BANGLADESH J CHILD HEALTH 2010; VOL 34 (3): 86-91

Determination of TOF Characteristics in a Tertiary Care Centre of Bangladesh

JAHANGIR KABIR[1], REZOANA RIMA[2], SOOFIA KHATOON[3], REZAUL HASSAN[4], AMM BADRUDDOZA[5], NAVEEN SHEIKH[6]

Abstract

Objective: *Tetralogy of Fallot (TOF) is the commonest cause of cyanotic congenital heart disease (CHD) worldwide. The aim of this study was to determine the demography, associated anomalies and status of peripheral pulmonary stenosis (PPS), type of operation, operative results and complications in TOF physiology patient.*

Materials & Methods: *The records of 52 patients were reviewed. These patients were admitted from January 2007 to November 2009 in United Hospital Limited, Dhaka.*

Results: *Male patients were 61.5% and females were 38.5%. The median age of surgery was 5 years and weight was 15 kg with severely undernourished patients were 27% and severely stunted were 11.5% respectively. Among the associated anomalies, percentage of patent ductus arteriosus (PDA), patent foramen ovale (PFO) / atrial septal defect (ASD), right aortic arch (RAA), coronary artery (CA) anomalies and peripheral pulmonary artery stenosis were 57.7%, 26.9%, 21.2%, 11.5% and 13.5% respectively. 13.5% TOF physiology patient had severely hypoplastic pulmonary annulus, 38.4% had severely hypoplastic MPA. TOF was more common in B blood group patients. About 11.5% patients underwent palliative operation (Gore-tex shunt) as the first operation. The youngest case was 7 days and the oldest 7.5 years old. Corrective operation, TC (Total correction) was done in 94%cases. The youngest patient undergoing TC was 1.5 years and the oldest one was 40 years old. Transannular patch (TAP) was used in 24 cases (46%). Post surgical overall mortality rate was 23% in three year which was 17.3% in 1st year, 3.84% in 2nd year and 1.92% 3rd year.*

Conclusion: *In this study total correction (TC) was done in most of the cases (94%) and this should be recommended as the preferred management strategy for TOF physiology patient. The mortality rate decreases significantly as the team get experienced.*

Key words: *TOF characteristics.*

Introduction

Tetralogy of Fallot (TOF) is the most common cyanotic congenital heart disease with an incidence of approximately 0.5/1000 live births (5% to 7% of congenital heart lesions)[1]. TOF, an anterior and cephalic displacement of the infundibular septum results in a large ventricular septal defect (VSD) and the development of infundibular pulmonary stenosis. Right ventricular (RV) hypertrophy is associated with both pulmonary stenosis and VSD (Fig.-1). The clinical spectrum encountered in TOF with pulmonic stenosis is diverse. Symptoms can range from no cyanosis, in the setting of modest pulmonic stenosis, to profound cyanosis resulting from severe pulmonic stenosis, pulmonary artery hypoplasia, and resultant right-to-left ventricular level shunting. The etiology of TOF is heterogeneous and includes both environmental and genetic factors that most likely interact with one another in certain cases. Several environmental teratogens have been shown specifically to increase the risk of developing TOF with PS, which includes retinoic acids, trimethadione, maternal diabetes and

1. Chief Cardiac Surgeon & Director, Cardiac Centre, United Hospital Limited, Dhaka
2. Fellow in Interventional, Paediatric Cardiology (India), Specialist, Paediatric Cardiology, United Hospital Limited, Dhaka
3. Professor & Head, Faculty of Paediatrics, Shaheed Suhrawardi Medical College, Dhaka
4. Junior Consultant, Cardiac Surgery, United Hospital Limited
5. Junior Consultant, Cardiac Anaesthesia, United Hospital Limited, Dhaka
6. Junior Consultant, Department of Paediatric Cardiology, United Hospital Limited, Dhaka

Correspondence: Dr. Jahangir Kabir

maternal phenylketonuria (PKU). Certain genetic factors are also thought to influence the development of TOF with PS. Many reports describing families with multiple affected members both within and across generations support a monogenic or polygenic mode of inheritance. The advent of surgical repair which includes closure of the VSD and relief of RV outflow tract (RVOT) obstruction has greatly improved the long-term survival of TOF patients. Complete repair of TOF in early childhood is now routinely available in most advanced centre. Without surgical intervention, most patients die in childhood with a rate of survival of 66% at 1 year of age, 40% at 3 years, 11% at 20 years and 3% at 40 years[2].

The aim of this study was to determine the demography, blood grouping, associated anomalies, status of peripheral pulmonary stenosis (PPS), type of operations done and outcome of the surgery and surgical complications of TOF physiology children.

Materials and Methods

This study is a descriptive cross sectional study based on the patient's records. The sample size consisted of 52 cases, operated during 3 years (2007-2009) in United Hospital cardiovascular center, Gulshan, Dhaka. According to the records, for all patients, history taking, physical examination, chest x-ray, ECG, echocardiography, catheterization, angiocardiography, pulse oxymetry and other diagnostic procedures were done. Diagnosis and classification of TOF physiology was done according to collected clinical data and results were recorded. One questionnaire was developed and filled up for each case. Types of operation, outcome of operation and other features were analyzed from these records.

Results

Among the 52 patients with TOF, 20 cases (38.5%) were female and 32 cases (61.5%) male (Fig.-1). At the time of operation, the median age was 5 years, ranging from 7 days to 40 years. Among the operated patients, 52% operated below 5 years of age, 23% operated at 6-10 years of age, 15.4% operated at between 11-20 years of age and 9.6% patients were above 20 years (Fig.-2). Range of weight was found 1.9% patients had <5 kg weight, 19.2% had between 5-10 kg, 48.1% had between 11-20 kg and 30.8% had >20kg (Fig.-3). Median weight was 15 kg with severely undernourished patients were 27% and severely stunted were 11.5% (Table-I). The mean hemoglobin at first presentation was 17 gm/dl (ranging from 11.5 to 24.3 gm/dl) for all patients irrespective of sex and age.

Table-I

Number and percentage of patient by Z score of height and weight

Z score	Height n (%)	Weight n (%)
-1 to -2	14 (26.9)	14 (26.9)
-2 to -3	10 (19.2)	12 (23.1)
> -3	6 (11.5)	14 (26.9)
-1 to +1	15 (28.8)	10 (19.2)
+1 to +2	6 (11.5)	

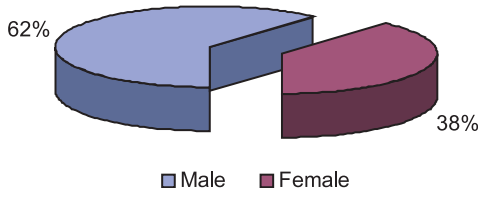

Fig.-1: *Distribution of cases by sex of the Patient*

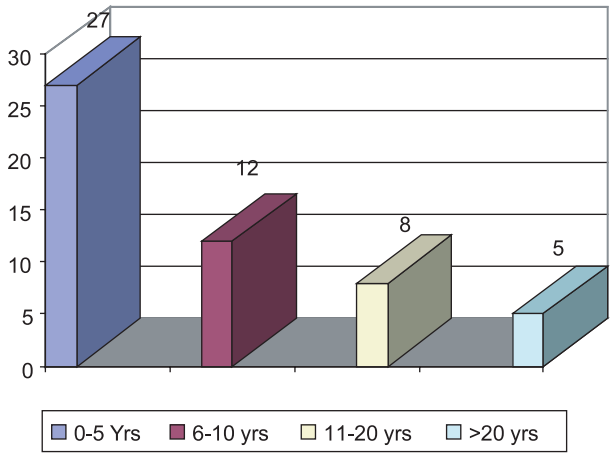

Fig.-2: *Distribution of TOF cases by age*

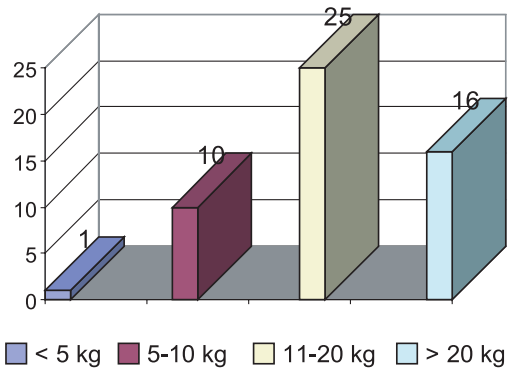

Fig.-3: *Distribution of cases by weight*

Among the diagnostic spectrum of TOF physiology patients, Tetralogy of Fallot constitute the maximum number (65%), Double chambered right ventricle and TOF variant double outlet right ventricle constitute another 21% patient. TOF with near and complete pulmonary atresia, absent pulmonary valve and absent LPA were found one case each. VSD with PS was found in 5.8% patient (Table-II).

Table-II

Distribution of patient by diagnosis of TOF physiology

Diagnosis	Frequency	Percentage
TOF	34	65.4
TOF with near pulmonary atresia	1	1.9
TOF with pulmonary atresia	1	1.9
DORV,VSD,PS	5	9.6
TOF with absent Pulmonary Valve	1	1.9
DCRV, VSD, PS	6	11.5
VSD,PS	3	5.8
TOF with absent LPA	1	1.9
No Anomalies	46	88.5
Single Ostium Coronary Artery	2	3.8
LAD from RCA	2	3.8
RCA arising from posterior sinus	2	3.8

TOF-Tetralogy of Fallot, DORV-Double outlet right ventricle, VSD-Ventricular septal defect, PS-Pulmonary stenosis, DCRV-Double chambered right ventricle, LPA-Left pulmonary artery.

Dyspnoea on exertion (96%) was the most frequently observed presenting features. Other features are failure to thrive (52%), cyanotic spell (42%), headache (17%), syncope (15%), hemoptysis (2%). Thirty five percent parents noticed cyanosis in their child below 6 months of age (Table-III).

Table-III

Distribution of patients by presenting features

Presenting features	Frequency	Percentage
Dyspnea on exertion	51	98
Failure to thrive	27	51.9
Cyanotic spell	22	42.3
Hemoptysis	1	1.9
Headache	9	17.3
Syncope	8	15.4

In 46% cases echocardiography was the only diagnostic tool. In another 53% cases cardiac catheterization aided the diagnosis. Z score of pulmonary annulus, MPA and branch pulmonary artery were obtained in all patients by echocardiography. It showed 13.5% patient had severely hypoplastic pulmonary annulus, 38.4% had severely hypoplastic MPA and 20% had severely hypoplastic branch pulmonary arteries.

PDA (57.7%) was the most frequently found associated anomalies. Other associated anomalies were PFO (17%), ASD (9.6%), major aorto-pulmonary collaterals (29%), peripheral pulmonary artery stenosis (13.5%), right aortic arch (21%),and coronary artery anomalies (11.5%). Three patients had persistent left superior venacava, one had retroaortic Innominate vein (Table-IV). A forty years old patient with TOF had associated coronary artery disease.

Table-IV

Distribution of patient by associated anomalies

Associated anomalies	Frequency	Percentage
PFO	9	17.3
ASD	5	9.6
PDA	30	57.7
MAPCA	15	28.8
Right aortic arch	11	21.2
LSVC	3	5.8
Coronary artery anomalies	6	11.5
Peripheral Pulmonary Artery Stenosis	7	13.5

PFO-Patent foramen ovale, ASD-Atrial septal defect, PDA-Patent ductus arteriosus, MAPCA-Major Aorto-pulmonary collaterals, PLSVC - Persistent left superior venacava.

Among patients with coronary artery anomalies, single ostium coronary artery (SOCA), the left coronary artery (LCA) arose from the right coronary artery (RCA) and the RCA arose from posterior sinus were found in two cases each.

Forty eight (92.3%) patients underwent corrective operation, total correction (TC). Among them only 8 (15.4%) patients had ICR alone, others had ICR with different form of corrective measures. The youngest patient undergoing TC was 1.5 years and the oldest one 40 years old. Transannular patch (TAP) was used in 24 cases (46%).Four patients (7.7%) underwent palliative operation (Gore-tex shunt) as the first operation (Table-V).

Table-V

Number and percentage of patient by corrective operation

Name of surgery	Frequency	Percentage
Total correction	48	92.3
ICR alone	8	15.4
ICR + Transannular patch	15	28.8
ICR + Transannular patch extended to br PA,s	9	17.3
ICR + RVOT patch	8	15.4
ICR + Open Valvotomy	7	13.5
ICR + ligation of MAPCA	1	1.9
BDG	1	1.9
BT shunt	3	5.8

ICR-Intracardiac repair, BDG-Bidirectional Glenn shunt, BT shunt-Blalock Taussig, shunt, MAPCA-Major aorto-pulmonary collaterals, RVOT-Right ventricular outflow tract.

Mean post repair LV to RV systolic pressure ratio was found 0.59 ranging from 0.29 to 0.95, RV to PA pressure gradient was 16.8 mm Hg ranging from 0 to 46 mm of Hg (Table-VI).

Table-VI

Mean, minimum, maximum post repair LV to RV systolic pressure ratio and RV to PA pressure gradient

	LV to RV systolic pressure ratio	RV to PA pressure gradient in mm of Hg
Mean	.5948	16.84
Minimum	.29	0
Maximum	.95	46

Post repair right ventricular systolic pressure (RVSP) was found less than half systemic in 15.4%, half systemic in 7.7%, half to 2/3 rd of systemic in 25%,>2/3rd systemic in 13.5% patient (Table-VII). Mean CPB and aortic cross clamp time was recorded as 123 minutes and 64 minutes respectively.

Table-VII

Number and percentage of patient by post repair RVSP (Right ventricular systolic pressure)

RVSP	Frequency	Percentage
Less than half systemic	8	15.4
Half systemic	4	7.7
Half to 2/3 rd of systemic	13	25.0
More than 2/3rd systemic	7	13.5

Excessive Bleeding requiring reoperation (7.7%), junctional ectopic tachycardia (9.6%), transient complete heart block (1.9%), right ventricular failure (38.5%), pleural effusion requiring >7days drainage (23%), neurological complication (7.7%), pulmonary complication (9.6%), septicaemia (25%) are the most frequently encountered immediate postoperative complications (Table-VIII). VSD Patch Leakage, moderate to severe residual pulmonary stenosis, moderate to severe pulmonary regurgitation were found in 36.5%, 11.5%, 25% respectively.

Table-VIII

Number and percentage of patient by postoperative complications

Postoperative complications	n (%)
Excessive bleeding requiring reoperation	4 (7.7)
Junctional ectopic tachycardia	5 (9.6)
VSD patch leakage	19 (36.5)
Residual stenosis (moderate to severe)	6 (11.5)
Pulmonary regurgitation (moderate to severe)	13 (25)
RV hypertension	13 (25)
Transient complete heart block	1 (1.9)
RV failure	20 (38.5)
Pleural effusion requiring >7days drainage	12 (23.1)
Neurological complication	4 (7.7)
Pulmonary complication	5 (9.6)
Septicaemia	13 (25)

Post surgical overall mortality rate was 23% which was 17.3% in 1st year, 3.84% in 2nd year and 1.92% 3rd year. The cause of death was mostly low cardiac output due to RV failure. Out of total 52 patients operated during the study period 40 patients survived (76.9%) and 12 pattients died (21.1%) (Table-IX).

Table-IX

Number and percentage of total mortality cases by year (n =12)

	Frequency	Percentage
Jan'2007-Dec'2007	9	17.3
Jan'2008-Dec'2008	2	3.8
Jan'2009-Nov'2007	1	1.9

Discussion

In our study, TOF physiology was more common in males (male/ Female= 1.5:1) than female. Though the trend for early primary repair of CHD in infancy is increasing in developed countries we have operated mostly 3-7 years age group TOF physiology patient because of delay in referral. According to a multicenter analysis of the choice of initial surgical procedure in TOF, focused on 938 patients from 12 institutions throughout the USA, who underwent their initial operation during a 10- year period (1986-1995), the percentage of palliative surgery (aortopulmonary shunt) decreased from 35% (1986-1990) to 22% (1991- 1995) and the percentage of primary complete repair increased accordingly[3].

Many other cardiac lesions may co-exist with TOF. The rate of associated cardiac anomalies in total is high. PFO and ASD are common. ASD is reported to be present in a majority of patients. In other studies a PFO or true ASD was found in 83% of TOF[4,5]. PDA (57.7%) was the most frequently found associated anomalies in our study, whereas PFO and ASD were found in 26.6% cases. A right aortic arch, though not of functional importance, is common and when detected, should alert the physician for further investigations in the diagnosis of TOF[6,7]. In one study in Iranian patient with TOF showed incidence of RAA is 21%[8] which is similar with our study. The incidence of a LSVC was found to be 11%[4,5] in different study which is 5.8% in our study.

Origin of the LAD from RCA with anterior course across RVOT was found in 5% of TOF in other studies which is 3.8% in our study. A large conal branch (accessory LAD) was seen in up to 15% of cases in another study which we didn't find any. SOCA may be present in approximately 4% of patients in different study[7,9]. This is almost similar in our study.

With the evolution of noninvasive technology such as echocardiography, the indications for diagnostic cardiac catheterization has diminished substantially. In our study 46% cases echocardiography was the only diagnostic tool. Because diagnostic catheterization is invasive and time-consuming, we recommend, that the patients may undergo surgery without invasive diagnostic procedures. Nonetheless, invasive procedure is, on occasion necessary for determination of PA, CA and aortopulmoanry collateral arteries anatomy in order to decide on surgical or medical management strategies, for interventional treatment and for a definitive anatomical diagnosis.

Hani A et al[10] showed independent risk factors for reoperation included an intraoperative pressure ratio between the right and left ventricles of 0.75 or greater (p=0.01), Doppler residual left pulmonary artery stenosis of 15 mm Hg or more, or Doppler right ventricular outflow tract obstruction gradient of 40 mm Hg or more at hospital discharge (p=0.002 and 0.02, respectively). Our study showed mean intraoperative pressure ratio between the right and left ventricles was 0.59, right ventricular outflow tract obstruction gradient 16.8 mm of Hg.

Early correction, as a single stage early TC of TOF worldwide[11-14] due to improvement in the comprehensive surgical approach, technology and PICU care, should be regarded as the preferred management strategy. Corrective operation TC (Total correction) was done in 94% cases in our study.

Post surgical mortality was high at the beginning of the centre which has come down to an acceptable range at present.

Conclusion

Early repair can prevent or reduce the development of severe right ventricular hypertrophy and fibrosis, reduce the risk of arrhythmias and encourage the development of more normal pulmonary vasculature At present the limiting factor to earlier operation is the timing of presentation or referral. A common attitude is not to intervene in asymptomatic, pink patients. We believe this is wrong and that this is probably the

group of patients that could benefit most from an early repair. We have opted for primary repair whenever possible, palliation is sometimes necessary, but primary repair at presentation remains our aim. Trend toward earlier total correction, and single stage early total correction of TOF should be recommended as the preferred management strategy.

References

1. Ho K W, Tan R S, Wong K Y, Tan T H, Shankar S, Tan J L. Late Complications Following Tetralogy of Fallot Repair: The Need for Long-term Follow-Up. Ann Acad Med Singapore 2007; 36: 947-53.
2. Bertranou EG, Blackstone EH, Hazelrig JB, Turner ME, Kirklin JW. Life expectancy without surgery in tetralogy of Fallot. Am J Cardiol 1978; 42: 458-66.
3. Mulder TJ, Pyles LA, Stolfi A, Pickoff AS, Moller JH. A multicenter analysis of the choice of initial surgical procedure in tetralogy of Fallot. Pedia Cardiol 2002; 23: 580-86.
4. Nora JJ, Nora AH. Genetic and environmental factors in the etiology of congenital heart diseases. South Med J 1976; 69: 919-26.
5. Higgins CB, Mulder DG. Tetralogy of Fallot in the adult. Am J Cardiol 1972; 29: 837-46.
6. Hennein HA, Mosca RS, Urcelay G, Crowley DC, Bove EL. Intermediate results after complete repair of tetralogy of Fallot in neonates. J Thorac Cardiovascul Surg 1995; 109: 332-42.
7. Li J, Soukias ND, Carvalho JS, Ho SY. Coronary arterial anatomy in tetralogy of Fallot: Morphological and clinical correlations. Heart 1998; 80: 174-83.
8. Farsani H Y, Moghadam M Y A. Determination of TOF Characteristics in Iranian Patients. Iran J Ped 2007;17: 5-10.
9. Dabizzi RP, Teodori G, Barletta GA, Baldrighi G, Baldrighi V. Associated coronary and cardiac anomalies in the tetralogy of Fallot. An angiographic study. Eur Heart J 1990; 11: 692-704.
10. Hani A, Hennein, Ralph S Mosca, Gonzalo Urcelay, Dennis C. Crowley , Edward L. Bove . Intermediate results after complete repair of tetralogy of Fallot in neonates. The Journal of Thoracic and Cardiovascular Surgery 1995; 109: 332-44.
11. Siwik ES, Patel CR, Zahka KG. Tetralogy of Fallot. In: Allen HD, Gutgesell HP, Clark EB, editors. Moss and Adam's Heart Disease in Infants, Children and Adolescents. Vol 2. 6th ed. Baltimore; Lippincott Williams & Wilkins: 2001.p. 881-902.
12. Shinebourne EA, Anderson RH. Fallot's tetralogy. In: Anderson RH, Baker EJ, McCartney FJ, editors. Pediatric Cardiology. Vol 2. 2nd ed. Philadelphia; Churchill Livingstone: 2002.p. 1213-50.
13. Reddy VM, Liddicoat JR, McElhinney DB, Brook MM, Stanger P, Hanley FL. Routine primary repair of tetralogy of Fallot in neonates and infants less than three months of age. Ann Thorac Surg 1995; 60 (6 Suppl): S592-96.
14. Knott-Craig CJ, Elkins RC, Lane MM, Holz J, McCue C, Ward KE. A 26 year experience with surgical management of tetralogy of Fallot: risk analysis for mortality or late reintervention. Ann Thorac Surg 1998; 66: 506-11.