A Study of Outcome Following Surgical Repair of Tetralogy of Fallot

Dr. Dilrag Bachan Singh Dhindsa¹, Dr. Samir Kapoor², Dr. Gunbir Singh³, Dr. Rajiv Gupta⁴, Dr. Sarju Ralhan⁵, Dr. Gurupreet S Wander⁶

¹Consultant (CTVS), Max Super-specialty Hospital Mohali, Punjab, India
²Assistant Professor, CTVS Hero DMC Heart Institute Ludhiana, Punjab, India
³Junior Resident, HDMC Heart Institute, Ludhiana, Punjab, India
⁴Professor, Cardiac Surgery, Hero DMC Heart Institute, Ludhiana, Punjab, India
⁵Senior Consultant, Cardiac Surgery Hero DMC Heart Institute, Ludhiana, Punjab, India
⁶Professor, and HOD, Department of Cardiology Hero DMC Heart Institute, Ludhiana, Punjab, India

DOI: 10.15520/jmbas.v8i2.213
Accepted 5 February 2020; Received 26 January 2020; Publish Online 8 February 2020

Reviewed By: Dr. Daniel V.

ABSTRACT

Aim: To assess the short-term effects and outcome of various techniques for Tetralogy of Fallot repair.

Materials & Methods: The present study was conducted on patients who underwent ICR for tetralogy of Fallot. Group I patients underwent TAP, while group II included cases that had simple Tetralogy of Fallot (TOF) repair without TAP. We subdivided group I patients into 2 groups. Group A patients and group B patients. Group A patients had TAP without a valve. Group B patients had TAP with monocuspid valve.

Results: VSD type was double committed seen 5 in group I, large inlet 3 in group I and 1 in group II, Peri-membranous 6 in group I and 10 in group II and Sub Aortic 68 in group I and 9 in group II. ECG finding was bifascicular block pattern 2 in group I, prolonged QRS duration was seen in 5 in group I, RBBB was seen 27 in group I and 3 in group II and RVH was seen 15 in group I and 2 in group II. RV dimension base, Mid, BA, RVFAC, TAPSE and LV RV Stains % between both groups found to be non-significant (P> 0.05).

Conclusion: This study suggested that TOF repair can be done with good short term results with either method, when a trans annular patch is needed, it should be tried to use as small a patch as possible, where a larger patch is needed a monocusp should be created to limit PR.

Key words: bi-fascicular block pattern–tetralogy of Fallot–monocusp

1 INTRODUCTION

Congenital heart disease (CHD) is the most common congenital birth defect and the leading cause of death in infants and children. Tetralogy of Fallot (TOF) is the most common of the complex cyanotic heart defects with a prevalence of 2.2 per 10,000 live births, and is a major cause of death in infants. Although Niels Stensen first described an abnormal heart, Etienne-Louis Arthur Fallot is credited for this disease, based on his description in 1888 of a lesion with pulmonary artery stenosis, ventricular septal communica-

* Corresponding author.
Absent pulmonary valve syndrome which is due to malalignment of the outlet septum is present in 1/10th of those suspected to have tetralogy of Fallot. In 2% of patients there is presence of an atroventricular septal defect combined with a common atrioventricular junction. The presentation and initial medical management remain unchanged, but surgical repair and post-operative care are more complex. [5] The present study was conducted to assess the short-term effects and outcome of various techniques for TOF repair.

2 MATERIALS AND METHODS

The present study was conducted in the department of Cardio, Thoracic and Vascular surgery. It comprised of all patients who underwent ICR for tetralogy of Fallot at the HDHI between 2010-2014 and from 2015-2016.

Exclusion criteria were patients who had undergone a previous palliative shunt procedure and patients with other hemodynamically important complex congenital heart lesions, including double-outlet right ventricle, situs inversus, and ventricular septal defect with pulmonary atresia.

We classified patients in 2 groups. Group I patients had TAP and group II had simple TOF repair without TAP. Patients in group I was subdivided into 2 groups: Group A which includes patients who had TAP without a valve. Group (B) includes those who had TAP with monocuspid valve. Demographic information, risk category, ICU parameters, ECG, ECHO (maximum RVOT gradient pre and post surgery, post-operative development of pulmonary regurgitation, RV FAC, TAPSE, R V dimensions, GLS RV strain and any additional valvular lesion) and different morbidity and early outcome was recorded.

2.1 Surgical technique

Intermittent cold cardioplegia was used. The approach used in our cases is the trans-atrial and trans-pulmonary approach. The ventricular septal defect closure was done through the tricuspid valve. The decision to do TAP was dependant on the (Z score) of the pulmonary annulus. If the Z score is $> -2$ full repair was done without the use of a TAP. If the Z score is $-2$ or smaller, a limited TAP was used for repair. The decision to use the monocuspid TAP was based on the surgeon discretion without any predetermined objective criteria.

The TA-TP approach has resulted in significantly less RV dilatation and better preservation of contractility at 10 years follow up. Since the description of the pulmonary cusp augmentation technique by Sung and associates, we have adopted this technique for most patients requiring a transannular patch.

Resection of the parietal extension of the infundibular septum, using a trans tricuspid approach. A Hegar dilator has been passed from the PA into the RV to demonstrate the outlet. In the majority of cases the pulmonary valve was bicuspid with location of the commissures at the 3 and 9 o’clock positions. An incision is made in the middle of the anterior cusp and then extended to the right ventricular free wall for approximately 10 to 15 mm. When the commissures are located at the 6 and 12 o’clock positions the commissures are anterior and posterior but located off the midline, we divide the pulmonary valve at or near the anterior commissure to preserve as much valve tissue as possible. The division of the remaining obstructing muscular and fibrous bands is performed through the ventriculotomy. The VSD is closed through the TV.

Other technique followed was transannular reconstructions. In patients in whom the commissure is eccentric, the patch is sutured to the main PA on one side and to the free edge of the leaflet on the other side.

For Monocusp valve reconstruction, the transannular patch started as usual from the distal main pulmonary artery, and ended with untreated autologous pericardium. The proximal free portion of the patch was turned back on its sutured part at the level of the annulus, exposing the RV infundibulum and divided native pulmonary valve. A second rectangular patch of untreated autologous pericardium was used to form a monocusp valve by suturing it to the undersurface of the upturned transannular patch, at the level of annulus. The monocusp valve patch measurements are detailed in Picture 10. Both side edges of the width of the rectangular patch used for the monocusp valve were sutured to the divided edges of the anterior leaflet of the native pulmonary valve on both sides. The free upturned proximal portion of the transannular patch was then turned back on the RV infundibulum and sutured in the usual way to complete the reconstruction (Picture 11). This procedure creates a complete valve at the pulmonary annulus, with a monocusp anteriorly and the native pulmonary valve leaflets posteriorly. This method of monocusp valve construction also creates a new annulus fashioned by the suture line running across the transannular patch, suspending the monocusp from its inner-surface.

3 RESULTS

Table 1 shows that VSD type was double committed seen 5 in group I, large inlet 3 in group I and 1 in group II, Peri-membranous 6 in group I and 10 in group II and Sub Aortic 68 in group I and 9 in group II. The difference was significant ($P< 0.05$).

Table 2 shows that average of bypass time in group I was 1.50 hours and in group II was 1.20 hours, average ventilation time in group I was 48.5 hours and in group II was 31.2 hours, average ICU length of stay in group I was 4.72 days and in group II was 3.35 days, average hospital length of stay was 12.8 days in group I and 9.7 days in group II. The difference was significant ($P< 0.05$).

Table 3 shows that ECG finding was bifascicular block pattern 2 in group I, prolonged QRS duration was seen in 5 in group I, RBBB was seen 27 in group I and 3 in group II and RVH was seen 15 in group I and 2 in group II. The difference was non- significant ($P > 0.05$).

Table 4 shows that RV dimension base, Mid, BA, RV FAC, TAPSE and LV RV Stains % between both groups found to
Table 1. Anatomic findings between group I and II

<table>
<thead>
<tr>
<th>Group</th>
<th>I</th>
<th>II</th>
<th>Total</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VSD Type</td>
<td>Total No.</td>
<td>Percentage</td>
<td>No.</td>
<td>Percentage</td>
</tr>
<tr>
<td>Double committed</td>
<td>5</td>
<td>6.1%</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Large Inlet</td>
<td>3</td>
<td>3.7%</td>
<td>1</td>
<td>5.0%</td>
</tr>
<tr>
<td>Perimembranos</td>
<td>6</td>
<td>7.3%</td>
<td>10</td>
<td>50.0%</td>
</tr>
<tr>
<td>Sub Aortic</td>
<td>68</td>
<td>82.9%</td>
<td>9</td>
<td>45.0%</td>
</tr>
<tr>
<td>Total</td>
<td>82</td>
<td>100.0%</td>
<td>20</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Table 2. Comparison of the operative data between group I and II

<table>
<thead>
<tr>
<th>GROUP</th>
<th>Group I</th>
<th>Group II</th>
<th>t</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average of Bypass time (Hours)</td>
<td>1.50 ± 0.62</td>
<td>1.20 ± 0.27</td>
<td>2.059</td>
<td>0.042</td>
</tr>
<tr>
<td>Average Ventilation Time (Hours)</td>
<td>48.59 ± 15.07</td>
<td>31.20 ± 11.28</td>
<td>4.831</td>
<td>0.000</td>
</tr>
<tr>
<td>Average ICU length of stay (days)</td>
<td>4.72 ± 1.31</td>
<td>3.35 ± 0.59</td>
<td>4.559</td>
<td>0.000</td>
</tr>
<tr>
<td>Average Hospital length of stay (days)</td>
<td>12.84 ± 2.82</td>
<td>9.70 ± 1.45</td>
<td>4.812</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Table 3. Comparison of the follow-up data between group I and II

<table>
<thead>
<tr>
<th>GROUP</th>
<th>Group I</th>
<th>Group II</th>
<th>Chi-square value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bifascicular Block Pattern</td>
<td>2</td>
<td>0.0%</td>
<td>2</td>
<td>8.255</td>
</tr>
<tr>
<td>Prolonged QRS duration</td>
<td>2</td>
<td>0.0%</td>
<td>2</td>
<td>8.255</td>
</tr>
<tr>
<td>ECG RBBB</td>
<td>27</td>
<td>32.9%</td>
<td>3</td>
<td>15.0%</td>
</tr>
<tr>
<td>RVH</td>
<td>15</td>
<td>18.3%</td>
<td>2</td>
<td>10.0%</td>
</tr>
</tbody>
</table>

Table 4. Comparison of the follow-up data based on the echo cardiography between group I and II

<table>
<thead>
<tr>
<th>GROUP</th>
<th>Group I</th>
<th>Group II</th>
<th>t</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>RV Dimension (mm)_Base</td>
<td>29.24 ± 6.25</td>
<td>28.00 ± 3.84</td>
<td>0.848</td>
<td>0.399</td>
</tr>
<tr>
<td>RV Dimension (mm)_Mid</td>
<td>30.88 ± 5.95</td>
<td>29.45 ± 3.89</td>
<td>1.018</td>
<td>0.311</td>
</tr>
<tr>
<td>RV Dimension (mm)_B.A</td>
<td>73.94 ± 0.63</td>
<td>70.30 ± 8.21</td>
<td>1.425</td>
<td>0.157</td>
</tr>
<tr>
<td>RV FAC (%)</td>
<td>34.48 ± 4.20</td>
<td>34.35 ± 1.14</td>
<td>0.138</td>
<td>0.890</td>
</tr>
<tr>
<td>TAPSE</td>
<td>18.34 ± 5.56</td>
<td>20.40 ± 9.65</td>
<td>-1.263</td>
<td>0.209</td>
</tr>
<tr>
<td>LV RV Strains (%)</td>
<td>-19.83 ± 5.01</td>
<td>-18.00 ± 8.87</td>
<td>-1.232</td>
<td>0.221</td>
</tr>
</tbody>
</table>

be non-significant (P > 0.05).

4 DISCUSSION

All patients underwent complete repair including closure of VSD in 20% of the patients. However, in the rest of our patients (80%), the pulmonary annulus was judged to be severely under-developed prohibiting surgical repair without patch augmentation. The marked male predominance in patients with TOF is consistent with previous studies. [6] The reported need for TAP varies from center to center. In most of our patients we did patch repair with smaller size.

A significant gradient associated with marked residual obstruction at the RVOT may not be tolerated as it may lead to difficult post-operative course or need for re-intervention to release the remaining obstruction. Multiple criteria have been used peri-operatively to assess the adequacy of PA annulus and the ability to reach satisfactory RVOT repair and size without need for patch augmentation. These criteria may include; measuring the PA annulus Z score before surgery, scrutinizing the number of pulmonary valve cusp, using Hagar’s dilator to properly size the RVOT during surgery, measuring RVOT gradient by intraoperative trans-esophageal echocardiography (TEE) and assessing the right ventricle to left ventricle pressure ratio (pRV/pLV) pre and post-repair. [7]

In general, residual RVOT obstruction post-repair is considered significant if RVOT gradient exceeds 40 mm Hg or if pRV/pLV ratio exceeds 0.85. [8] In our series, we depended mainly on the intra-operative TEE gradient. None of our patients had intra-operative RVOT gradient that exceeded 40 mm Hg post-repair and none required re-intervention during their post-operative ICU course.

The average ICU and hospital length of stay in our patients were approximately 5 and 11 days, respectively and all cases were discharged home with satisfactory results. Shorter ICU stay, ventilation time and pleural drainage duration are factors that affect the functioning monocusp valve on the early postoperative course. There was a significant decrease in the average bypass time, ventilation time, ICU length of stay in the second half of the study period.
In our 28% cases, there was reduction in pRV/ pLV ratio. We found no early or late-mortality. However, 1 patient needed late re-intervention. This highlighted the observation that RVOT gradient seen immediately after repair tends to decrease with time as it was observed frequently during late follow up of many patients. [9]

In present study we used limited TAP with or without monocusp valve in patients with severe cases of TOF repair that required PA augmentation. Many authors favor the use of a valveless trans-annular patch that proclaim to decrease the degree of valve incompetence. [10] Various types and techniques have been reported in the literature to construct TAP with valve. These may include valveless homograft patch, apolyltetrafluoroethylene (PTFE) monocusp valve, and separate trans-annular outflow patch (STOP) with turned-down equine pericardial monocusp. [11, 12] We used the pericardial monocuspid valve in our patients. When we compared our TOF patients who did not require (TAP), and those who required (TAP) with or without monocusp, we observed no substantial difference in the ICU course, outcome or complications rates between the two groups. In spite of what appear to be good results seen immediately after applying various type of valveless TAP, the long term results are still in doubt.

Proponents of valveless patch consider the remaining valvular function, though regressed, and would still be a better and safer option than the free Pulmonary Regurgitation experienced by the patients with the classic valveless TAP. [13] Many groups had abandoned the monocusp use as they appreciate no significant advantage for their patients. [14] In our series we used the monocusp TAP in 24 patients and it significantly decreased the incidence of post-operative Pulmonary Regurgitation, but it failed to show any significant improvement in the early post-operative course in comparison with patient having the classical limited TAP. A small pulmonary annulus and bicuspid PV were risk factors for early progression of moderate or greater Pulmonary Regurgitation. Although most of the patients were in good status and free from medication, two thirds of the patients had qualitatively dilated right ventricle owing to concomitant Pulmonary Regurgitation.

The development of arrhythmias is a well-known problem in patients with TOF, and, in addition to other factors, atrial enlargement and repeated cardiac surgical procedures induce atrial arrhythmias. [15] Echo based RV Global Longitudinal Strains (GLS) for assessment of RV Systolic function. The mean GLS RV was not significant when comparison done between group I and Group II and then between group I(A) and I(B). GLS RV cut off value of -18% sensitivity and 77% specificity in identifying RVEF <45%.

5 CONCLUSION

Authors suggested that TOF repair can be done with good short term results with either method, when a transannular patch is needed, it should be tried to use as small a patch as possible, where a larger patch is needed a monocusp should be created to limit PR; the current study failed to demonstrate any advantage of monocusp over no monocusp and for long term results a longer follow up is needed and a larger preferable a randomized trial is needed and to assess the fate of the conservative approach on cardiac morphology and myocardial function.

REFERENCES