

## COMPLEX CORONARY PATTERN AFFECTING THE SURGICAL OUTCOME OF ARTERIAL SWITCH OPERATION

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### ABSTRACT

#### BACKGROUND

Arterial switch operation (ASO) has become the procedure of choice for the transposition of great arteries as well as for Taussig-Bing anomaly. Relocation of coronary arteries remains a technical problem in anatomic correction of the transposed great arteries. The present prospective study is designed to analyse the effect of coronary artery pattern on surgical outcome of arterial switch operation.

#### METHOD

From August 2014 to November 2015, total 60 patients underwent ASO. The patients are divided in three groups. Group-A 21 patients with d-TGA with intact ventricle septum (d-TGA intact IVS), in Group-B 33 patients d-TGA with ventricular septal defect (d-TGA, VSD), and in Group C 6 Taussig Bing anomaly. The coronary pattern and outcome is analyzed.

#### RESULTS

The overall mortality related to coronary pattern was 5%. The 2 patients died due to Intramural coronary artery leading to post-operative ventricular dysfunction, another patient with single retro pulmonary coronary artery died secondary to low coronary implant leading to kinking in coronary artery and myocardial dysfunction. On 12 monthly follow up, one of the Patients in group A had right pulmonary artery stenosis with gradient of 30 mm of Hg. Another patient in group B had supraaortic gradient of 20 mm of Hg.

#### CONCLUSION

The ASO for TGA and Taussig-Bing anomaly has low early and late mortality. However, the mortality is still seen in the patients with Intramural coronary artery and in the patient with single coronary artery with retro pulmonary course.

#### KEYWORDS

Coronary Patterns, Arterial Switch Operation, Transposition of Great Arteries.

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**INTRODUCTION:** Transposition of great arteries is a congenital cardiac anomaly in which the aorta arises entirely or largely from the right ventricle and the pulmonary trunk arises entirely or largely from left ventricle. The transposition of great arteries is the most frequent cyanotic heart disease diagnosed in newborns and accounts for 5% to 7% of congenital heart defects. Anatomic correction of transposition of great arteries (TGA) by Arterial switch operation (ASO) has attracted paediatric cardiac surgeons

and the cardiologist since the availability of cardiopulmonary bypass.<sup>(1-5)</sup> The anatomical repair not only gives the full correction of the anatomy as well as the normal physiology of the patient when compared with the physiological repair. The various coronary patterns are described in English medical literature<sup>(6)</sup> in the TGA, and the technique of relocation varies as per surgeon's preference as well as the type of coronary anatomy.

**MATERIAL & METHOD:** This prospective study was conducted at U. N. Mehta Institute of Cardiology and Research Centre over a period of fifteen months. After approval from the institutional ethics committee, the patients who underwent arterial switch operation are included in the study. The demographic details are given in Table 1. The standard technique of cardiopulmonary bypass and cardioplegic arrest (aortic and bicaval cannulation and in TGA VSD and in patients with Taussig-Bing anomaly group and aortic and single RA cannulation for was used for TGA intact septum group) was used.

The Aorta was transected at the level of pulmonary artery bifurcation and the coronary buttons are excised and relocated to the neo aorta. The coronary artery patterns of our patients are given in Table 2 and Fig. 1. The punch hole technique was used for LCX and single anterior coronary artery when it is arising from sinus one, and trap door was used RCA for the patients with intact septum group. However, in TGA with VSD group punch hole technique was used for the transfer of both the coronary arteries as the size of the neo aorta is good so it is technically easy to transfer

both the coronaries using punch hole technique. The wide medial base flap was used when the circumflex coronary artery was arising from the sinus two along with the RCA. This flap provides an additional length to the circumflex coronary artery and avoids any acute kinking of the artery. For the intramural coronary artery, we have unroofed the coronary artery and divided the buttons into two, and transferred to their respective sinuses. We have no experience in transfer in the intramural coronary artery as a single button.<sup>(7, 8)</sup> The neo pulmonary artery was constructed using glutaraldehyde treated pericardial patch. The neo aorta is reconstructed, patent foramen ovale was closed using a brief period of circuitry arrest in patients with intact septum. Aortic cross clamp was removed after desiring the heart. The neo pulmonary anastomosis was constructed. The bypass was weaned off with elective support of Adrenaline 0.05 micrograms/Kg/mt, and Milrinone 0.5 micrograms/Kg/mt. The mean bypass times was 148 minutes in intact septum group and mean cross clamp time was 106 minutes and mean bypass time in TGA, VSD and Taussig-Bing group was 166 minutes and mean cross clamp time was 130 minutes. Chest was left open in 15 patients for the first post-operative day due to diffused bleeding and was closed the next day. Post procedure patients had stable hemodynamic course without any ECG changes of Ischemia.

**STATISTICAL ANALYSIS:** The statistical calculations were performed using SPSS software v 20.0 (Chicago, IL, USA). Qualitative datas were expressed as percentage.

**RESULTS:**

VARIABLES	Group A 21(35.0)	Group-B 33(55.0)	Group-C 6(10.0)	TOTAL 66
Age at operation (Range)	14.3(0-34days)	62.15(0-2.9Y)	52(15-83 days)	45.4 days
Sex (males/females)	19/2	28/5	4/2	51/9
Mean weight (kg)	2.9(1.8-3.9)	4.2(3.2-5.1)	4.1(3.3-4.9)	3.8(1.8-5.1)

**Table 1: Demographic data of all patients group wise**

VARIABLES	Group A 21(35.0)	Group-B 33(55.0)	Group-C 6(10.0)	TOTAL 66
A(1LCx; 2R) (%)	16(76.2)	21(63.6)	4(66.6)	41(68.3)
B(1/2LCxR) (%)	0	1(2.5)	0	1(1.6)
C(1/2LCxR) (%)	0	0	0	0
D(1L; 2CxR) (%)	4(19.0)	6(18.1)	2(33.3)	12(20.0)
E(1LR; 2CX) (%)	0	1(2.5)	0	1(1.6)
F(1R, 2LCx) (%)	1(4.7)	1(2.5)	0	2(3.3)
Intramural LCA (%)	1(4.7)	1(2.5)	0	2(3.3)
Intramural RCA (%)	0	1(2.5)	0	1(1.6)

**Table 2: Coronary artery pattern of all patients group wise**

L: Left anterior descending coronary artery, cx: circumflex coronary artery, R: Right coronary artery, LCA: Left main coronary artery, RCA: Right coronary artery.

Out of 60 patients who underwent arterial switch operation, the overall mortality related to coronary pattern was 5%. For the patient with intramural left coronary artery who had accidental injury to the left coronary artery during dissection, though a 5mm Gortex (W.L. Gore and Associates, Flagstaff, AZ) graft was used from innominate artery to the

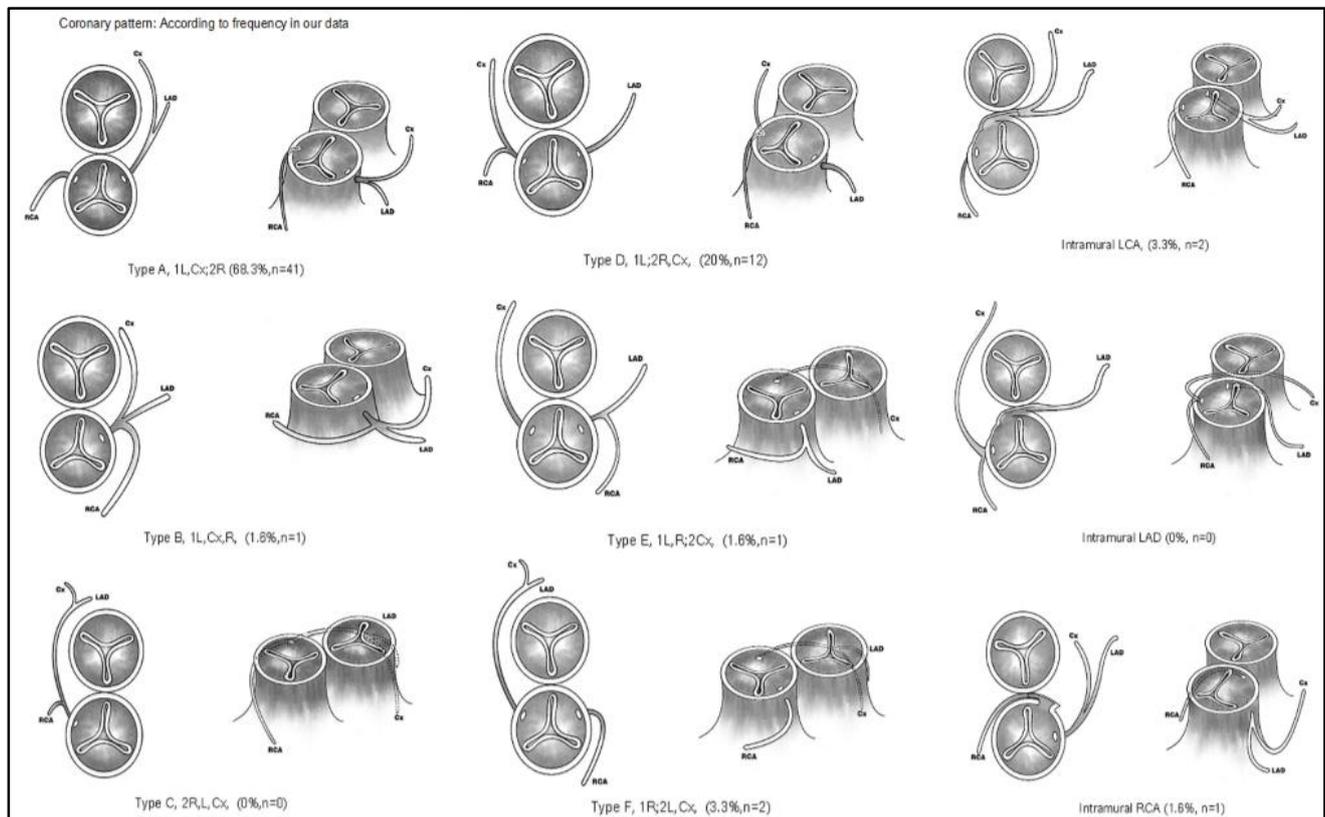
single coronary button for coronary blood supply in a desperate attempt to save him, he died in the operating room secondary to bleeding and severe ventricular dysfunction. Another 9 days old newborn having TGA with intact IVS on prostaglandin infusion with both intramural coronary arteries with no intraoperative problem had

moderate left ventricular dysfunction on 2D echocardiography six hours after surgery, despite showing stable hemodynamic parameters without any ECG changes of Ischemia. He died from intractable ventricular arrhythmias fifteen hours after surgery. Another patient with single retro pulmonary coronary artery died secondary to low coronary implant leading to kinking in coronary artery leading to myocardial dysfunction coronary artery was again relocated but patient died 10 hours after surgery due to low cardiac output secondary to prolong bypass time and myocardial oedema.

Rest of the patients did well in immediate post-operative period. On every visit the patients underwent ECG, 2D

echocardiography. One patient in group A had proximal right pulmonary artery stenosis with peak gradient of 30mm of Hg. Another patient in group B had supra valvular pulmonary gradient of 20 mm of Hg.

None of the patient had any regional wall motion abnormality with good biventricular function without any evidence of regional wall motion abnormality with good biventricular function, without any valvular or supravalvular aortic/Pulmonary stenosis or regurgitation. None of the patient underwent any post procedural intervention till date. On 12 monthly follow up of there was no late death.



**Fig. 1: Coronary artery pattern of all patients group wise**

**DISCUSSION:** The transposition of great arteries is a commonest congenital cyanotic heart disease seen in the newborns. Various anatomical variability in coronary arterial distribution with regards to arterial switch operation has been described.<sup>(9,10)</sup> The successful relocation of the coronary artery to neo aorta is the most important surgical step in arterial switch operation. Almost all kind of coronary patterns can be relocated, however the presence of an intramural coronary artery offers a several challenges and carries high mortality and morbidity.<sup>(11-15)</sup> The term intramural coronary artery refers to the coronary pattern in which there is an intimate relationship between aortic and coronary arterial walls;<sup>(16)</sup> Histologically the aortic and coronary medial walls are attached without interposed adventitia. Intramural coronary artery is rare in patients with normal ventricle arterial connection, but proportionally more common in TGA. The presence of intramural artery offers several surgical challenges.

The intramural coronary artery might have more or less normal epicardial course and diagnosis by external inspection might be impossible, exposing to the risk of injury to the to the abnormally traversing intramural coronary artery, as seen in in one of our patient. Because of abnormal ostium is usually para commissural, it is necessary to mobilize the posterior valvular commissure, the mobilization of posterior commissure carries increased risk of post-operative neo pulmonary valve regurgitation. The abnormal angle of taking off of coronary artery is a potential risk for post-operative kinking and stenosis during follow-up, as seen in one of our patient who had myocardial dysfunction secondary to kinking of coronary artery. Various types of intramural coronary patterns are described in the literature. A meta-analysis by Pasquali SK. et al,<sup>(17)</sup> reported that the presence of intramural coronary artery is associated with the highest mortality compared to any other arterial pattern,

with more than six-fold increase in mortality compared to the usual arrangement. As seen in our series also.

The single coronary artery<sup>(18)</sup> is another important surgical difficulty encountered in arterial switch operation, the primary technical limitation of the arterial switch most commonly relates to the precise transfer of the coronary artery without undue tension, or kinking. Particularly susceptible to the latter is the origin of the coronary arteries from a single aortic sinus. In Most series the origin of all coronaries from a single aortic sinus continues to be associated with the greater degree of mortality.<sup>(9,10)</sup> The complexity of and variety of coronary arterial anatomy in hearts with TGA have been well documented<sup>(1-5)</sup> All three main coronary arteries arise from a single aortic sinus in 7% to 9% of those afflicted with TGA. Rarely the coronary arteries arise from two or more separate ostia within the same aortic sinus.

The performance of the arterial switch without coronary transfer has been advocated by some to deal with either single origin or intramural course of the coronaries<sup>(19,20)</sup> Early mortality may be decreased, however, late right ventricular outflow tract obstruction by the commonly oversized inter arterial baffle and late ostial stenosis remains theoretical hazards that may require future revision. Of great significance, the continued abnormal course of the coronary persists as a potential nidus for mortality among children as they mature. Sudden death remains frequent among young adults with an abnormal course of their coronary arteries (usually found between the great arteries) Dilatation of the pulmonary artery during high output states such as exercise may recreate in essence the lethal situation.

**CONCLUSION:** Arterial switch operation is a gold standard operation for D-TGA and Taussig-Bing anomaly and in current era it can be performed with acceptable mortality of 6% to 7%. However, some extremely complex variants of coronary artery anatomy like Intramural coronary artery, artery with abnormal retro pulmonary artery course of single coronary artery from posterior sinus may cause intra-operative as well as post-operative and long term problem and needs regular follow-up of patients.

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