AZJCVS
AZerbaijan Journal of CardioVascular Surgery

AZJCVS 2025;6(2):51-5
DOI: 10.5455/azjcvs.2025.02.03

Case Report

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Received: 27 February, 2025
Accepted: 25 May, 2025
Published: 28 July, 2025

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CITATION
Gasimova M, Aliyev B, Mammadova K, Abbasaliyeva A, Gulmaliyev C, Memiyev E, et al. Ross procedure- surgical solution pediatric aortic valve endocarditis: Case report and literature review. AZJCVS. 2025;6(2):51-5.

Ross procedure- surgical solution pediatric aortic valve endocarditis: Case report and literature review

Abstract

The Ross procedure, involving the replacement of a diseased aortic valve with the patient's own pulmonary valve (autograft) and subsequent pulmonary valve replacement with a homograft or xenograft, is particularly advantageous in pediatric patients due to its growth potential and reduced need for future surgeries. This technique also minimizes complications associated with mechanical and bioprosthetic valves, such as thromboembolism and the need for anticoagulation therapy. However, it is technically complex and may lead to double-valve disease. Infective endocarditis (IE), an infection of the endocardium, especially affecting heart valves, poses significant challenges in children with congenital heart disease or a history of cardiac surgery. The Ross procedure offers a viable alternative, demonstrating a lower reoperation rate than homografts and eliminating the need for anticoagulation. We present a case of a 6-month-old boy with congenital aortic stenosis and severe IE who underwent the Ross procedure after appropriate antibiotic therapy. He survived without significant short-term sequelae, underscoring the procedure's efficacy in managing pediatric IE and valve disease.

Keywords: Ross procedure, aortic valve, enfective endocarditis

INTRODUCTION

The Ross procedure, also referred to as the switch procedure, involves excising the diseased aortic valve and replacing it with the patient's own pulmonary valve (autograft). The pulmonary valve is subsequently replaced with a homograft or xenograft (1). Developed in the late 1960s, this technique is particularly beneficial in pediatric patients, as the autograft can grow with the child, thereby reducing the need for future surgical interventions. Additionally, it minimizes complications associated with mechanical or bioprosthetic valves, such as thromboembolism and the requirement for anticoagulation therapy (2). The procedure offers the advantages associated with a native valve, such as enhanced hemodynamic performance, the removal of anticoagulation requirements, and growth potential. However, it is technically intricate and poses the risk of transforming single-valve disease into double-valve disease (3).

Infective endocarditis (IE) is an infection of the inner lining of the heart, especially affecting the heart valves (4). In children, particularly those who have undergone cardiac surgery, the risk of developing IE is heightened due to factors related to congenital heart defects, surgical interventions, and invasive procedures. Although rare, IE in children presents significant management challenges. The most prevalent risk factor is

a history of congenital heart disease; however, emerging predisposing conditions include central venous catheters and chronic debilitating illnesses (5). Cases in previously healthy children have also been documented.

Historically, the treatment of IE has relied on biologic homografts or mechanical valves. However, the Ross procedure presents a promising alternative for young patientss. It demonstrates a lower incidence of reoperation compared to biologic homografts and negates the need for anticoagulation associated with mechanical valves—a critical factor for younger patients who may have lower compliance with treatment regimens (6).

Although the Ross procedure is less frequently performed than other aortic valve replacement techniques, it constitutes approximately 3–6% of all pediatric aortic valve interventions in high-volume congenital cardiac surgery centers. Its utilization varies depending on institutional expertise and surgeon preference but remains a key strategy in selected pediatric patients with infective endocarditis or congenital aortic valve disease (7).

Herein, we report the case of a 6-month-old boy admitted to the hospital with a severe infection and a relevant medical history of surgical intervention for congenital aortic stenosis. The patient received appropriate antibiotic therapy and subsequently underwent the Ross procedure, successfully surviving the acute illness without significant short-term sequelae.

CASE REPORT

The patient was admitted to our hospital for open heart surgery, presenting with a diagnosis of congenital dysplastic aortic valve and severe aortic stenosis, with a normal aortic annulus. Initial preoperative echocardiography Bicuspid, dysplastic aortic valve. Severe aortic stenosis (aortic annulus is normal). (peak gradient 94 mmHg, mean gradient 43 mmHg). No aortic insufficiency (AI) observed. Left ventricle (LV) is severely hypertrophic. The patient underwent aortic valve repair and valvuloplasty utilizing cardiopulmonary bypass during the procedure. During the procedure, it was determined that the aortic valve exhibited dysplastic characteristics and presented as a bicuspid valve.The findings of the postoperative echocardiography is 28 mmHg peak gradient and no insufficiency observed.

Postoperatively, the patient was able to tolerate oral feeding, and his prior treatment regimen was discontinued. He was transferred back to Clinical Children's Hospital on the seventh postoperative day. Subsequent follow-up indicated elevated infection markers alongside worsening temperature and overall clinical condition, prompting the initiation of antibiotic therapy.

Given the seriousness of the patient's condition, which exhibited signs consistent with endocarditis during a follow-up echocardiographic examination, the patient was transferred back to our facility. Upon evaluation, vital signs revealed a high fever of 39.0°C, tachycardia at 160 bpm, and severe respiratory distress. An echocardiogram demonstrated significant aortic regurgitation and identified a mobile mass consistent with vegetations on the aortic valve, suggesting a possible infectious etiology.

The patient was intubated and placed on mechanical ventilation and start milrinon. Initial laboratory investigations revealed the following results: C-reactive protein (CRP) at 100 mg/L, procalcitonin at 1.30 ng/mL, white blood cell count (WBC) at 6.77 k/uL, hemoglobin (HGB) at 11.2 g/dL, hematocrit (HCT) at 34.1%, and platelet count (PLT) at 74 k/uL.Broad-spectrum antibiotics were initiated for the patient following the collection of blood cultures.The blood culture yielded no growth, whereas sputum culture identified *Acinetobacter baumannii*, and urine culture isolated *Candida albicans*.

In response to these findings, antibiotic therapy was initiated, consisting of vancomycin , meropenem and caspofungin. Following the stabilization of hemodynamic and infectious parameters, a multidisciplinary consultation resulted in the decision to proceed with the Ross procedure.

Surgical Procedure

After redo mediane sternotomie Aorto-bicaval cannulation performed and Cardiopulmonary bypass initiated. The aortic valve displayed severe dysplastic features, characterized by the presence of verrucous tissue. Abscess pockets were observed in the aortic root, right ventricular outflow tract, and the sinus of Valsalva. The pulmonary artery was transected at the level of the bifurcation. The pulmonary valve appeared morphologically normal, with no significant discrepancies noted. The coronary arteries were identified as arising from the aortic wall in a wide island configuration. The remaining aorta was excised in its entirety, and the coronary arteries were meticulously freed from the surrounding tissue. The incision site in the right ventricle, adjacent to the pulmonary valve, was identified, and the preparation of the pulmonary valve autograft was undertaken. The autograft was meticulously sutured to the aortic root, with an orifice created at the optimal location for the left main coronary artery (LMCA ostium). Anastomosis of the LMCA to the autograft was successfully executed. Subsequently, a suitable site for the right coronary artery (RCA) was identified and prepared, facilitating the creation of a wide orifice for RCA anastomosis. The 16 mm Contegra conduit was adjusted to the appropriate length. The distal anastomosis was first completed using a 6-0 Prolene suture, followed by the proximal anastomosis, also utilizing a 6-0 Prolene suture. Epicardial assessment revealed minimal aortic insufficiency and minimal pulmonary insufficiency, with ventricular function remaining well preserved (Figure 1-4).

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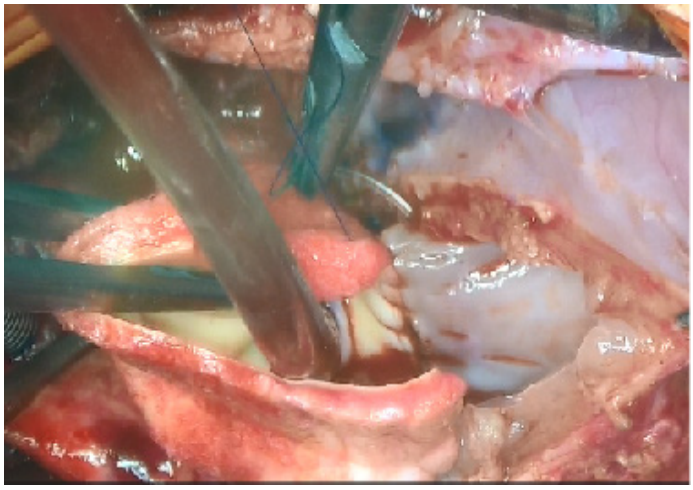

Figure 1. Contegra RVOT reconstruction

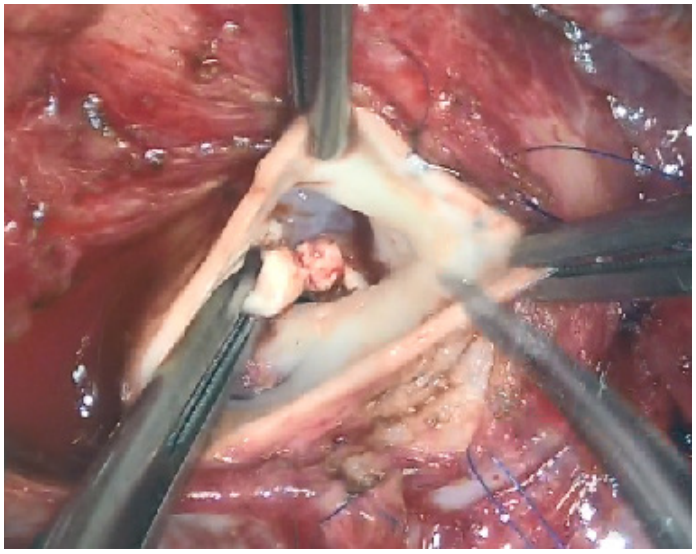

Figure 2. Preoperarive aortic valve

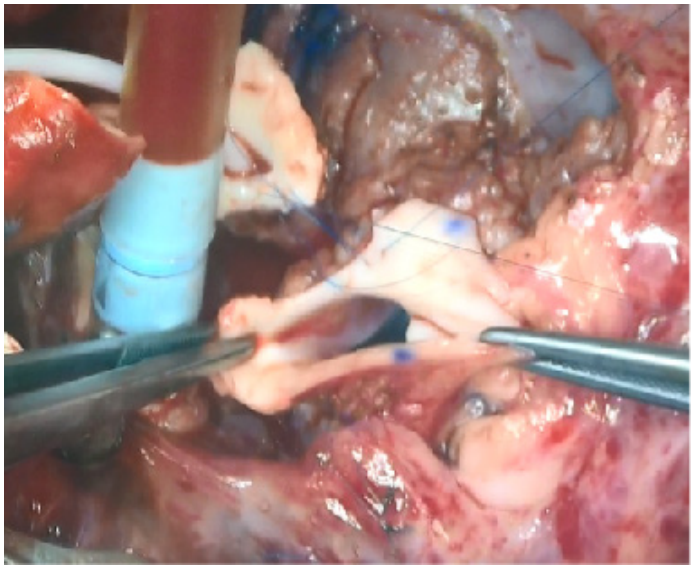

Figure 3. Pulmonar autograft

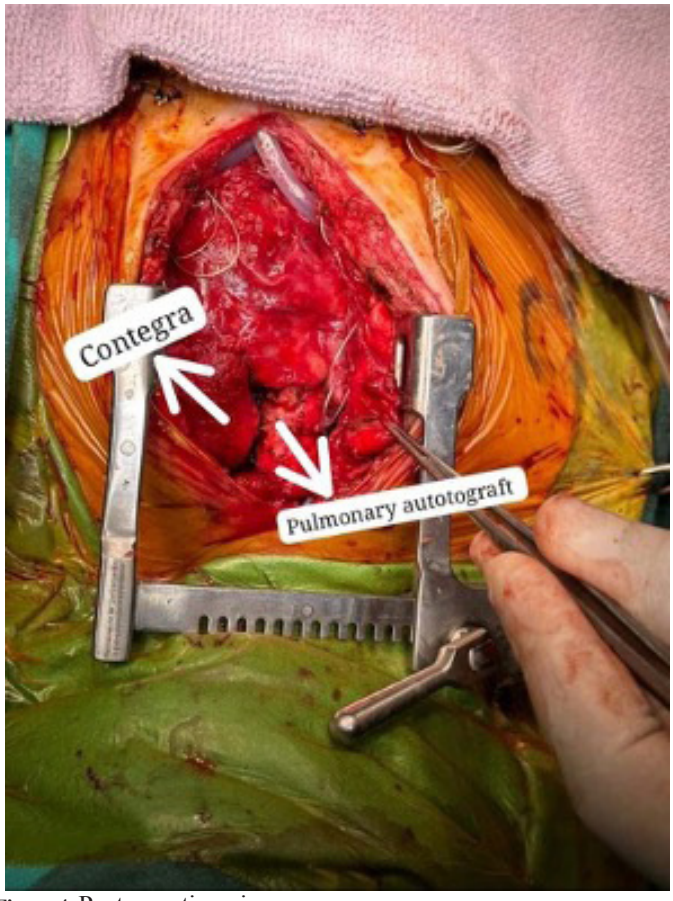

Figure 4. Postoperative view

Cardiopulmonary bypass (CPB) was maintained for a duration of 248 minutes, with aortic cross-clamping lasting 161 minutes. Following the surgical procedure, the patient was transferred to the Cardiac Intensive Care Unit (CICU) with an open chest. The sternum was subsequently closed 24 hours postoperatively. The infant was extubated within 4 days and continued to be monitored in the CICU, exhibiting a good recovery with gradual improvement in respiratory function and feeding. The patient was discharged from the hospital on the 15th day following the surgical procedure (Figure 5,6).

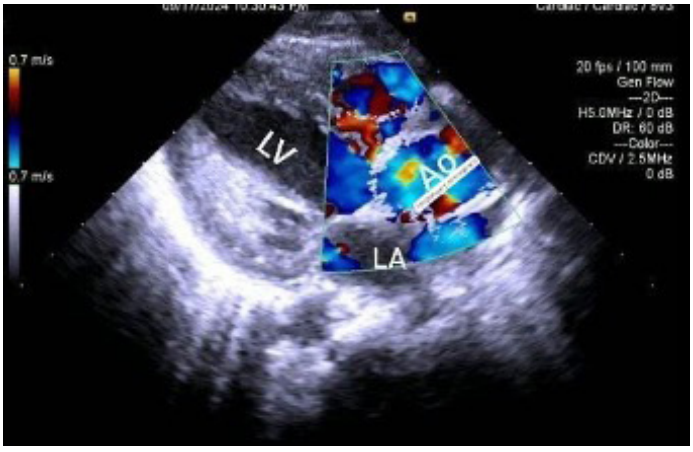

Figure 5. Postoperative echocardiography

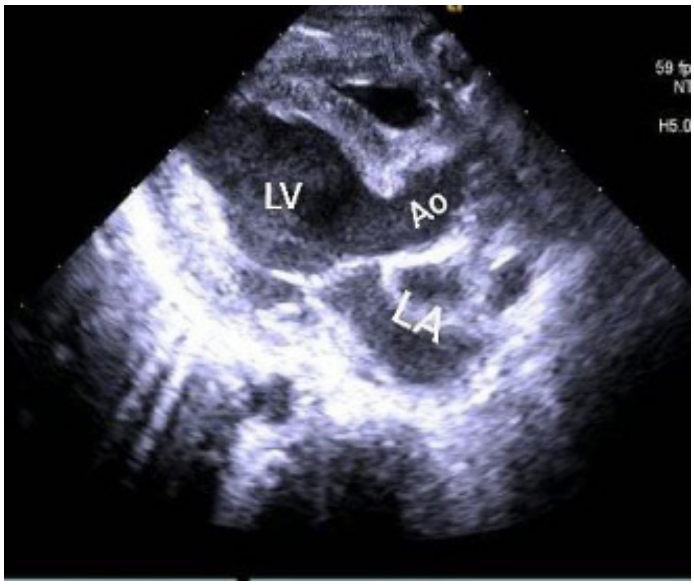

Figure 6. Postoperative echocardiography

DISCUSSION

The Ross procedure presents several significant advantages, particularly for pediatric patients. Firstly, the utilization of the patient's own pulmonary valve as an autograft facilitates optimal hemodynamic performance, closely resembling normal valve function (8). Additionally, the autograft possesses the capacity for growth alongside the patient, thereby diminishing the necessity for subsequent surgical interventions during maturation. Furthermore, this procedure reduces the need for anticoagulation therapy, subsequently lowering the risk of thromboembolic events and related complications. Empirical studies have also demonstrated that the Ross procedure is associated with reduced rates of reoperation when compared to mechanical or bioprosthetic valve alternatives.

The Ross procedure, despite its advantages, also poses several disadvantages in pediatric patients. The technical complexity of the procedure necessitates a high level of surgical expertise, which can elevate the risk of complications. Additionally, there is a potential for aortic regurgitation to develop over time, especially if the autograft undergoes dilation. While the autograft is anticipated to perform adequately, it remains susceptible to dysfunction or deterioration, potentially requiring future surgical interventions. Ongoing follow-up and regular echocardiographic evaluations are essential to monitor valve function and identify complications at an early stage. Furthermore, the necessity for repeated surgeries may have psychological implications for both the patient and their family.

Much of the criticism surrounding the Ross procedure centers on the rising incidence of autograft and homograft failures observed in the second decade following surgery. There are concerns not only about the frequency of these failures but also about the challenges associated with reoperating on affected patients (9).

Notably, a secondary Ross procedure following a primary aortic valve replacement shows better survival rates and lower reintervention rates compared to a primary Ross procedure. However, it is important to consider that unmeasured confounding factors may be influencing these results (10).

Etnel and colleagues conducted a meta-analysis of 42 studies from 1991 to 2015, evaluating the outcomes of the Ross procedure, homograft aortic valve replacement, and mechanical aortic valve replacement in pediatric patients. Their findings indicated that the Ross procedure is associated with reduced early and late mortality rates when compared to both homograft and mechanical valve replacements (11).

The evolution of congenital cardiac surgeries that involve reconstructing the right ventricular outflow tract (RVOT) or replacing the autograft pulmonary valve in the Ross procedure has led to a growing demand for valved conduits, particularly in neonates and small infants. A popular solution is the Contegra conduit, made from bovine jugular vein, which features a natural tri-leaflet valve and a sinus. It is preserved in a low concentration of buffered glutaraldehyde to ensure flexibility. Available in diameters of 12, 14, 16, 18, 20, and 22 mm, the Contegra offers advantages such as structural continuity and immediate availability. Its design, based on venous tissue, allows it to function well under the low-pressure conditions typical of the pulmonary vascular system, rather than the higher pressures of systemic circulation (12).

The Contegra conduit presents several disadvantages, including an increased risk of thrombosis and stenosis, which may adversely affect long-term outcomes. These complications can lead to impaired hemodynamics and necessitate additional interventions, thereby complicating the management of patients over time (13).

İnfants with a history of cardiac surgery are at increased risk for infective endocarditis, and the clinical presentation can be insidious. In our case, the development of endocarditis can be attributed, in part, to social determinants of health, particularly the extended hospitalization of the child due to recurrent acute respiratory illnesses. Prolonged hospital stays can increase the risk of nosocomial infections, including infective endocarditis, especially in pediatric patients with underlying cardiac conditions. Given that the operation was planned to be repeated, it is noteworthy that, aside from the Ross procedure, there were limited alternative surgical options available. The Ross procedure stands out as a viable technique due to its ability to utilize the patient's own pulmonary valve, effectively mitigating some of the complications associated with prosthetic valves, such as structural degeneration and thromboembolic events.The most optimal management strategy for our patient

involved the administration of antibiotics in accordance with an evidence-based antibiotic regimen, followed by a carefully timed surgical intervention contingent upon the assessment of positive trends in infection parameters.

The Ross procedure in infants, particularly following infective endocarditis, poses unique challenges due to the patient's size and the need for appropriately sized grafts. However, this case illustrates the viability of the procedure in managing severe aortic regurgitation and provides a favorable alternative to mechanical prostheses, reducing the need for anticoagulation and associated complications in this young population.

CONCLUSION

The Ross procedure offers a durable and effective surgical solution for pediatric patients with severe aortic valve disease, including those with infective endocarditis. It provides several advantages, such as enhanced hemodynamic performance, the potential for valve growth, and the elimination of the need for anticoagulation therapy. Although the procedure is technically demanding and requires specialized expertise, its long-term outcomes, particularly in pediatric patients, justify its use as an alternative to other valve replacement strategies. Further research, including multi-center trials, will be essential to refine the application of the Ross procedure and address the challenges associated with its use in young children, especially in cases involving infective endocarditis.

The case presented here underscores the utility of the Ross procedure in managing a complex pediatric case of aortic valve insufficiency following infective endocarditis, with favorable outcomes and a successful recovery.

Conflict of Interests: The authors declare that there are no conflict of interests.

Financial Disclosure: The authors declare that there is no financial support.

Patient Informed Consent: Written informed consent was obtained from the patient's legal guardians for the inclusion of clinical information and any identifiable images. Patient confidentiality was strictly maintained, with all personal identifiers removed. The report was reviewed and approved by the institutional ethics committee, ensuring compliance with relevant ethical standards in medical research and publication.

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