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# EARLY OUTCOMES OF TOTAL CORRECTION IN TETRALOGY OF FALLOT IN A TERTIARY CARE HOSPITAL OF PESHAWAR, KHYBER PAKHTUNKHWA, PAKISTAN; A TWO-YEAR RETROSPECTIVE STUDY

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**Contribution**
SR conceived the idea and designed the study. Data collection and manuscript writing was done by SMAS, SR, and RAK. Critical review was done by MAAK and MKH. All the authors contributed equally to the submitted manuscript.

All authors declare no conflict of interest.

## ABSTRACT

**Objective:** To investigate the early outcomes of patients undergoing total-correction (TC) for Tetralogy of Fallot (TOF).

**Methodology:** A retrospective study was carried out after acquiring Institutional ethical review committee approval. All patients diagnosed with TOF combined with pulmonary stenosis that had undergone primary repair between November 2016 and November 2018 at the Cardiothoracic Surgery Unit of Rehman Medical Institution, Peshawar were included while patients having anatomical defects alongside TOF were excluded from the study. Data was collected using a proforma. SPSS version 25 format was used for data entry and analysis. Comparisons between age related intraoperative parameters and age related early outcomes of the procedure was done by using the Student's T-test and Chi-squared test keeping $p \leq 0.05$ as significant.

**Results:** A total of 186 patient's data was retrieved from the hospital record. There were 109 (58.60%) males and 77 (41.40%) females. Mean cardiopulmonary bypass time (CBP) was 94.84±37.92 minutes and aortic cross clamp (ACC) time was 67.17±31.86 minutes. In the postoperative period, 11 (5.91%) patients developed Low cardiac output syndrome (LCOS). Prolonged ventilator support (>24 hrs.) was required in 21(11.29%) patients and prolonged ICU stay (>48 hrs.) was seen in 38(20.43%) patients. A total of 166 (89.25%) patients were discharged while 20 (10.75%) died post operatively due to complications.

**Conclusion:** Total repair for TOF is a favorable option in most patients as early outcomes were satisfactory with acceptable mortality rate after surgery.

**Keywords**: Atrioventricular Septal Defect, Congenital Heart Disease, Heart Septal Defects, Tetralogy of Fallot

## INTRODUCTION

Tetralogy of Fallot (TOF), is known to be the commonest amongst cyanotic congenital heart disease. Its incidence corresponds to approximately 0.5 in every 1000 live births.[1] Stensen first described TOF back in 1672, but Etinne – Louis Arthur Fallot in 1888 was the one to elucidate the clinicopathological manifestation of TOF, around 200 years after its first description.[2] Cyanosis is the main presentation shortly after birth and it requires urgent medical attention.

The survival of non-corrected TOF is mainly influenced by how severe the anatomic defect is. In the first year of life, 25% of surgically uncorrected infants die, 40% die by the age of three, 70% by age 10 while 95% deaths have been recorded by the age of 40 years. The risk of sudden death is greatest in the initial years of life however, the risk then tends to stay constant until about 25 years of life after which it begins to rise.[3] The mortality rate of TOF is considerably high and if left untreated, the 10-year survival in untreated patients is only a mere 24%.[4]

The four diagnostic features of the TOF include ventricular septal defect (VSD), right ventricular outflow tract obstruction (RVOTO), right ventricular hypertrophy and overriding of aorta. These features are a result of the anatomical defects originating from the anterior and cephalic deviation of the infundibular septum. Cyanosis, that required urgent medical attention, is the disease's main physical feature and its severity can be determined by the degree of RVOT. To assess the Right Ventricular outflow Tract, pulmonary arteries, aorta, and aortopulmonary collateral arteries Magnetic Resonance Imaging (MRI) can be used. This tool, due to its superior imaging quality and its ability to quantify biventricular size and function, pulmonary regurgitation (PR), and myocardial viability, is the gold standard for diagnosis.[5,6]

Surgery is the treatment option of choice in TOF patients since all the patients are viable candidates for surgery. There are few other possibilities that include palliative procedures or total repair. The main aim of total repair is VSD Closure and to relive the RVOT.[4] A problem that is common after TOF repair is right ventricular dysfunction. PR, residual RVOTO and VSD are contributors to the right ventricular dysfunction.[7] Placement of transannular

patch usually results in this pulmonary regurgitation. Although the PR is very well tolerated by some patients, others might not tolerate it efficiently and consequently develop right ventricular dysfunction like poor functional status, arrhythmias and sudden death.[8]

Where possible, primary repair should be the treatment of choice in the first year of life. Patients with severe cyanosis, unfavorable anatomy and other comorbidities may undergo a palliative shunt procedure before Total Correction for TOF later in life.[9]

This study was carried out to investigate the early outcomes of patients undergoing total correction for tetralogy of fallot (TOF).

## METHODOLOGY

After approval from the Rehman ethical committee, a retrospective study was carried out. All patients with TOF along with pulmonary stenosis which had undergone total repair between November 2016 and November 2018 at the Cardiothoracic Surgery Unit of Rehman Medical Institution, Peshawar were identified from hospital data base. Patients with other associated defects like the absence of pulmonary valve syndrome, atrioventricular septal defect, or pulmonary atresia were excluded from the study.

A proforma was formulated and data was collected on it accordingly. The proforma included basic demographic parameters (age, gender, weight). Operative parameters included operative technique, cardiopulmonary bypass time (CPB) and aortic cross clamp time (ACC). Postoperative CICU data comprised duration of ICU stay, duration of mechanical ventilation, postoperative conduction abnormalities such as low cardiac output syndrome (LCOS) and death in postoperative period. Prolonged CICU stay was defined as being greater than 48 hours and prolonged mechanical ventilation as greater than 24 hours.

The essential surgical steps in the surgery were similar in every patient which included the use of CPB and sparing the ventricles in as many patients as possible. Patients that had undergone palliative technique in the past were assessed for the size of

pulmonary artery and their hemodynamic parameters. The patients with reversible pulmonary arterial hypertension and unfavorable pulmonary anatomy were subjected to total repair of TOF. The objective of the surgery was to fix the RVOT and complete VSD closure. Infundibulectomy was done in subpulomic narrowing patients and transannular patch was placed in patients with narrow pulmonary valve annulus. Pulmonary insufficiency was compromised for in cases where infundibulectomy was carried out to relive the pulmonary obstruction.

Data collected were entered into Microsoft Excel Spreadsheets as a record. Statistical analysis was done using SPSS version 25 by comparisons between age related intraoperative parameters and age related early outcomes of the procedure by using the Student's T-test and Chi-squared test keeping $p \leq 0.05$ as significant.

# RESULTS

On basis of the inclusion criteria in this study, 186 patient's data was retrieved out of which 109 (58.60%) were male and 77 (41.40%) were female. The overall age ranged from 1 year to 47 years with the mean age being 12.25±8.01 years. The average weight of the patients ranged from 8.50 kg to 86.00 kg with the mean weight being 32.61±16.99 kg.

Pre-operative medications were also analyzed in this study and it was seen that beta-blockers were used by 99 (53.23%), Diuretics by 10 (5.38%), Aspirin by 8 (4.30%) and antiplatelet by 6 (3.22%) patients.

Intraoperatively, an Autologous Pericardial Patch was used, for Main Pulmonary Artery Augmentation, in 161 patients (99.46%), whereas Prosthetic Patch was used in just 1 patient (0.54%). Mean cardiopulmonary bypass time (CPB) for all the procedures was 94.84±37.92 minutes and aortic cross clamp (ACC) time was 67.17±31.86 minutes. The mean times according to age quartiles are shown in Table 1.

The patient population was divided into according to age quartiles, 0 – 7 years (30.32%), 8 – 12 years (24.60%), 13 – 16 years (29.51%) and >17 years (15.57%). Due to the retrospective nature of data, only 122 records (65.60%) were found to be complete for analysis of outcomes. The mean CBP time was highest in the >17 years age quartile (114.29 ± 54.79 minutes) while least for the 0 – 7 years quartile (86.80 ± 29.87 minutes) [p=0.111]. A similar trend was seen in the ACC time (p=0.071) as shown in Table 1. As age increases, the need for a prolonged ICU stay decreased however no significance was found to imply it as a general trend (p=0.536). Similarly, the need for ventilatory support did not show any relation with age (p=0.466). Table 1 shows the clinical, electrocardiographic and echocardiographic characteristics of patients with LV ejection fraction more than 50% and less than 50%.

**Table 2: Intraoperative Parameters according to age quartiles**

|  | Discharged | Death | P-value |
|---|---|---|---|
| **Total (N)** | **109** | **13** |  |
| **Age (years)** |  |  |  |
| 0 – 7 | 30 (27.52) | 7 (53.85) |  |
| 8 – 12 | 26 (23.85) | 4 (30.77) | 0.121 |
| 13 – 16 | 35 (32.11) | 1 (7.69) |  |
| ≥ 17 | 18 (16.51) | 1 (7.69) |  |
| **Weight (kg)** |  |  |  |
| 0 – 20 | 33 (30.28) | 7 (53.85) |  |
| 21 – 29 | 21 (19.27) | 2 (15.38) | 0.382 |
| 30 – 45 | 32 (29.36) | 2 (15.38) |  |
| ≥46 | 29 (26.61) | 2 (15.38) |  |

Tables 2 shows impact of age and weight on the post-operative outcomes of TOF. Age 0 – 7 years and weight 0 – 20 kg show the highest mortality (53.85% and 53.85%) of the overall deaths, no significant relation of age and weight with outcomes could be found (p=0.121 and 0.382 for age and weight respectively)

**Table 1: Intraoperative Parameters according to Age Quartiles**

| Parameters | 0 – 7 years | 8 – 12 years | 13 – 16 years | > 17 years | P-value |
|---|---|---|---|---|---|
| **Total patients (N)** | 37 | 30 | 36 | 19 | - |
| CPB time (min) | 86.80 ± 29.87 | 94.52 ± 37.56 | 92.07 ± 31.30 | 114.29 ± 54.79 | 0.111 |
| ACC Time (min) | 60.65 ± 24.35 | 64.07 ± 28.19 | 66.45 ± 28.40 | 84.56 ± 47.21 | 0.071 |
| ICU Stay (>24 hours) | 6 (16.22) | 4 (13.33) | 2 (5.56) | 2 (10.53) | 0.536 |
| Ventilator support | 5 (13.51) | 1 (3.33) | 3 (8.33) | 1 (5.26) | 0.466 |

In the postoperative period, 11 (5.91%) patients developed Low cardiac output syndrome (LCOS). Prolonged ventilator support (>24 hrs.) was required in 21(11.29%) patients and prolonged ICU stay (>48 hrs) was see in 38 (20.43%) patients. 20 (10.75%) patients developed complications leading to their death, in all cases. These complications included: sepsis, arrhythmias, Acute Kidney Injury (AKI) and Acute Respiratory Distress Syndrome (ARDS), bleeding and aspiration as shown in Table 3.

**Table 3: Early Post-operative Outcomes**

| Characteristics (Post-Op outcome) | N (%) |
|---|---|
| Prolonged ICU Stay | 38 (20.43) |
| Prolonged Ventilator support | 21 (11.29) |
| Low cardiac output syndrome (LCOS) | 11 (5.91) |
| Sepsis | 1 (0.54) |
| Bleeding | 2 (1.08) |
| Arrythmias | 2 (1.08) |
| AKI and ARDS | 2 (1.08) |
| Aspiration | 2 (1.08) |
| **Outcomes** | |
| Discharged | 166 (89.25) |
| Expired | 20 (10.75) |

## DISCUSSION

The corrective surgery for TOF is being performed for the past 60 years.[10] Even though it is a common endeavor among a cardiothoracic surgeon and a pediatric cardiologist to reduce the long-term complications, there are controversies regarding the optimal timing and technique for RVOT surgery in surgical repair.[11] The possible advantages of early total repair of TOF include, reduced late cardiac arrhythmia, higher preservation of left ventricular function and higher functional capacity. Apart from the early advantages, some long term advantages include avoiding a palliative shunt, right ventricular pressure overload and cyanosis.[12,13] Best results are obtained when sinus rhythm is preserved, no residual stenosis in RVOT is present, the pulmonary valve remains competent, and the VSD is completely closed.[14] The early outcomes of total repair of TOF have improved since its inception in 1950. However, patients with a repaired TOF can develop complications later. These include heart failure symptoms, arrhythmia, also sudden cardiac death;[12]

though the later outcomes for early repair still remain unclear.

The use of transannular patch speaks volumes regarding RVOT obstruction severity at the annular level and the cardiac anomaly. In a retrospective study, Murphy et al. proved that the use of a transannular patch was not associated with reduced survival after 30 years.[15] Advancement in the surgical field has resulted in improvements in mortality and morbidity of primary surgical repair of TOF at an early stage, which lead it to be the standard practice in many developed countries. Some of these countries have reported the mortality rates to be as low as 0.2%.[16,17] In developing countries however, the mortality rate for surgical repair of TOF in infants is 28-70 times higher than the developed countries because late surgical repair of TOF is a common practice in these countries.[18,19]

The risk of complications such as suboptimal pulmonary vasculature development, pulmonary artery distortion, diastolic dysfunction, pulmonary vascular disease, end-organ dysfunction and right ventricular hypertrophy have increased due to two-staged operations for TOF. Later in life these sequelae can lead to life threatening arrythmias and even death.[20,21] In developing countries, including Pakistan, many factors contribute towards late repair. These include failure in early diagnosis, lack of surgical expertise, lack of medical equipment and facilities, financial restrictions and parental education.

Surgical morbidity and mortality in this study was on the higher side in the pediatric age group, age less than or equal to 16 years, (9.84%) but it was much lower in the adult age group, greater than 16 years, (0.80%). The mortality in pediatric age group is comparable to other developing countries, 5.7–14.2% but, it is still higher than the standards worldwide.[18,19]

The mean Cardiopulmonary Bypass time and Aortic Cross Clamp time recorded in our study were 94.84±37.92 minutes and 67.17±31.86 minutes respectively which, as compared to a study by Egbe and colleagues, is comparatively higher.[17] Our mean CICU stay managed to be shorter as compared to studies by Hirsh et al who reported an average stay of 9±8 days, Kolcz and Pizarro reporting mean ICU stay of 7 days, and Tamesberger et al presented the average stay to be 6 days.[19, 22,23]

CPB and ACC times play an important role in morbidity and mortality after congenital heart disease repair. An increase in these times will directly increase the risk of morbidity and mortality of

these cases.[24] Although no relation was found in the CPB time and ACC time with age (p=0.111 and p=0.071 respectively), surgical mortality with age decreased in our study as age progressed from 53.85% to 7.69% however, this too was not significant (p>0.05).

Pulmonary Regurgitation (PR) can develop as a postoperative complication following a RVOT obstruction correction. This can further progress to Right Ventricular dilation and if it becomes severe, can lead to life threatening arrythmias and in some cases sudden death.[25] In the Early postoperative period, children tend to tolerate PR well, but if it progresses and gets severe, it can lead to serious life threatening condition later on in their life as described earlier. Therefore, patients undergoing total correction of TOF must be followed for the rest of their life to assess the progression of PR and to make timely intervention for the prevention of theses complications possible.

It is still undecided what the ideal age to perform the surgical repair of TOF is. It can be performed at any age with considerably low operative risk in well-established institutions.[26] Although the early repair is not without a few long-term heart problems such as arrhythmias or problems resulting from original repair, these issues can easily be resolved with medication. Hence, surgical repair of TOF is an absolute necessity.[27]

This study is likely to be biased due to deficiencies in the retrospective nature. Secondly, because of a small sample size and focused on early outcomes, the results could not be generalized.

Studies of this nature need to be conducted comparing both the early and late complication of total correction in TOF.

## CONCLUSION

Total repair for TOF is a favorable option in most patients, with acceptable mortality after surgery.

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