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Original investigation

Long Term Outcomes of Arterial Switch Operation At The Transposition of the Great Arteries

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ABSTRACT

Purpose: In this study, we present an assessment of late term outcomes of patients with the diagnosis of transposition of the great arteries of who were applied arterial switch operation between 2007 and 2017 in our clinic.

Methods: Medical records of the patients who were applied arterial switch operation and kept in long term follow-up, were analyzed retrospectively. The mean follow-up time of the patients was 62 months. The patients after discharge were examined via transthoracic echocardiography with regard to the necessity of reoperation requirement.

Results: There was no mortality in late term follow-up. Functional classification of the patients were NYHA I and II. Only in three patients (5.1%), complications that requiring surgical treatment were observed in long term follow-up. Enlargement operation with a patch was applied to two patients due to a stenosis in pulmonary artery. A valve sparing reconstruction with a Dacron patch was applied to one patient owing to neoartic root dilatation.

Discussion: Despite arterial switch operation are able to be successfully performed with a high long term survival rate in experienced centers in the treatment of transposition of the great arteries, the patients should be kept in close follow-up considering the development of possible late complications.

Keywords: Transposition of the great arteries, Complication, Congenital Heart Disease

INTRODUCTION

Transposition of the great arteries (TGA) is the most common cyanotic heart disease and accounts for approximately 5% of all congenital heart diseases (1). The first successful arterial switch operation (ASO) to provide anatomic correction in TGA was described by Jatene et al. (2) in 1975. Since this technique provided lower mortality and morbidity compared to the Senning and Mustard procedures providing a correction at the atrial level that had been performed previously, it has gained much attention in a short period of time and became the most preferred technique for TGA treatment worldwide (3-4). Although different variations are defined in time, the surgical technique remained unchanged (5). Nevertheless, long-term follow-up of Jatene patients might be associated with complications including coronary ischemia, root dilatation in neoaorta, stenosis in the neoaortic valve and a decreased left ventricular function (4,6,7). In particular, a semilunar valve with pulmonary origin becoming a systematic valve has been reported to be an important factor for long-term complications (8). Herein with this study, we aimed to evaluate the complication causes and rate that requiring reoperation following initial ASO.

METHODS

Our retrospective study was carried out at Ege University Faculty of Medicine with the approval of the Local Ethical Committee on July 31, 2018 with the protocol number of 18-7.1/99. A written consent form was obtained from each patient before the writing process of this article.

Fifty-eight patients who underwent Jatene procedure in our clinic between 2007-2017 and had long-term follow-up were included in the study. Eight patients could not be included although being operated in our center, as they were followed-up in another center and we could not access their data after discharge. Medical records of the patients were retrospectively reviewed. There was no consanguineous marriage in the medical history of the patients. Cyanosis was present in the physical examination of all patients before the surgery. All patients were preoperatively evaluated by transthoracic echocardiography (TTE) and computed tomographic angiography.

Table 1. Demographic data and clinic features

Variable	Value
Age (Day)	9.07±11.8
Wight (kg)	3.58±0.53
Male	30
Female	28
Interventions Before Surgery	
Atrial septostomy	16
Pulmonary banding + Modified Blalock-Taussig Shunt	1
Prostaglandin E2 Requirement	32

Data are presented as mean ± SD or number.

Of the 58 patients, 32 were male and 26 were female. The mean age mean weight of the trial population were 9,07 ± 11,8 (1-92) days and 3,58 ± 0,53 (2,6-4,8) kg, respectively (Table 1).

There were several accompanying congenital abnormalities in the patients prior to the surgery. Only 28 patients had isolated TGA. Twelve patients had ventricular septal defect and 18 had conotruncal or aortic arch abnormalities. Two patients had Taussig-Bing malformation. The arteries were in the side-by-side position in 6 patients. In addition, 2 patients had 1L - 2CxR type coronary artery anomaly. 36 of the patients had received prostaglandin E2 (PGE2) treatment before the surgery. Balloon atrial septostomy was required in 19 of these patients and the procedure was performed preoperatively. In addition, four patients were intubated in the intensive care unit due to acidosis, difficulty in breathing and hypoxia, and one intubated patient was transferred from an external center to our clinic.

Additionally, a patient underwent pulmonary banding and modified Blalock-Taussig shunt surgeries to train left ventricle then, the patient was reoperated for the complete correction 28 days following the surgery.

We apply the arterial switch procedure with a method similar to the "button technique" present in the literature (9). This method includes the main steps below, following selective cannulation.

- Transection of the ascending aorta,
- Preparation of button-shaped coronary ostia for the translocation of the coronary arteries,
- Determining the locations of the coronary anastomoses before devising neoaorta to be formed,
- Routine LeCompte maneuver implementation and reconstruction of the neo-pulmonary artery with a pericardial patch.

The most important and different application of our technique relies on the preparation of coronary buttons as small as possible in order to create lower a stitch area during the preparation of coronary buttons (Figure 1). Thus the overall stitch line reduced compared to conventional ASO (Figure 2).

The mean follow-up period was 62 months and the follow-up period of patients included in the study ranged from 1 to 10 years.

The patients were followed-up for reoperation requirements with TTE in the early post-discharge period, later on repeated at postoperative month 1, 3, 6 and 12. Then, TTE was performed annually for long-term follow-up.

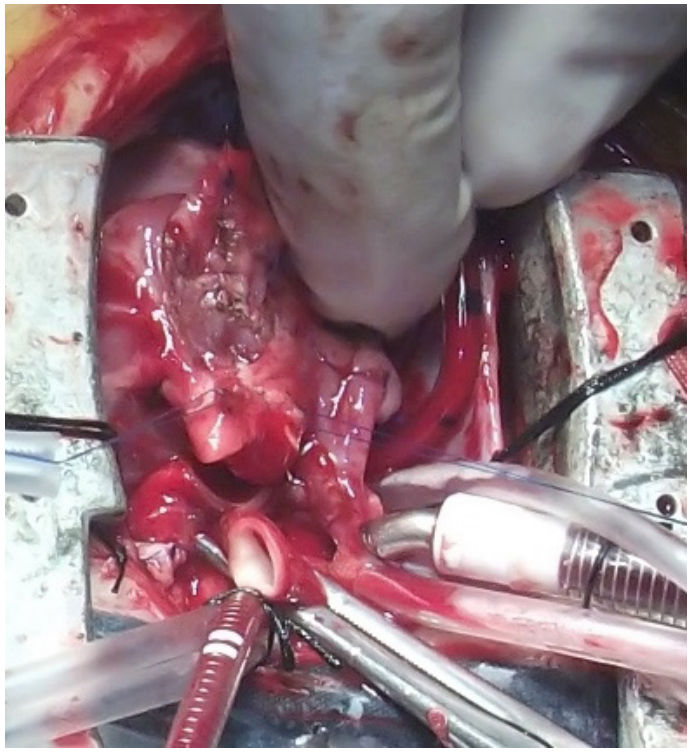

Figure 1. The prepared shape of the coronary orifice with minimal adjacent tissue

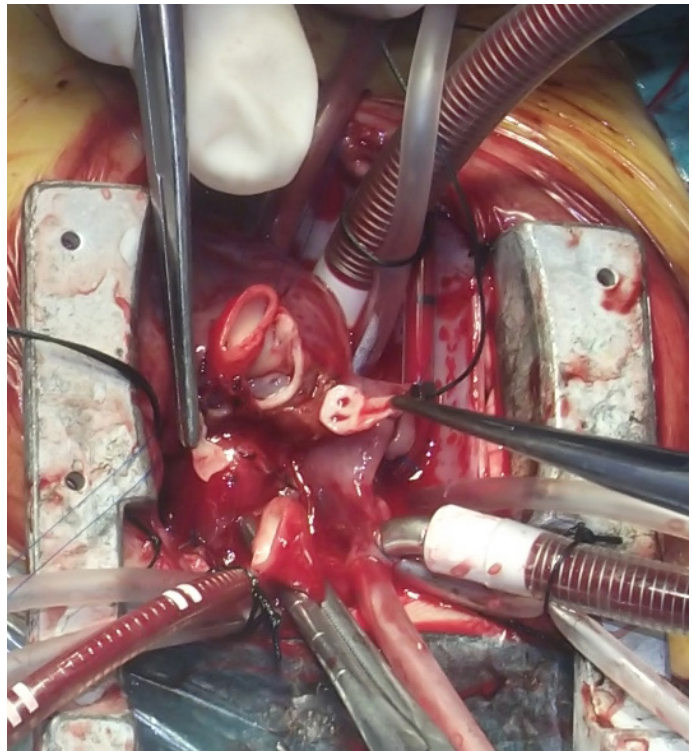

Figure 2. A view of coronary anastomosis indicating reduced overall suture line

Statistical Analysis

All data were presented as mean ± standard deviation and median (interquartile range). Statistical analysis was performed using SPSS 20.0 software program.

RESULTS

When the operation data of the patients were evaluated the mean cardiopulmonary by-pass duration was 148.73 ± 21.57 minutes and the mean aortic clamping time was 109.87 ± 18.15 minutes. The mean duration of intubation and the intensive care unit stay were found to be 36.42 ± 54.76 and 75.73 ± 111.14 hours, respectively (Table 2).

Table 2. Intraoperative Data and Concurrent Surgical Approaches

Variable	n
Cardiopulmonary bypass time (minutes)	148.73±21.57
Aortic cross-clamp time (minutes)	109.87±18.15
Additional surgical procedures	
Atrial septal defect closure	30
Patent ductus arteriosus closure	29

Data are presented as mean ± SD or number.

In the late period, only 3 patients ~~had requiring~~ required surgical intervention pathology. Pulmonary artery stenosis was observed in 2 patients and, aneurysmatic dilatation of the left coronary orifice in one patient. The mean pulmonary artery pressures were 75 and 85 mmHg, respectively in two patients with pulmonary hypertension. Although there was no valvular pathology, the stenosis was at the supravalvular level for both patients. The procedure of pulmonary artery dilatation was performed to those 1 and 4 years, respectively, after the initial surgery. In one patient, the patch was extended to the pulmonary bifurcation, while in the other patient an adequate pressure drop was achieved with the expansion of the main pulmonary artery. No significant gradient was measured in any patient in the postoperative period.

A patient with dilatation at the root of neoaorta was operated for the second time 8 years after the initial operation. The patient had an increase of 6 mm in the aortic root in the last 6 months of follow-up. Although the right coronary artery button was appropriately prepared and mobilized in the first operation, the left coronary artery could not be mobilized due to early collaterals. For this reason, the patch was prepared via autologous pericardium that shaped like a hood, then, the left coronary button was anastomosed in order to cover the coronary orifice. Afterwards, an aneurysm was observed to develop from this region. Reconstruction was made by using a 20 mm Dacron graft thus the valve was preserved. No mortality was observed for any of these surgeries.

DISCUSSION

The course of TGA disease has changed completely after the introduction of arterial switch surgery. Inspite of the fact that ASO, called Jatene procedure, has been performed in our clinic for many years, here in this study, we present an analysis of the patient data of the last decade as follow-up data could be easily accessed in digital environment.

Long-term mortality was not observed in our cases. Similar to our findings, long-term mortality was reported to have very low rates by various researchers in the literature. Villalbaen et al. (10) reported 98% survival in 224 patients with a mean follow-up of 7.6 years; Hutter et al. (6) reported the results involving late mortality only in 2 patients in 151 cases.

In several studies, rates of late complications requiring post-ASO surgery have been reported to vary between 2% and 8% (11). The complications have been reported to mostly include supravalvular pulmonary stenosis, aortic root dilatation, aortic valve stenosis, coronary artery stenosis, residual arch obstruction, and malignant arrhythmias (11-14).

The most common late complication noticed in our patients was pulmonary stenosis. For the development of primary pulmonary stenosis, narrowing in the suture lines at the supravalvuler level and the tension occurring following LeCompte maneuver in the pulmonary branching region ~~are~~ is suggested to be in charge and, its frequency increases in time (12). Two patients underwent surgery due to pulmonary stenosis. One of the patients was operated for balloon angioplasty prior to the operation for stenosis. For the other patient, although the extension of the main pulmonary artery with patch was sufficient, the patch was placed in a T-shape extending to the branches of the pulmonary artery. Raju et al. (14) reported the need for reconstruction of the pulmonary artery to emerge earlier than the need for neoaorta. In the same study, the most common causes of reoperation ~~were~~ consisted of the right side pathologies of the heart and, in 18 [56.3%] of 32 reoperations patch plasty was applied to the pulmonary artery.

The root dilatation of neoaorta was reported as the second most common reason for reoperation. McMahon (15) et al. followed neoaorta root expansion in patients and identified several factors for the etiology. Although approximately one half of 119 patients had a statistically significant increase in neoaortic root and annulus diameters, severe systemic atrioventricular valve regurgitation was found to be rare. Previous pulmonary banding operation, residual VSD and Taussig-Bing abnormality are reported to be significant risk factors. Similarly, Koolbergen et al. (16) emphasized neaortic root expansion to be multifactorial.

In our series, aortic root enlargement was observed only in one patient at 8 years after ASO. In order to prevent the development of aneurysmatic dilatation, we keep the anastomosis lines shorter by preparing the coronary buttons with a very small diameter in our clinic. Formigari et al. (17) reported that the "trap door 'method involving a wider patch, was associated with increased neoaorta complications. In the previous operation note of the patient who developed an aneurysm, it was observed that the left coronary button was brought closer with the hood technique and repaired with a pericardial patch as it was not fully mobilized. The aneurysm formation was found to develop from that pericardial

region and treated with supracoronary tubular graft with valvular preservation. Liebrich et al. (18) emphasize that annular stabilization can be achieved in addition to this technique. For our patient who developed an aneurysm, we think that a non-routine application and the use of the pericardial patch in the anastomosis area played an important role in the development of this late complication. Thus, we believe the current situation is consistent with our ~~own~~ hypothesis.

The development of stenosis in the coronary arteries is a rare complication and has been reported as approximately 2% in large case-series (8,10). The development of malignant arrhythmia is even less common (4,6-8,10,11). Prevalence of both late-term complications has been reported to be increased over time in the trials. Although these complications are not observed in our case series, patients are closely followed-up in our center.

CONCLUSION

ASO, that can be safely applied and provide a high long-term survival rate, is an effective surgical method in experienced centers in patients with TGA. Although complications which require surgical intervention are reported at a low rate, late-term complications that might develop in these patients should be well identified and patients should be kept in a close follow-up.

Informed Consent: The informed consent form was obtained from each parent of the infants

Compliance with Ethical Standards: Ege University School of Medicine, decision no: 18-7.1/99 date 31/07/2018

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Author Contributions: Concept - GA, ÇB; Design - GA, ÇB; Supervision - ONT, YA; Fundings - ONT, YA; Materials - ONT, YA; Data Collection and/or Processing - GA, ÇB, ONT; Analysis and/or Interpretation - GA, ÇB; Literature Search - GA, ONT; Writing Manuscript - GA, ONT; Critical Review - GA, ÇB

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