7 years), and the need for multiple valve surgery (91 [51.4%] patients underwent more than 1 valve surgery). Additionally, most patients had moderate-to-severe pulmonary hypertension and chronic

atrial fibrillation at presentation in our setting,¹⁴ which might have contributed to the increased postoperative mortality in our setting.

Of the 2 patients who underwent left maze procedure along with mitral valve surgery for RHD, 1 patient turned to sinus rhythm, whereas the other patient continued to have the atrial fibrillation with controlled ventricular rate postoperatively. According to Jae and colleagues,¹⁵ the rate of sinus conversion within 7 days postsurgery for modified maze procedure is 86%, irrespective of the cause (ie, rheumatic or degenerative).

The team performed 7 redo heart surgeries over the 4-year period and there was no operative death following the redo surgery. None of these redo surgeries required peripheral cannulation for bleeding and all went through central cannulation uneventfully. There was an 11% operative mortality in the report from Arkalgud and colleagues¹⁶ in those patients who underwent redo mitral valve replacement for a previous valve replacement surgery.

According to Howell and Bradlow,¹⁷ atrioventricular block, ventricular septal defect, and aortic regurgitation are the common complications following surgical myectomy for hypertrophic obstructive cardiomyopathy. None of these complications happened in the only 27-year-old patient who underwent surgical septal myectomy, and the patient's left ventricular outflow tract gradient dropped from 85 to 12 mm Hg postoperatively.

Among the patients who underwent intracardiac mass excision procedures, 1 patient had an exceedingly rare mass with 6 × 4.5 cm dimensions arising from the interventricular septum that caused right ventricular outflow tract obstruction. Through a dual ventriculotomy and atriotomy approach, a successful mass excision was achieved. There was no heart block, ventricular septal defect, or tricuspid valve regurgitation following the procedure. Histologic study of the excised mass showed mature teratoma of the right ventricle¹⁸; this kind of right ventricle tumor is exceedingly rare and only few cases are reported.¹⁹

CONCLUSIONS

Over the 4-year period, the local team performed heart surgeries ranging from shunt lesions such as atrial septal defect, ventricular septal defect, and atrioventricular septal defect to button Bentall procedures, CABG surgeries, left maze procedures, redo surgeries, and multiple valve surgeries with very good patient outcomes. However, the pediatric heart surgeries were limited to lesions such as tetralogy of Fallot repair, cor triatrium sinister, and partial atrioventricular canal defect repair. Complex congenital heart lesions such as transposition of the great arteries and lesions that require single-ventricle pathway were not performed by the team. Apart from the very sophisticated setup that these surgeries require, the experience it demands from a heart team might be a contributing reason for the paucity

of complex congenital surgeries in our setup. In addition to operating on a large number of cardiac patients, the local cardiac surgical team was able to do complex surgical procedures such as button Bentall, CABG, left maze procedure and redo valve surgeries in a resource-limited setup. Therefore, in addition to helping improve patient outcomes, the findings of the current study will help the team to improve its learning curve so that it will plan to perform those advanced heart surgeries. The overall patient outcomes were comparable with reports from other centers.

Conflict of Interest Statement

The authors reported no conflicts of interest.

The *Journal* policy requires editors and reviewers to disclose conflicts of interest and to decline handling or reviewing manuscripts for which they may have a conflict of interest. The editors and reviewers of this article have no conflicts of interest.

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