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ANALYSIS OF EARLY AND LATE OUTCOMES OF TAPVC REPAIRS– A SINGLE SURGEON'S PERSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Introduction: Total anomalous pulmonary venous connection (TAPVC) is a congenital heart defect. Without surgical correction, it has a high mortality rate. Owing to the improved perioperative care and surgical techniques, the overall results have also improved. Our study assesses the early and late outcomes of TAPVC repairs done over last 10 years under a single surgeon.

Methods: Eighty-eight patients who were surgically treated for TAPVC over last 10 years from 01 June 2009 to 31 May 2019 by a single surgeon formed the basis of this retrospective observational study. The information regarding patient demographic details, pre-operative evaluation, surgical procedure, post-operative course and follow up after discharge was retrieved by searching operation theater registries, medical record sections and finally by patient follow up in outpatient department/telephonic follow up.

Results: Mean age and weight at surgery were 10.82 months and 5.27 kg respectively. Out of 88, 64 (72.7%) were male patients and 24 (27.3%) were females. 25% of the participants had Age ≤1 Month. The TAPVC anatomy was supra-cardiac in 41 (46.6%) cases, cardiac in 24 (27.3%), infra-cardiac in 14 (15.9%) and mixed in 9 (10.2%). Of the 88 TAPVC patients, 33 (37.5%) were obstructed at the time of operation. Twenty-nine (33%) patients had to be taken up for emergency TAPVC repair. The vertical vein was left open in 34 cases (38.6%). Mean duration of mechanical ventilation was 4.18 days (+/-2.17 SD). Mean ICU stay was 8.01 days (+/-3.63 SD). Mean hospital stay was 17.8 days (+/-10.47 SD). Eleven (12.5%) patients died in the early post-operative period. There were 3 late deaths, 2 of which occurred in infra-cardiac TAPVC patients, while the third was of mixed TAPVC type.

Conclusions: Early mortality was found to be 12.5%, while late mortality was 3.9%. All the patients included in our study have been operated by a single surgeon, thus eliminating bias. Our study emphasizes the fact that the overall outcome of TAPVC repair has improved compared to previous similar studies, mostly as a result of advancement of management strategies, both medical and surgical.

Keywords: TAPVC, surgical repair, outcome, mortality, observational study

INTRODUCTION

Total anomalous pulmonary venous connection, often known as TAPVC, is a congenital cardiac condition that affects between one and three percent of children who have cardiovascular abnormalities [1]. For survival, it is essential for the newborn to have a right-to-left shunt, which can be in the form of either a patent foramen ovale or an atrial septal defect [2]. It is a congenital heart abnormality that poses a significant risk to the patient's life and requires surgical treatment. On the basis of the location of the aberrant draining of pulmonary veins into the systemic circulation, it is categorised into the following types: supra-cardiac, infra-cardiac, cardiac and mixed [3].

The mortality rate associated with uncorrected TAPVC in infants is more than 78% [4]. The mortality rates have become relatively better over the past couple of decades, primarily as a result of advancements in management tactics, both medical and surgical [5-7]. Despite the fact that numerous published studies have recorded early post-operative mortality ranging from less than 10% to 50%, the mortality rates have become relatively better. Infants who have complicated TAPVC lesions that are coupled with additional severe cardiac abnormalities have a worse prognosis when compared to infants who have simple TAPVC with biventricular structure and no other severe cardiac abnormality [5,6]. Arrhythmias, pulmonary hypertension, and pulmonary vein stenosis are some of the post-operative morbidities that might occur after TAPVC repair [6,8]. These potential complications can occur either inside the pulmonary veins or at the anastomotic site.

This study outlines the results of TAPVC repair by a single surgeon over a period of ten years. The aim of our study was to describe early and late outcomes after TAPVC repair.

MATERIALS AND METHODS

The purpose of the study was to investigate the early and late outcomes of eighty-eight patients who had undergone surgical treatment for TAPVC over the course of ten years, beginning on June 1, 2009 and ending on May 31, 2019, and who had been operated on by a single surgeon. The protocol for the study was checked out by the Institutional Ethics Committee. On April 23, 2020, the approval for the institute's ethical clearance was done (Reference Number: IECPG-113/23.04.2020). For the purpose of publication of study data, informed consent was granted by the guardians of every participant. There was no conflict of interests.

All patients who underwent surgical treatment for TAPVC by a single surgeon during a period of ten years, beginning on June 1, 2009 and ending on May 31, 2019, were included in this study.

The information that was retrieved included the demographic details of the patient, the pre-operative evaluation, the surgical procedure, the post-operative course, and the follow-up after the patient was discharged. This information was retrieved by searching the registries of the operating theatre, the sections of the medical record, and finally by following up with the patient in the outpatient department on the phone.

Diagnosis was made based on echocardiographic findings. If there was echocardiographic data that indicated a considerable gradient between the pulmonary veins and their point of drainage (flow acceleration of 2 meters per second by echocardiogram), then the pulmonary veins were considered to be occluded prior to the operation. An operation was considered to be an emergency procedure if the patient was transported to the operating room during the first twenty-four hours after the patient was presented with symptoms of haemodynamic or ventilatory compromise. At the time of clinical manifestation or during routine radiographic surveillance, pulmonary venous blockage following repair was identified as the cause of the condition. The diagnosis of isolated or simple TAPVC was

made when the patient had TAPVC in conjunction with either a patent ductus arteriosus or a secundum atrial septal defect, or more than one of these conditions. Patients were classed as having either single-ventricle or two-ventricle physiology based on whether or not their anatomy was regarded acceptable for a single-ventricle or two-ventricle repair. A death that occurred within thirty days of a surgery or within the initial hospitalisation period was considered to be an example of early mortality [9].

Techniques Used in Surgery:

Standard cardiopulmonary bypass and moderate hypothermia were utilised during the surgical procedures for each and every patient. For myocardial protection, cold, hyperkalaemic blood cardioplegia, and topical hypothermia were administered to each and every patient. Dissection of the ductus was performed routinely on each and every patient, and it was then looped and ligated soon after the bypass was started. In individuals who had infra-cardiac connections or obstructed TAPVC, the vertical vein was only addressed after bypass was initiated. It was looped and snugged . The subsequent rectification was carried out in accordance with the type of drainage.

For supracardiac type of TAPVC, the apex of the heart was elevated cephalad and to the right. The right pleural cavity was left wide open. This manoeuvre leads to good exposure [10]. Long transverse incisions were made on the left atrium and the common pulmonary venous chamber and a running 6/0 polypropylene suture was used to create a big anastomosis between these two chambers, which was done from the outside. A right atriotomy was made and the atrial septal defect was closed.

For cardiac type TAPVC, according to Malm [11], the coronary sinus was unroofed and a large opening was created between the left atrium and the coronary sinus in the patients who had a cardiac type of TAPVC. A single patch, either synthetic or autologous pericardium, was used to close the atrial septal defect and the coronary sinus. This patch was strategically placed so that it was not in contact with the conduction tissue that was located at the margin of the coronary sinus.

For infracardiac TAPVC, the heart was pulled up and a broad anastomosis was established between the pulmonary venous chamber and the left atrium by making an incision in the left atrial body that was directed in an oblique direction. In infra-cardiac and blocked TAPVC patients, the vertical vein was ligated in order to treat complications.

Statistical Analysis:

The outcomes of TAPVC repairs were assessed in our study. Continuous variables are presented as mean while categorical variables are presented as numbers. Fisher exact test, Pearson Chi square test were done for categorical variables. Kruskal Wallis, Wilcoxon Mann-Whitney U test were used to compare continuous variables. Statistical analysis was done using SPSS Version 20.

RESULTS

Patient Demographics:

A total of eighty-eight (88) patients who underwent TAPVC repair were studied. Mean age and weight at surgery were 10.82 months and 5.27 kg, respectively (Table 1). Out of 88, 64 (72.7%) were male patients and 24 (27.3%) were females (Table 2). 25% of the participants had Age ≤1 Month. The TAPVC anatomy was supra-cardiac in 41 (46.6%) cases, cardiac in 24 (27.3%), infra-cardiac in 14 (15.9%) and mixed in 9 (Table 2). Of the 88 TAPVC patients, 33 (37.5%) were obstructed at the time of operation (Table 2). The association of obstruction with infra-cardiac TAPVC was found to be statistically significant (P=0.004). Twenty-nine (33%) patients had to be taken up for emergency TAPVC repair (Table 2).

Table 1: Distribution of the Participants in Terms of Age & Weight (n = 88)

Age (Months)	
Mean (SD)	10.82 (17.34)
Median (IQR)	3.5 (1.38-12)
Range	0.07 – 84
P value	0.073[1]
Weight (Kg)	
Mean (SD)	5.27 (3.26)
Median (IQR)	4.05 (3.18-6.78)
Range	1.8 - 19.9
P value	0.014[2]

1: Wilcoxon-Mann-Whitney U Test, 2: Kruskal-Wallis Test

Table 2: Distribution of the Participants in Terms of Gender, TAPVC Type, Obstruction & Timing of Surgery (n = 88)

GENDER	**FREQUENCY**	**PERCENTAGE**	**P value**
Male	64	72.7%	0.635[1]
Female	24	27.3%	
TAPVC TYPE	**FREQUENCY**	**PERCENTAGE**	**P value**
Supracardiac	41	46.6%	
Cardiac	24	27.3%	
Infracardiac	14	15.9%	
Mixed	9	10.2%	
OBSTRUCTION	**FREQUENCY**	**PERCENTAGE**	**P value**
Present	33	37.5%	0.004[1]
Absent	55	62.5%	
TIMING OF SURGERY	**FREQUENCY**	**PERCENTAGE**	**P value**
Emergency	29	33.0%	0.001[2]
Elective	59	67.0%	

1: Pearson Chi Squared Test ,2: Fisher's Exact Test

Perioperative Data:

Out of the 88 patients, 33 had preoperative Pulmonary Artery Hypertension (PAH). Thirteen (14.8%) patients were on mechanical ventilation preoperatively and 18 (20.5%) patients required preoperative inotropic support (Table 3). The median total cardiopulmonary bypass time (CPB) for all patients was 62 minutes, and median cross clamp duration was 32.5 minutes (Table 4). The vertical vein was left open in 34 cases (38.6%). Mean duration of mechanical ventilation was 4.18 days (+/-2.17 SD). Mean ICU stay was 8.01 days (+/-3.63 SD). Mean hospital stay was 17.8 days (+/-10.47 SD). (Table 4)

Table 3: Distribution of the Participants in Terms of Pre-Operative Mechanical Ventilation, Pre-Operative Inotropes (n = 88)

PRE-OPERATIVE MECHANICAL VENTILLATION	**FREQUENCY**	**PERCENTAGE**	**P value**
Yes	13	14.8%	<0.001[1]
No	75	85.2%	
PRE-OPERATIVE INOTROPES	**FREQUENCY**	**PERCENTAGE**	**P value**

PRE-OPERATIVE MECHANICAL VENTILLATION	FREQUENCY	PERCENTAGE	P value
Yes	18	20.5%	<0.001[1]
No	70	79.5%	

1: Fisher's Exact Test

Table 4: Distribution of the Participants in Terms of CPB Time, AOX Time, Duration of Mechanical Ventilation, ICU Stay, Hospital Stay (n = 88)

CPB TIME (MINUTES)	
Mean (SD)	63.36 (12.21)
Median (IQR)	62 (55-70)
Range	42 – 96
P value	0.630[1]
AOX TIME (MINUTES)	
Mean (SD)	34.40 (8.45)
Median (IQR)	32.5 (28-40.25)
Range	21 – 59
P value	0.702[1]
DURATION OF MECHANICAL VENTILATION (DAYS)	
Mean (SD)	4.18 (2.17)
Median (IQR)	4 (2.75-6)
Range	1 – 12
P value	0.130[1]
ICU STAY (DAYS)	
Mean (SD)	8.01 (3.63)
Median (IQR)	8 (5-9)
Range	3 – 22
P value	0.460[1]
HOSPITAL STAY (DAYS)	
Mean (SD)	17.80 (10.47)
Median (IQR)	17 (11-23)
Range	4 – 91
P value	0.911[1]

1: Kruskall Wallis Test

Post-operative Outcome:

In the post-operative period, 3 patients developed pneumonia, which was managed conservatively and these patients responded with appropriate upgradation of antibiotics. Fifteen (17%) patients developed low cardiac output syndrome in the immediate post operative period which was managed conservatively initially. But in 2 patients, ECMO (Extra Corporeal Membrane Oxygenation) had to be instituted, out of which 1 did not survive. Peritoneal dialysis was instituted in 15 (17%) patients in the post-operative period. Eleven (12.5%) patients were tracheostomised for prolonged requirement of mechanical ventilation. In subgroup analysis, none of these post-operative complications had any statistically significant difference among the four TAPVC types.

Two (2.3%) patients developed diaphragmatic palsy, 1 (1.1%) developed chylothorax and 2 (2.3%) had supraventricular tachycardia in post-operative period, which were managed conservatively.

Eleven (12.5%) patients died post-operatively (Table 5). Out of these, 8 had age of less than 1 month (P<0.001). Also, the mean weight of the patients with early mortality is 3.85 kg (+/-2.17 SD), while the mean weight of the surviving patients is 5.48 kg (+/-3.35 SD), (P<0.05). All of the 11 mortalities had at least some PAH in the post-operative period. However, 16 out of the surviving 77 patients had

PAH (P<0.001). There were 3 late deaths, 2 of which occurred in infra-cardiac TAPVC patients, while the third was of mixed TAPVC type.

Table 6 summarizes the comparison of various parameters between neonatal and older patients in our study. The ICU stay and hospital stay durations in the two subgroups were comparable. Notably, older patients were found to have statistically significant incidence of obstructed TAPVC and PAH. Also, early mortality was found to be more in neonates as compared to the older patients (p-value <0.001).

Table 5: Distribution of the Participants in Terms of Hospital Mortality (n = 88)

HOSPITAL MORTALITY	FREQUENCY	PERCENTAGE	P value
Yes	11	12.5%	0.298[1]
No	77	87.5%	

1: Fisher's Exact Test

Table 6: Distribution of the various parameters with respect to neonatal (n=22) versus older patients (n=66)

PARAMETERS	AGE		P value
	< 1 MONTH (n=22)	>1 MONTH (n=66)	
1. GENDER -MALE -FEMALE	 21 1	 43 23	0.006[1]
2. WEIGHT (kg)	2.83 +/- 0.43	6.09 +/- 3.39	<0.001[2]
3. TAPVC SUBTYPE - SUPRACARDIAC -CARDIAC -INFRACARDIAC -MIXED	 9 3 9 1	 32 21 5 8	0.004[3]
4. OBSTRUCTION	15	18	<0.001[1]
5. PAH	11	22	0.162[1]
6. ICU STAY (days)	8.32 +/- 3.21	7.91 +/- 3.78	0.367[2]
7. HOSPITAL STAY (days)	17.82 +/- 7.12	17.79 +/- 11.41	0.609[2]
8. EARLY MORTALITY	8	3	<0.001[3]
9. LATE MORTALITY	1	2	0.462[3]

1: Chi-Squared Test, 2: Wilcoxon-Mann-Whitney U Test, 3: Fisher'sExact Test

DISCUSSION

Recent reports of TAPVC repair have indicated that surgical outcomes have improved over the past three decades [5,12-14]. This has largely been a result of better preoperative management, minimization of invasive preoperative work-up, operative advancements and better post-operative care, including extracorporeal membrane oxygenation (ECMO) and nitric oxide.

The median age of children with TAPVC undergoing surgery in our study was 3.5 months, which is comparable to most of the other similar studies [14-17]. However, some studies had early presentation for surgery [18-20]. On the contrary, in some studies, the age of children undergoing surgery was found to be comparatively more [21,22]. The reason for this delay is contemplated to be a lack of widespread prenatal diagnosis, delayed postnatal diagnosis and referral and scarcity of tertiary care centers offering pediatric cardiac surgery services. The median weight of children with TAPVC undergoing surgery in our study was 4.05 kg, which is comparable to most of the other similar studies

[6,14-23]. The gender distribution in our study is also comparable to most of the other similar studies [6,14,17,19,22,23].

The TAPVC anatomy in our study was supra-cardiac in 41 (46.6%) cases, cardiac in 24 (27.3%), infra-cardiac in 14 (15.9%) and mixed in 9 (10.2%). This is comparable to the observations of some similar studies [14,17,19,20]. However, certain other studies demonstrated much higher incidence of supra-cardiac type of TAPVC [6,15,18,22]. This can be explained by relatively fewer number of cases being studied, leading to some amount of bias.

In our study, obstructed TAPVC cases being operated were 37.5%. This finding was comparable to that observed by other studies. For example, Lemaire et al reported 45% obstructed TAPVCs in their study [14], while Choudhary et al [15] and Kelle et al [18] reported 49% and 29%, respectively. Hancock et al [6], Yong et al [19] and Harada et al [17] reported higher incidence of obstruction in their studies while Elamry et al [22] reported only 15.7% obstructed TAPVC in their study.

About 33% of cases in our study had to be operated as emergency procedures. This was comparable to the findings of Harada et al [17]. Choudhary et al [15] reported 20.5% as emergency procedure and Yong et al [19] reported it to be 19.1%. However, Hancock et al [6] had 53% of cases which were operated as emergency.

The need for preoperative mechanical ventilation and preoperative inotropes was not reported in most of the studies. In our study, 14.8% cases required preoperative mechanical ventilation, while this data for Yong et al [19] and Harada et al [17] was 57% and 36.3%, respectively. In our study, 20.5% cases needed preoperative inotropes, while 34% cases in the study by Harada et al [17] and 48% in that by Hancock et al [6] required preoperative inotropes.

The average CPB time and aortic cross clamp time in our study was comparatively lesser than most of the studies [6,16,23].

The duration of mechanical ventilation, ICU stay and hospital stay in our study was comparable to most of the similar studies [15,18,19,22,23].

The early mortality in our study has been found to be 12.5%, which is comparatively lesser than most of the similar studies. Sugano et al [20] reported an in-hospital mortality of 34%, while Choudhary et al [15] and Hancock et al [6] reported an early mortality of 23.3% and 24%, respectively. Lemaire et al [14] reported early mortality in their study as 21.1%, while Domadia et al [24] and Sakamoto et al [21] reported early mortality to be 18% and 18.27%, respectively. Adzamli et al [23] reported that the in-hospital mortality in their study was only 7.5%. This can be attributed to the fact that they included only supra-cardiac type of TAPVC in their study, which has been known to have much lesser incidence of obstruction and better post-operative results. Similarly, Xiang et al [16] reported only 7.7% early mortality in their study. They included only mixed type of TAPVC, excluding infra-cardiac TAPVCs which is a known risk factor for poor post-operative outcome. Elamry et al [22] studied only those cases which were operated on an elective basis, excluding all the emergency cases. Consequently, the early mortality reported by them was only 5.7%. Kelle et al [18], Yong et al [19] and Harada et al [17] reported very good post-operative results in their studies, with early mortality of 12%, 7.9% and 2.7% respectively.

Bayya et al [25] reported only 0.9% early mortality in their study. However they included only isolated TAPVC patients without any associated lesion. Also, it is not mentioned whether they included cases which were operated on emergency basis [25].

Shentu et al in their study reported overall, mortality of 25 patients (10%), at a median of 0.26 months In their study lower weight, greater last arterial lactate level before surgery, emergency surgery, noncardiac connection type, long CPB, and cross-clamping time were associated with death [26].

Talwar et al have reported no early or late deaths among 98 patients operated for TAPVC [27]. However, a noteworthy difference is that they studied patients who presented and were operated after their first decade of life.

Tailor et al reported a mortality of 5.4% in their study [28]. However, only early mortality was mentioned.

Late mortality in our study has been found to be 3.9%, which is comparatively lesser than most of the similar studies. Kelle et al [18] reported late mortality to be 8% in their study, while Harada et al [17]

and Sakamoto et al [21] reported it to be 10.1% and 16.29%, respectively. Yong et al [19], Lemaire et al [14] and Xiang et al [16] reported the early mortality to be 5.1%, 6.1% and 7.7% in their respective studies.

Limitations:

This study has some limitations. First, patients in this cohort tended to be older at presentation and there was possibility that more critically ill newborns may die before referral, potentially reflecting a selection bias. Second, there may be underestimation or overestimation of the postoperative PAH, in which situation the diagnosis was only based on a combination of echocardiographic calculation and clinical judgement. Retrospective nature and a small sample size are other limitations.

CONCLUSIONS

In our study, early mortality was found to be 12.5%, while late mortality was 3.9%. The most common post-operative complication was low cardiac output followed by prolonged mechanical ventilation (which required tracheostomy), pneumonia, supraventricular tachycardia, diaphragmatic palsy and chylothorax. Longer duration of inotrope usage, mechanical ventilation, and ICU stay were seen in obstructed TAPVC in comparison to unobstructed TAPVC patients.

All the patients included in our study have been operated by a single surgeon, thus eliminating bias. Our study emphasizes the fact that the overall outcome of TAPVC repair has improved compared to previous similar studies, mostly as a result of advancement of management strategies, both medical and surgical.

REFERENCES

1. Wilson AD: Total anomalous pulmonary venous connection. eMedicine. Available at: http://www.emedicine.com/ped/topic254.
2. Patricia Stein RN: Total Anomalous Pulmonary Venous Connection. AORN Journal - Wiley Online Library [Internet]. 2007, 10.1016/S0001-2092(07)60123-9
3. Kanter KR: Surgical Repair of Total Anomalous Pulmonary Venous Connection. Seminars in Thoracic & Cardiovascular Surgery: Pediatric Cardiac Surgery Annual. 20061, 9:40-4. 10.1053/j.pcsu.2006.02.015
4. Burroughs JT, Edwards JE: Total anomalous pulmonary venous connection. American Heart Journal. 1960, 59:913-31. 10.1016/0002-8703(60)90414-2
5. Kirshbom PM, Myung RJ, Gaynor JW, Ittenbach RF, Paridon SM, DeCampli WM.: Preoperative pulmonary venous obstruction affects long-term outcome for survivors of total anomalous pulmonary venous connection repair. The. Annals of Thoracic Surgery. 2002, 1:1616-20. 10.1016/s0003-4975(02)03935-8
6. Hancock Friesen CL, Zurakowski D, Thiagarajan RR, Forbess JM, del Nido PJ, Mayer JE.: Total Anomalous Pulmonary Venous Connection: An Analysis of Current Management Strategies in a Single Institution. The. Annals of Thoracic Surgery. 2005, 79:596-606. 10.1016/j.athoracsur.2004.07.005
7. Morales DLS, Braud BE, Booth JH, Graves DE, Heinle JS, McKenzie ED.: Heterotaxy Patients With Total Anomalous Pulmonary Venous Return: Improving Surgical Results. The. Annals of Thoracic Surgery. 2006, 82:1621-8. 10.1016/j.athoracsur.2006.05.053
8. Tanel RE, Kirshbom PM, Paridon SM, Hartman DM, Burnham NB, McBride MG.: Long-term noninvasive arrhythmia assessment after total anomalous pulmonary venous connection repair. American Heart Journal. 2007, 153:267-74. 10.1016/j.ahj.2006.11.003
9. Herlong JR, Jaggers JJ, Ungerleider RM: Congenital Heart Surgery Nomenclature and Database Project: pulmonary venous anomalies. Ann Thorac Surg. 2000, 69:56-69. 10.1016/S0003-4975(99)01237-0
10. Bhan A, Sharma R, Iyer KS, Venugopal P: Improved exposure of TAPVC repair by posterior approach [Letter]. Ann Thorac Surg. 1996, 62:1000.

11. Malm JR: Secundum atrial septal defects and associated anomalous pulmonary venous drainage. In: Cooper P, ed. The craft of surgery. Boston, Massachusetts: Little Brown. 1964, 546:62.
12. Bando K, Turrentine MW, Ensing GJ, Sun K, Sharp TG, Sekine Y.: Surgical management of total anomalous pulmonary venous connection. Thirty-year trends. Circulation. 19961, 94:12-16.
13. Michielon G, Gharagozloo F, Julsrud PR, Danielson GK, Puga FJ: Modified Fontan operation in the presence of anomalies of systemic and pulmonary venous connection. Circulation. 1993, 88:141-148.
14. Lemaire A, DiFilippo S, Parienti JJ, Metton O, Mitchell J, Hénaine R.: Total Anomalous Pulmonary Venous Connection: A 40 years' Experience Analysis. Thorac Cardiovasc Surg. 2017, 65:9-17. 10.1055/s-0036-1588007
15. Choudhary SK, Bhan A, Sharma R, Mathur A, Airan B, Saxena A.: Repair of total anomalous pulmonary venous connection in infancy: experience from a developing country. The. Annals of Thoracic Surgery. 1999, 68:155-9. 10.1016/S0003-4975(99)00375-6
16. Xiang M, Wu C, Pan Z, Wang Q, Xi L: Mixed type of total anomalous pulmonary venous connection: diagnosis, surgical approach and outcomes. J Cardiothorac Surg. 20202, 15:293. 10.1186/s13019-020-01332-7
17. Harada T, Nakano T, Oda S, Kado H: Surgical results of total anomalous pulmonary venous connection repair in 256 patients. Interact Cardiovasc Thorac Surg. 20191, 28:421-6. 10.1093/icvts/ivy267
18. Kelle AM, Backer CL, Gossett JG, Kaushal S, Mavroudis C: Total anomalous pulmonary venous connection: results of surgical repair of 100 patients at a single institution. J Thorac Cardiovasc Surg. 2010, 139:1387-1394. 10.1016/j.jtcvs.2010.02.024
19. Yong MS, Yaftian N, Griffiths S, Brink J, Robertson T, D'Orsogna L.: Long-Term Outcomes of Total Anomalous Pulmonary Venous Drainage Repair in Neonates and Infants. Ann Thorac Surg. 2018, 105:1232-8. 10.1016/j.athoracsur.2017.10.048
20. Sugano M, Murata M, Ide Y, Ito H, Kanno K, Imai K.: Midterm results and risk factors of functional single ventricles with extracardiac total anomalous pulmonary venous connection. Gen Thorac Cardiovasc Surg. 2019, 67:941-8. 10.1007/s11748-019-01141-3
21. Sakamoto T, Nagashima M, Umezu K, Houki R: Ikarashi J, Katagiri J, et al. Long-term outcomes of total correction for isolated total anomalous pulmonary venous connection: lessons from 50-years' experience†. Interactive CardioVascular and Thoracic Surgery. 2018, 1:20-6. 10.1093/icvts/ivy034
22. Elamry E, Alkady HM, Menaissy Y, Abdalla O: Predictors of In-Hospital Mortality in Isolated Total Anomalous Pulmonary Venous Connection. Heart Surg Forum. 2019, 22:191-6. 10.1532/hsf.2415
23. Adzamli IK, Gaikwad S, Garekaar S, Mali S, Naseer NB, Agarwal V: Experience with the superior approach (Tucker's repair) for repair of supracardiac total anomalous pulmonary venous connection (TAPVC). Indian Journal of Thoracic and Cardiovascular Surgery. 2016, 1:12-6. 10.1007/s12055-015-0410-5
24. Domadia S, Kumar SR, Votava-Smith JK, Pruetz JD: Neonatal Outcomes in Total Anomalous Pulmonary Venous Return: The Role of Prenatal Diagnosis and Pulmonary Venous Obstruction. Pediatr Cardiol. 2018, 39:1346-54. 10.1007/s00246-018-1901-0
25. Bayya PR, Varghese S, Jayashankar JP, et al.: Total anomalous pulmonary venous connection repair: Single-center outcomes in a lower-middle income region. World Journal for Pediatric and Congenital Heart Surgery. 2022, 13:458-65. 10.1177/215013512211034
26. Shentu J, Shi G, Zhang Q, et al.: Surgical repair of neonatal total anomalous pulmonary venous connection: A single institutional experience with 241 cases. JTCVS Open. 2023, 1:739-54. 10.1016/j.xjon.2023.07.021
27. Talwar S, Arora Y, Gupta SK, Kothari SS, Ramakrishnan S, Saxena A, et al. Total anomalous pulmonary venous connection beyond the first decade of life. World J Pediatr Congenit Heart Surg 2019; 10: 185–91.

28. Tailor KB, Dharmani KH, Kadam SV, Kattana HB, Rao SG A single center, retrospective analysis of total anomalous pulmonary venous connection repair early outcome at a tertiary care center in India. Ann Card Anaesth 2021; 24: 333–8.