

Transatrial approach for total tetralogy of Fallot TOF correction: analysis of 24 cases.

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Abstract:

Background: Tetralogy of Fallot TOF is the most common cause of congenital cyanotic heart disease. It is the most common congenital lesion that is likely to result in survival to adulthood and encountered in adult after repair. Tetralogy of Fallot comprises around 7.5 % of all congenital heart diseases in Iraq.

Objective: The aim of this study is to analyse the transatrial strategy for total correction of tetralogy of Fallot TOF.

Methods: Cross-sectional study was done during the period between 2012-2014 for twenty-four patients that admitted to Ibn Al-Bitar hospital in Baghdad with amenable TOF pathology for transatrial repair.

Results: Twenty-four patients, 16 were males and 8 were females. Ages ranged from 2-31 years. There was no early or late postoperative mortality in this review for follow-up period ranged from 6 – 24 months. The early and late postoperative echocardiography data in regard to pulmonary and tricuspid regurgitation and right ventricle RV function were delineated. Normal pulmonary valve (62.5%, 58.3%), mild pulmonary regurgitation (29.2%, 37.5%), moderate pulmonary regurgitation (8.3%, 4.2%). Normal tricuspid valve (75%, 70.8%), mild tricuspid regurgitation (20.8%, 20.8%), moderate tricuspid regurgitation (4.2%, 8.3%) respectively. No severe pulmonary or tricuspid regurgitation was reported. Postoperative RV function was normal in (87.5%, 83.3%), mild RV dysfunction in (8.3%, 12.5%), moderate RV dysfunction in (4.2%, 4.2%) respectively. No severe RV dysfunction was reported. The mean RVOT pressure gradient was 36.8 mmHg. This gradient decreased on follow-up echocardiography, mean 24.5 mmHg. P values were less than 0.05%.

Conclusion: The transatrial approach is a feasible technique for total repair of TOF in adequate pulmonary annulus size with satisfactory late postoperative echocardiography performance.

Keywords: Tetralogy of Fallot. Total correction. Transatrial repair.

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Introduction:

Tetralogy of Fallot TOF is the most common cause of congenital cyanotic heart disease with approximately 3000 new annual cases are diagnosed in United States 1. It is the most common congenital lesion that is likely to result in survival to adulthood and encountered in adult after repair 2. Tetralogy of Fallot comprises around 7.5 % of all congenital heart diseases in Iraq 3. The cephalad and anterior deviation of infundibular septum is the ground etiology. This septal displacement narrows the right ventricular outflow tract RVOT, with failure of main body of interventricular septum to meet the infundibular septum, creating a ventricular septal defect VSD. Pressure equalization across VSD leads to ventricular hypertrophy. Pulmonary stenosis may be valvular or more rarely supravalvular and usually subvalvular 4. The surgical approaches for TOF repair involve either an initial palliation by construction of a systemic to pulmonary artery shunt followed by a definite repair i.e. total correction or primary complete repair. The right ventriculotomy with or without transannular patch is the classic approach, with acceptable operative risk and long-term survival 5. However, the late complications and incidence of re-operation are the concern owing to right ventriculotomy and pulmonary incompetence 5. In this review, we would discuss our experience

with total TOF repair via pure right atrial approach, preserving the right ventricle and without transpulmonary incision.

Patients and Methods:

This is a cross-sectional study for twenty-four patients that admitted to Ibn Al-Bitar centre in Baghdad with amenable TOF pathology for transatrial repair, studied during the period 2012-2014. Sixteen were males and 8 were females. The mean age was 12 years, ranged from 2 – 31 years. The mean body weight was 39.3 kg, ranged from 11.5 – 62 kg. Age and weight distributions are shown in Tables 1 and Figure 1 respectively. The diagnosis based on echocardiography, cardiac catheterization and cineangiography. The suitable cardiac anatomy for total transatrial approach correction was defined as discrete infundibular obstruction with adequate pulmonary annulus and good-sized pulmonary arteries. This can be estimated preoperatively by calculating Z-score with echocardiography or on angiocardiography. We consider Z-score > -3 eligible for transatrial repair. Alternative approaches instead of the transatrial repair were performed when the pulmonary valve annulus is small or arterioplasty is needed to enlarge pulmonary arteries. We considered these conditions as a prohibition to the transatrial strategy. In this review, we excluded all patients who were changed to transventricular or have additional pulmonary annuloplasty or arterioplasty from the study.

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Surgical technique: The operation was performed under standard total cardiopulmonary bypass with moderate hypothermia, 28 – 32 C°. The surgical procedure accomplished as follow: right atriotomy is performed, resection of parietal and septal bands of the infundibulum os through the tricuspid valve or assisted by traction of septal leaflet. After adequate resection, the pulmonary valve was visualized and its cusps were pulled down and everted and valvotomy could be performed. Then patch closure of interventricular septum. Evaluation of the tricuspid valve sufficiency and valvuloplasty were performed when necessary. **Follow-up:** The patient stayed at the intensive care unit ICU for two days as a routine in our centre while the whole hospital stay ranged from 7 - 10 days. The patients discharged from hospital after doing routine haematological, biochemical, radiological investigations and echocardiography. The patients have followed-up at first week then 1, 3, 6, 12 months and annually. **Statistical analysis:** The data are presented in frequency, percentage and mean as appropriate. Chi-square test used to notice the difference between observed and expected frequencies, whether the difference is of statistical significance or obtained by chance. Student t-test used to compare two paired samples to obtain significance of difference.

Results:

In this study, there was no early or late postoperative mortality in this review for follow-up period ranged from 6 – 24 months. The mean cardiopulmonary bypass time was 127 minutes, ranged from 83 - 165 minutes. The mean aortic cross clamp time was 103 minutes, ranged from 67 – 126 minutes. The patients needed 6 – 10 hours to wean off from assisted ventilation. The inotropic support on coming off bypass or during ICU stay was required in 37.5% (9 cases) while 62.5% (15 cases) no inotropes were needed. The associated cardiac anomalies were 14 in 12 cases (50 %) that illustrated in Figure 2. There were two associated anomalies in two cases. The early (within first month) and late (more than 6 months) postoperative echocardiography findings in regards to pulmonary and tricuspid regurgitation and right ventricular RV function were delineated in Figure 3 and Table 2. The RVOT pressure gradient ranged from zero – 55 mmHg, mean 36.8 mmHg. The gradient decreased on late follow-up echocardiography, mean 24.5 mmHg. The postoperative complications were shown in Table 3.

Table 1: Age distribution in 24 TOF cases with amenable transatrial repair.

Age group (year)	Frequency
2 - 5	8
6 - 10	3
11 - 15	4
16 - 20	5
21 - 25	2
26 – >30	2
TOTAL	24

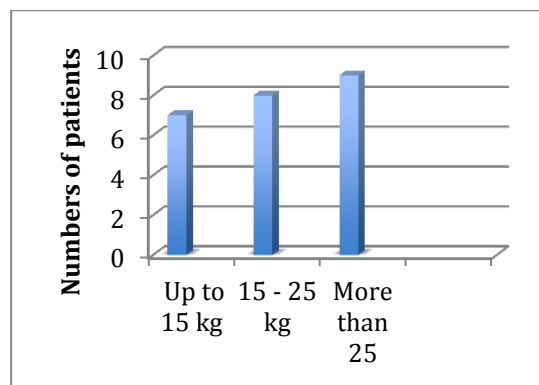


Figure 1: Weight distribution in 24 TOF cases with amenable transatrial repair.

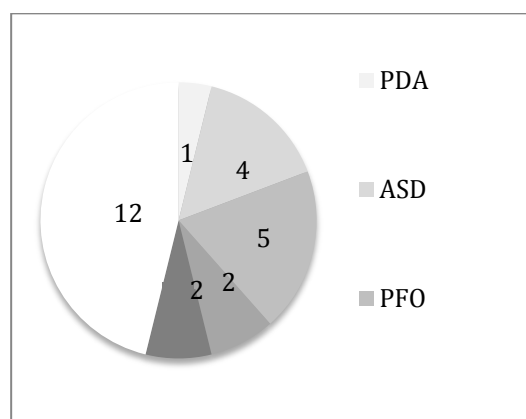


Figure 2: Types of associated cardiac anomalies in 24 cases of TOF with amenable transatrial repair. PDA patent ductus arteriosus, ASD atrial septal defect, PFO patent foramen Ovale, LCA left coronary artery.

Table 2: Comparison between early and late (more than 6 months) postoperative echocardiographic data in 24 cases of transatrial TOF repair.

Parameter	Early (%)	Late (%)	P value
PR			
No regurgitation	15 (62.5)	14 (58.3)	<0.05
Mild regurgitation	7 (29.2)	9 (37.5)	
Moderate regurgitation	2 (8.3)	1 (4.2)	
Severe regurgitation	0	0	
TR			
No regurgitation	18 (75)	17 (70.8)	<0.05
Mild regurgitation	5 (20.8)	5 (20.8)	
Moderate regurgitation	1 (4.2)	2 (8.3)	
Severe regurgitation	0	0	
RV function			
Normal function	21 (87.5)	20 (83.3)	<0.05
Mild dysfunction	2 (8.3)	3 (12.5)	
Moderate dysfunction	1 (4.2)	1 (4.2)	
Severe dysfunction	0	0	
RVOT pressure gradient			
Mean (mmHg)	36.8	24.5	<0.05

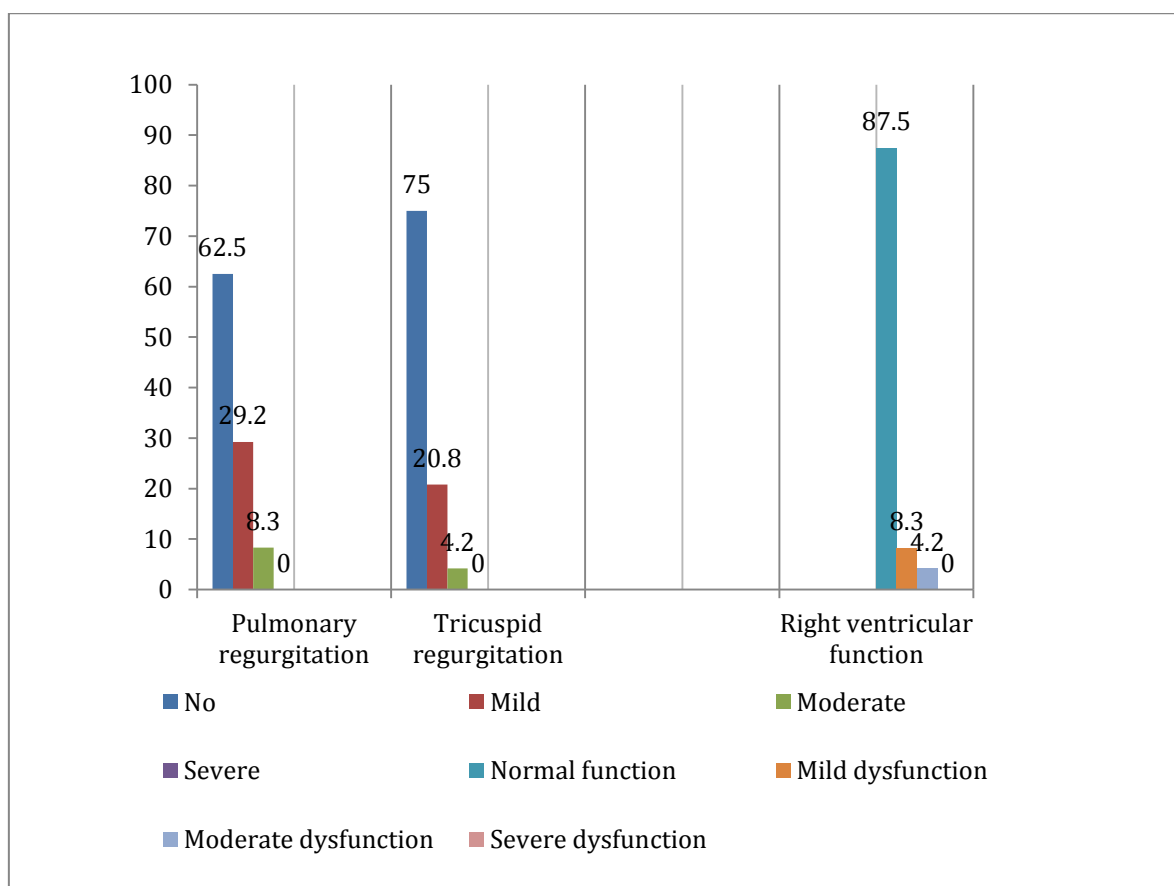


Figure 3. The early postoperative echocardiography data in 24 cases of TOF with transatrial total correction, values in percent.

Table 3: Postoperative complications after transatrial total TOF correction in 24 cases.

Type of complication	Frequency	Percent
Persistent cardiac arrhythmia	0(24)	0
Temporary pacemaker need	5(24)	20.8
RBBB	9(24)	37.5
Complete heart block	0(24)	0
Pleural effusion	1(24)	4.2
Wound infection	1(24)	4.2
Residual VSD flow	1(24)	4.2
Death	0(24)	0
TOTAL	17(24)	70.8(100)

PR, pulmonary regurgitation. TR, tricuspid regurgitation.
RV, right ventricle. RVOT, right ventricular outflow tract.

Discussion:

The surgical repair of TOF is accomplished nowadays with low mortality, around 0-5% in most centres, while there is an increasing trend towards correction at younger age 6 - 8. Despite excellent early result, late right ventricular, tricuspid and pulmonary valves dysfunction, and arrhythmias are the main dubiousness that has been attributed to ventriculotomy 9. Transatrial approach has gained increase popularity because of several advantages. The reported advantages are 6:

1. Preserving right ventricle when ventriculotomy is avoided.
2. Minimizing the risk of injuring a major ventricular branch of right coronary artery or an anomalous left coronary artery.

3. Minimizing the risk of life-threatening ventricular arrhythmias and sudden death that originated at site of ventriculotomy scar.

4. Decreasing the risk of pulmonary regurgitation.

5. Repairing the tricuspid valve when it is necessary.

The feasibility of this approach does not related to the extent and length of infundibular obstruction, degree of aortic overriding, the size and position and even number of VSDs. However, the absolute contraindication was hypoplastic pulmonary annulus for which valvulotomy, annuloplasty or arterioplasty may be required 10. In our experience, it was difficult to use the transatrial approach in children less than two years old. We thought that the severe form of infundibular and pulmonary annular hypoplasia make this approach difficult to perform. Other authors believe that the infants aged more than 3 months or weighing more than 5 kg are likely to be suitable for primary total correction using this approach 10. The transatrial strategy has a special profit in anomalous coronary artery crossing the right ventricular outflow tract RVOT. We applied this approach in two cases (8.3%) allowing adequate correction without use of conduit or two patches technique. In this review, the postoperative RV pressure gradient results were encouraged and comparable to other studies. The mean residual RV

pressure gradient was 36.8 mmHg on early postoperative echocardiography, ranged from 0 – 55 mmHg. Most of the immediate postoperative pressure gradients were dynamic, i.e. RVOT dimensions have changed during cardiac cycle. These gradients were gradually declined noticeably at follow-up echocardiography 5. Kaushal SK et al 11 mentioned that dynamic RVOT gradient usually decreases progressively after surgery irrespective of their severity. Nevertheless, re-intervention for residual or recurrent RVOT obstruction is a potential problem. We have not been re-operated for high-pressure gradient; however, the pressure gradient ranges have been decreased with increasing of our experience in infundibular resection. The behind causes of arrhythmia and right bundle branch block RBBB after TOF correction are right ventriculotomy, infundibular resection and closure of VSD 12,13. The incidence of significant arrhythmias is lesser than that accompanied the transventricular approach 14. There were no clinical significant arrhythmias reported on follow-up electrocardiogram ECG in this review, although no patient underwent 24 hours Holter monitoring. The RBBB has been reported in 9 cases (37.5%) that might be due to infundibular resection 15. Airan et al reported nearly same results (35%) 10. Tricuspid valve incompetence or valve dysfunction due to VSD patch closure, leaflet detachment or port usage is unlikely 16. In addition, pulmonary valve incompetence is less prevalent with transatrial strategy 10. Stewart and his colleagues reported that 70 – 85 % of transannular patch patients have moderate or severe pulmonary regurgitation while it was 15 – 36 % in valve sparing approach 5. Therefore, the incidence of postoperative RV dysfunction will be decreased 14, 17. The RV distension and dysfunction are attributed to a severe degree of pulmonary insufficiency, residual or recurring obstruction of the RVOT, aneurysm of the patch used to widen the RVOT, or other residual lesions (VSD, ASD, or stenosis of pulmonary artery branches) 7. We reported no case of severe pulmonary or tricuspid valves regurgitation or severe RV dysfunction in this review. The mortality rate and incidence of reoperation in transatrial/transpulmonary are lesser than that of transventricular strategy. It is 0-2% and 0-5% while it may be more than 1 and up to 20% respectively 7. Kawashima et al 17 reported improved RV function and a decreased prevalence of ventricular arrhythmia with transatrial approach in compare to transventricular repair. Similarly, Dietl et al 14 showed that the transatrial approach would decrease the prevalence of both RV dysfunction and pulmonary regurgitation, and also would reduce the risk of ventricular arrhythmia without a concomitant increase in atrial arrhythmia. In that sense, these results will decrease mortality and reoperation rates in transatrial approach. Lindberg et al 18 showed no difference between transatrial and transventricular repairs on long-term survival but transannular patch would increase the risk of re-operation significantly.

The crucial drawback against transatrial approach is residual or recurrent RVOT obstruction gradient 5, 10, 11. High residual gradient can affect the outcome of corrective surgery and the re-operation may be inevitable. Improving experience for the operating surgeon may optimize opening of RVOT which may decrease the postoperative RV pressure gradient 19, keeping balance to avoid restrictive RVOT and over-resection that leads to pulmonary regurgitation. We accept Hegar,s probe size at least same of that predicted by Rowlatt charts. Other authors maximize annulus by at least 1 – 2 mm greater than normal values. We have to imply degree of infundibular narrowing than leaving pulmonary incompetence as it is well tolerated by the patients 9, 20 - 23.

Conclusion:

The transatrial approach is a feasible technique for total repair of TOF in adequate pulmonary annulus size with satisfactory echocardiography performance of late postoperative right ventricle and pulmonary valve functions.

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