Tetralogy of Fallot repair: influence of surgical technique on post operative morbidity and mortality

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Abstract: **Background:** Tetralogy of Fallot (TOF) is one of the most common cyanotic heart diseases. Total repair of such cardiac lesion is now spreading with intentions to save children at younger age and lower body weight. The purpose of this study was to evaluate the different associated anatomical variations if present and evaluate the outcome of different surgical approaches. **Patients and Methods:** Between **June** 2008 and **October** 2012, seventy two children with TOF were operated upon. Children were divided into two groups: group A included 36 patients who had trans-atrial with or without associated trans-pulmonary approaches, and group B included 36 patients where ventriculotomy was needed in the repair whether minimal or extended in addition to the approach in group A. **Results:** There was significant drop in both Right ventricle (RV) pressure and Pressure gradient (PG) across the Right ventricle outflow tract (RVOT) in both groups denoting successful surgical relief of the RVOT obstruction in either surgical techniques (P value <0.0001). However the RV pressure was significantly higher in group A versus group B in the immediate postoperative period (P value = 0.01) but the PG across the RVOT showed no significant difference between the 2 groups during the same period (P value > 0.05). This difference improved on follow up so did the pulmonary regurgitation (PR) in both groups. On follow up, none of our patients needed re-intervention for residual/recurrent ventricular septal defect (VSD) or residual significant RVOT obstruction Through this study, there were two mortalities (2.78%) both were in group B and were due to RV dysfunction. **Conclusion:** Children undergoing TOF repair had excellent short-term outcome with the current protective strategy aiming to spare valvular function, and conserving myocardial function. We encourage full trans-atrial repair with pulmonary approach whenever feasible, avoiding ventricular incisions, otherwise a limited ventriculotomy could be sufficient in most cases rather than extended ventriculotomy with trans-annular repair. Long term follow up is needed to evaluate long term effects of the different techniques.

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1.Introduction

Tetrlogy of Fallot (TOF) is a spectrum of disease that ranges from mild to severe form. In simple cases associated with mild right ventricle outflow tract (RVOT) obstruction, surgical repair can be accomplished without the need for patch augmentation of the RVOT (**Karl et al., 1992; Stewat et al., 2005**).

In severe forms of TOF,where there is marked hypoplasia of the pulmonary annulus with severe RVOT obstruction, augmentation of the pulmonary valve annulus using trans-annular patch (TAP) repair becomes inevitably necessary. TAP repair releases the obstruction at the valvular, supra-valvular, and RVOT levels but leads to pulmonary insufficiency that was once considered to be innocent, tolerated and not harmful (**Murphy et al., 1993; Nollert et al., 1997**).

Surgical treatment of TOF can be done safely both as a primary repair and as a staged procedure with very low mortally and morbidity during infancy. Surgical correction as the primary procedure is today the most preferred inter- vention; however, it may carry a higher risk of TAP in early age than the sequential technique. Long-term follow-up reveals that patients subjected to TAP exhibit a significant higher risk of redo procedures. It, therefore, seems wise to carefully select patients for primary repair in early infancy, where preservation of the pulmonary annulus seems possible **(Harald L. Lindberg et al., 2011)** .

A valve- and infundibulum-sparing reconstruction of the RVOT has been advanced reciprocally through and together with lowering the age at repair during transatrial–transpulmonary correction of ToF. This change has been achieved without compromising the immediate clinical outcome, but at the cost of an increased early re-operation rate for residual and/or recurrent obstruction. As the length of the trans-annular relief of the RVOT is, with time, the main determinant of RV dilation, further long-term follow-up is needed to disclose whether such infundibulum-sparing approach is more protective against progressive RV dysfunction **(Thierry** Bové **et al., 2012).**

Traditionally, TOF was repaired through a right

ventricular incision providing an excellent exposure for closure of the VSD and relief of the RVOT obstruction but there were concerns that the resultant scar may increase the incidence of ventricular arrhythmias, cause impairment of right ventricular function and sudden death ***(Christos et al., 2002).***

In our study, we are going to evaluate the results of different surgical techniques used for total correction of TOF and their effect on postoperative morbidity and mortality.

2. Patients and Methods

Approval for this study was granted by our institutional ethics board at Al Azhar University hospital and Egypt Children hospital., and individual patient consent was waved. Between January 2008 and September 2011, 72 patients with TOF with different anatomical variations were randomly collected in a prospective study. The study excluded Patients with previous palliative procedures, patients with pulmonary atresia, absence of one branch pulmonary artery, absent pulmonary valve and TOF with atrio-ventricular canal defects.

Patients were divided based on the planned surgical approach needed during repair into:

- Group A where the TOF was repaired either trans-atrially alone or combined with trans-pulmonary approach, without Ventriculotomy.
- Group B in which ventriculotomy either limited or extended was used to repair TOF whether associated with trans-atrial or trans- pulmonary approach.

All children were subjected to:

The routine pre-operative assessment including:

Trans-thoracic echocardiography

All patients underwent echocardiographic studies using a Philips HD machine (Philips Medical Systems, Andover, MA). Standard 2D echocardiogram was done for all patients enrolled in the study using phased array transducers of different frequencies tailored according to each patient's age, body built and weight.

The study included 2D, M mode and color flow Doppler from all standard echocardiographic windows (i.e. subcostal, apical, parasternal and suprasternal) applying the sequential analysis to establish the situs, AV and VA connections, great vessel relation and abnormalities, ventricular dimensions and functions, state of cardiac valves, venous connections, and any intra cardiac shunts. with special emphasis on degree and level of RVOTO, diameters of the main pulmonary artery and its branches, size and Position of the VSD (VSD), Degree of aortic overriding, Mc-Goon ratio, cardiac dimensions, LV index and presence of other abnormalities.

Echocardiographic examination was repeated during the first week postoperative and periodically thereafter to determine the state of the repaired IVS, degree of residual obstruction of the RVOT or pulmonary insufficiency or any other relevant complications

Cardiac catheterization:

Patients underwent cardiac catheterization if indicated to verify echocardiographic findings, saturations, pressures and describe coronary anatomy.

Surgical Techniques

All the study patients underwent repair using hypothermic cardiopulmonary bypass. An arresting (induction) dose of cold blood cardioplegia (20 mL/kg) was given after the aortic cross-clamping. To maintain the cardiac arrest, the same dose of cardioplegia was repeated every 20 minutes. Right ventricular infundibular obstruction was released by division of parietal and septal extensions of the infundibular septum without muscle excision initially and passing the predicted Hegard's dilator to assure adequacy of the resection. Further muscle resection was done if needed. The VSD was closed transatrial.

Any obstruction at the level of the pulmonary annulus was released with a transannular pacth. At the end of the repair, left and right ventricular pressures were measured in addition to right atrium.

Statistical analysis

Data were coded and analyzed using the SAS Version 9.1 software for Windows (SAS Institute, Inc, Cary, NC).. Qualitative data were presented using the frequency and its related percentage and were analyzed by using $\chi 2$ analyses or the Fisher's exact test, while quantitative data were presented using the mean and standard deviation. Changes in continuous variables were evaluated using the paired t-test. A P value of <0.05 was chosen as the level of significance.

3. Results

Sixty patients out of 72 were in the pre-school age <6 years (83.33%) while the other 12 cases (16.67 %) were in the school age,. Age and body weight distribution were similar in both groups Table 1 and figure 1

Subvalvular stenosis occured in 100% of the cases and it was combined with valvular stenosis in 94.44% of them , supravalvular stenosis(MPA) occured in 16.67% and branch stenosisin LPA occurred in 5.55%. (Table 2) there was highly significant comparison between groups A and B as regard to RV pressure (P = F0.01). PG across the RVOT was insignificantly higher in group B than in group A (P = 0.150).

Main, right and left pulmonary artery measures, Mc Goon ratio, RV pressure and PG across the RVOT for the different groups are shown in Table 3.

Intra-Operative:

According to intra-operative approach, we divided patients into two groups:

- Group A: included 36 patients (50%) in whom the repair of TOF was done completely without Ventriculotomy, Right atrial approach alone was used in 14 patients (19.44%) (A1) or combined approach through the right atrium and pulmonary artery in 22 patients (30.56%) (A2).
- Group B: included 36 patients (50%) in whom ventriculotomy was included in the repair, trans-annular patch was used in twenty six cases (72.22%), while eight patients (30.77%) had minimal Ventriculotomy (B1) (less than 5 mm below the annulus) while the other 18 patients (69.23%) had extended Ventriculotomy (B2) (more than 5 mm below the annulus) and two separate patches repair without crossing the annulus was used in 10 (27.78%) patients (B3) Table 5.

In cases where the approach to relief the RVOTO were trans-atrial, trans-pulmonary (22 patients) (A2), pulmonary valvotomy was just accepted. While in cases where TAP were used, single pulmonary valve cusp was excised in four patients (5.55%) while two cusps were excised in fifteen patients (20.83%) and for the remaining 7 cases (9.72%), trimming of the valve's free edges were just accepted.

Autologus un-treated pericardial patches were used to re-construct the RVOT and PA and in 5 cases out of 72 (6.94%), MPA patch was extended beyond the origin of the LPA.

The CPB time was significantly longer in group B than in Group A ($p > 0.05$) , the aortic cross clamp was significantly longer in group B than in Group A ($p > 0.05$) (Table, 5).

Group B needed prolonged mechanical ventilation, more inotropic support, and prolonged hospital stay in the intensive care unit and this showed a statistical significant P value = 0.05, 0.01, 0.01 respectively (Table 6).

Early post-operative complications included 2 Patients (2.78%) in group A who had superficial wound infection and 1 case (1.39%) also in the same group who had transient seizures that was controlled with anti- epileptic drugs. In group B three cases (4.17%) needed re-intubation and re- ventilation due to low cardiac output (LCO), re-exploration for surgical bleeding was needed in 3 cases (4.17%) out of 72 and another 3 cases had arrhythmia in the form of junctional ectopic tachycardia (JET) rhythm which could be reverted back to sinus rhythm with amiodarone (Table, 7).

Immediate Postoperative outcome

There was significant drop in both RV pressure and PG across the RVOT in both groups denoting successful surgical relief of the RVOT obstruction in either surgical techniques (P value <0.0001)(Table 8). However the RV pressure was significantly higher in group A versus group B in the immediate postoperative period (P value = 0.01) but the PG across the RVOT showed no significant difference between the 2 groups during the same period (P value > 0.05) (Table 9)

Early postoperative echocardiographic study for assessment of pulmonary regurgitation showed no pulmonary valve regurgitation in 19 patients (26.38%), mild regurgitation in 12 patients (16.66%), and mild to moderate regurgitation in 5 patients (6.94%) in group A. For group B, there was, mild to moderate regurgitation in 5 patients (6.94%), moderate regurgitation in 5 patients (6.94%), moderate to severe in 7 patients (9.72%) and severe pulmonary regurgitation was found in 19 patients (26.39%) (Table 10).

Tricuspid regurgitation was reported in 14 patients postoperatively all of which were in group B 12 patients had mild regurgitation (16.67%) and 2 patients had moderate degree of tricuspid regurgitation (2.78%),

In group A, two cases out of 36 (5.56%) maintained high RV pressure inspite of wide RVOT. We considered this elevated RV pressure as a dynamic rather than true obstruction to the outflow tract and the two patients were put on B-Blockers in the early postoperative period that diminished progressively at follow up.

Follow up

The median follow up was 12 (6 ± 24) months, including clinical evaluation, ECG, CXR and echocardiography.

At follow up echocardiography, all patients had intact patch with no residual shunt across the VSDs . However, six out of 72 patients (8.33%) still had residual gradient across the RVOT above 30 mmHg.

The RV pressure decreased significantly post operatively but with the presence of PR and Ventriculotomy scars (cases with TAP) we found that the patients who were in need for medications are still depending on it as a result of impaired RV function.

There was no significant difference between group A and B as regard the RV pressure and PG across the RVOT in the follow up period (p=0.122) and (p=0.08) respectively.(Table 9).

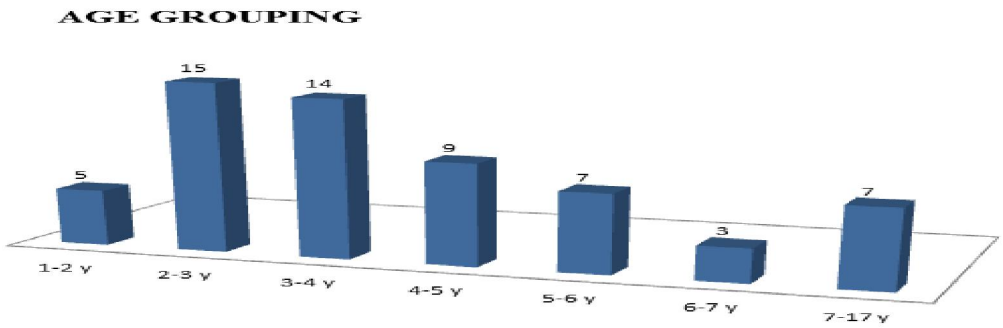

Figure (1): Age distribution among the studied groups

Table (1): Age and body weight distribution in relation to different group

	Group A		Group B		P Value
	Range	Mean ± SD	Range	Mean ± SD	
Age	1-19	5.64 ± 5.48	1-12.5	4.1 ± 2.72	> 0.05
Body Weight	9-56	19.64 ± 13.87	9-43	15.7 ± 8.22	> 0.05

Table (2): Showing the level of Right ventricle outflow tract obstruction (RVOTO)

Level of RVOTO	Number	Percentage
Infundibular	72	100%
Valvular	68	94.44%
Pulmonary Annulus	36	50%
MPA	12	16.67%
Proximal LPA stenosis	5	6.94%%
RPA	0	0%
Peripheral PA	0	0%

Table (3): Comparison between both groups as regard main, right and left pulmonary artery measures, Right ventricular(RV) pressure and Pressure gradient (PG) across the Right ventricle outflow (RVOT).

	Group A		Group B		P Value
	Range	Mean ± SD	Range	Mean ± SD	
MPA	9-15	13.18 ± 4.69	7-18.5	9.71 ± 3.09	< 0.05
RPA	5-12	11.84 ± 5.74	5-14	9.45+2.95	< 0.05
LPA	6-12	11.93 ± 6.03	5-13	9.21 ± 3.7	< 0.05
Mc Goon ratio	1.7-2.2	1.87± 0.33	1.75-2	1.93 ± 0.35	< 0.01
RV pressure	75-120	102.19 ± 16.63	90-140	107.15 ± 18.43	< 0.01
PG	65-110	86.42 ± 13.87	70-125	89.23 ± 18.28	> 0.05

Table (4): Distribution of patients according to the different surgical approaches

GROUP A 36 pts.	A1	Trans- atrial	14	No Patches Used
	A2	Trans- atrial+Trans- pulmonary	22	Patch for MPA
GROUP B 36 pts.	B1	+ minimal ventriculotomy	8	Trans-annular patch 26 cases (36.11%)
	B2	+ Extended ventriculotomy	18	
	B3	+ Double patches with no TAP	10	Double patch repair 10 (13.88%)

Table (5): Shows Cardiopulmonary bypass(CPB) time and Aortic cross clamp(ACX) time in studied groups

	Group A		Group B		P Value
	Range	Mean ± SD	Range	Mean ± SD	
CPB time	45-100	78.26 ± 20.34	75-100	89.15 ±16.51	> 0.05
ACX time	30-75	57.65 ± 16.22	60-75	67.15 ± 14.93	> 0.05

Table (6): Post-operative ventilation time, duration of inotropic support and Intensive care unit (ICU) stay in both groups.

	Group A		Group B		P Value
	Range	Mean ± SD	Range	Mean ± SD	
Ventilation time	9-20	13 ± 15.82	15-96	19 ± 17.23	< 0.05
Inotropes	2-4	3.01 ± 1.09	2-7	3.09 ± 1.23	< 0.01
ICU Stay	2-6	3.15 ± 1.18	2-8	3.85 ±1.43	< 0.01

Table (7): Early Post operative Complications in 17 Patients

	Group A	Group B
Bleeding	0	3
Nodal rythm	0	3
Prolonged ICU stay	0	5
Prolonged Ventilation	0	3
Wound infection	2	0
Transient Seizures	1	0

Table 8: comparison between the pre and post operative Right ventricular(RV) pressure and Pressure gradient (PG) in each group:

	Preoperative		Postoperative		P Value
	Range	Mean ± SD	Range	Mean ± SD	
	Group A				
RV pressure	75-120	102.19 ± 16.63	35-60	43.92 ± 8.30	<0.0001
PG	65-110	86.42 ± 13.87	15-40	23.38 ± 8.31	<0.0001
	Group B				
RV pressure	90-140	107.15 ± 18.43	33-65	48.38 ± 8.24	<0.0001
PG	70-125	89.23 ± 18.28	5-30	19.65 ± 7.42	<0.0001

Table (9): Showing the early and late postoperative comparison between both groups as regard Right ventricular(RV) pressure , Pressure gradient(PG) and Left ventricular(LV) pressures.

	Group A		Group B		P Value
	Range	Mean ± SD	Range	Mean ± SD	
RV pressure	35-60	43.92 ± 8.30	33-65	48.38 ± 8.24	= 0.01
PG	15-40	23.38 ± 8.31	5-30	19.65 ± 7.42	> 0.05
LV pressure	90-130	115.91 ± 12.61	90-130	111.0 ± 11.30	> 0.05
RV/LV ratio	0.29-0.55	0.41 ± 0.09	0.29-0.58	0.45 ± 0.07	< 0.05
RV late follow up	25-45	38.67 ± 10.80	30-45	42.63 ± 7.63	0.122
PG late follow up	5-40	15.50 ± 10.85	7-30	18.17 ± 8.26	0.08

Table (10): Residual Pulmonary regurgitation (PR) in both groups

(PR)	Group A	Group B	%
No	19	0	26.39%
Mild	12	0	16.66%
Mild to Moderate	5	5	13.88%
Moderate	0	5	6.94%
Moderate to severe	0	7	9.72%
Severe	0	19	26.39%
Total	36	36	100%

Operative Mortality

In our series we had 2 mortalities representing 2.78%.

Those two cases were in group B, in both the PV was excised, TAP was applied with extended ventriculotomy.

Case Number 1

This was a male patient 2.5 years old, underwent an uncomplicated transventricular repair with a TAP. The following day he became hypotensive and developed low cardiac output unresponsive to vigorousresuscitative measures.; During his ICU stay, bed-side echocardiography was done, revealing no residual shunt across the VSD, a gradient of 33mmHg across the RVOT, with severe PR due to excision of the pulmonary valve, mild TR with PG across it 40mmHg and dilated RV with impaired function.

Case Number 2

The second mortality among our study groups was male patient 2 years old; his body weight was 10KG., underwent an uncomplicated transventricular repair with a TAP. Six hours later, drainage from chest tubes exceeded 300 cc, at a rate more than 50 cc per hour and was decided for exploration., there was no obvious source of bleeding.

Child was transferred back to ICU in LCO unresponding to vigorous resuscitative measures .

Next morning in ICU, bed- side echo was done and revealed intact VSD patch with no residual flow across it. Gradient across the RVOT was 40 mmHg with moderate PR, mild TR, dilated RV with impaired function that progressed into biventricular failure and the child died 2 days postoperatively.

4. Discussion

In our study we had 72 patients with TOF who underwent total repair. They were subdivided into 2 groups based on surgical approach implemented for repair. Their age ranged between one and 19 years and both groups were similar regarding age and body Weight.

Among our series, the degree of RVOTO was correlated with age (higher incidence of RVOTO with progression of age), the degree of Cyanosis was found higher among older patients in both groups. These results are similar to reports of ***Ujjwal et al; in 2006*** who advocated early repair of TOF to minimize organ damage due to chronic hypoxia and to reduce long-standing pressure overload of the right ventricle and arrhythmia. However, in our study, the mean age at time of repair for patients in group A (5.64 years) was higher than that of group B (4.13 years) which means that, the need for ventriculotomy was not correlated with age. The RV pressure and pressure gradient across the RVOT were lower in group A, compared to group B, this explains the need of variable degree of ventriculotomy in Group B to relieve the obstruction.

In the present study, all VSDs were closed through the right atrium.

The same was published by ***Pozzi; in 2000***, who claimed that all VSDs could be repaired through the right atrial approach whether or not a trans-annular patch is used, because this approach allows to minimize the length of the right Ventriculotomy (length only necessary to relieve the RVOT obstruction and not for the VSD exposure).

This approach is in contrast to ***Pacific et al; in 1990*** that operated upon 61 patients, 60 VSDs were closed via TV and the one with doubly committed VSD was through the TV and pulmonary artery incision that extended 5 mm below the annulus.

In order to relieve the RVOTO we had no planned approaches for cases before surgery, but we classified patients after repair into two groups. Group A where the RV was kept intact in all 36 cases (50%) and group B included patients for whom some degree of Ventriculotomy was needed in addition to trans-atrial and trans-pulmonary approaches.

In our study trans-atrial resection of infundibular obstruction was sufficient alone in 14 (19.44%) patients (group A1) or combined with pulmonary artery access in 22 patients (30.56%) (groupA2).

In the remaining 36 cases (50%), hypoplasia of the outflow tract was the main problem. In addition to

this, the pulmonary annulus was judged to be severely under-developed prohibiting surgical repair without patch augmentation, So decision was made that relieve of this obstruction would not be achieved without ventriculotomy which should be limited as possible. ***Pozzi; in 2000*** recommended ventriculotomy in such cases which should be at least a few millimeters longer than the anteriorly displaced infundibular septum. ventriculotomy was included in the repair of this group, trans-annular patch was used in twenty six cases (36.11%), eight patients (11.11%) out of them had minimal ventriculotomy (B1) (less than 5 mm below the annulus) while the other 18 patients (25%) had extended ventriculotomy (B2) (more than 5 mm below the annulus) and two separate patches repair without crossing the annulus was used in 10 (13.88%%) patients (B3) .

We followed the same technique described by ***Mee; in 1995***, by passing graded Hegar's dilator through the RVOT 2mm larger than the predicted Hegar's dilator. We believe this (rather than performing the trans-annular patch repair while the Hegar's dilator kept in place through the pulmonary annulus) would be sufficient to relieve the obstruction and usually ensures no significant fixed anatomical obstruction in the outflow tract post-operatively.

In both groups we were able to pass the predicted Hegar's dilator nicely without obstruction or significant difference between both groups

The reported need for TAP varies from center to center. In a review of 160 patients underwent TOF repair, the authors reported a need for TAP in 60% of their patients (**Kaushal et al., 1999**). Others have reported lesser need for the use of TAP and advocated preserving the pulmonary valve as much as possible and accepting variable degree of residual RVOT stenosis and RVOT gradient in trade of maintaining PA annulas and valve integrity (**Stewart et al., 2005; Morales et al., 2009**).This could be attributed to the younger age at operation in their series which could explain the higher possibility for the need of TAP.

The CPB time was significantly longer in group B than in Group A ($p > 0.05$). with significant longer clamp time in group B than in Group A ($p > 0.05$).

Mechanical ventilation time was longer in patients in group B compared to those in group A, the same also seen when we tried to taper off inotropes, that was reflected over the ICU stay which was longer in group B compared to group A.

The operative mortality in this series was low, there were two mortalities (2.78%) both are in group B and are due to RV dysfunction. Similar early death rates have been described by ***Christos A et al; in 2001*** they had three hospital deaths (two in the RV versus one in the RA group) giving an overall operative mortality of 1.9%

Complications in both groups were almost similar to those published by ***Christos A et al; in 2001***. They had 13 cases out of 89 patients (14.6) with early post-operative complications, compared to 17 Patients (23.61%) in our series. in Christos literature, complications ranged between cardio-respiratory failure in 4 patients, chest infection in 3 cases, Intra-vascular hemolysis in one patient, transient seizures in one patient, Renal failure in one case, one case exposed to cardiac arrest, one infant showed coagulase-negative staphylo-coccal septicemia and Pericardial effusion that required open drainage was seen in one patient.

In the present study, some complications occurred in patients in group B, as bleeding which occurred in three cases none of them were due to surgical cause but mostly it was due to coagulopathies and poly- cythaemia commonly seen in TOF cases, as reported by ***Black-stone et al; 1988***.

Cardiac arrhythmias occurred only in patients in group B, especially in cases with extended Ventriculotomy with the insertion of trans-annular patch (B2). There were three patients admitted to ICU with Nodal rhythm that could be converted back to sinus rhythm with Amiodarone, this was in concordance with ***Dodge et al; 2002***. While reports from India by ***Ujjwal et al; 2006*** about 183 patients undergoing intra cardiac repair of Tetralogy of Fallot aged between 12 months to 42 years that were studied by light and electron microscopy for their operatively resected crista supra-ventricularis muscle, showed incidence of left bundle branch block in 32 patients, atrial flutter in 12 cases, and ventricular extra-systoles in 24 patients.

In-contrast to group B, the type and incidence of complications were different in group A, there were two patients with superficial wound infection (wet skin) and one patient who showed transient seizures that were controlled with anti-epileptic drugs.

During the postoperative period, the RV pressure and gradients across the RVOT were significantly decreased in both groups when compared with the pre-operative findings. In addition, the RV pressure post-operatively in group A was nearly equal to that of group B.

In group A, two patients ended with high RV pressure post- operatively in spite of having a wide RVOT, we considered it dynamic rather than true obstruction and we attributed this to the effect of inotropes, dynamic obstruction and pulmonary and tricuspid regurgitation, in those cases β blockers were used. In the follow up period we found that there was progressive decrease of RV pressure and gradients with no significant difference between both groups. This observation was in concordance with results by

Goor et al; in 1981, Wensley et al; in 1987 and Bove et al; in 2006.

Spray and Wernovsky; in 1998, commented on the incidence of heart failure in TOF post-operatively due to: Dysfunction of the PV, development of ventricular arrhythmias and development of progressive aortic valvular insufficiency. In the present study, pulmonary regurgitation (n=30) and tricuspid regurgitation (n=12) were present in the early post-operative period, So we used anti failure measures, especially in cases where the PV was excised. Diuretics were the initial therapy, followed by digoxin and ACE inhibitors.

In the follow up period, among 72 patients, there was no residual shunt across the VSD patch the same as published by ***Pozzi; in 2000*** and ***Christos et al; in 2001***.

The PR that was seen in 30 cases in the early post-operative examination regressed gradually and persisted in only 20 cases. These are the cases where the PV annulus and RV were opened; those patients were kept on continuous medical treatment.

In the follow up period the PG across the RVOT and the RV pressure showed insignificant difference and none of the patients had gradient over 40mmHg.

No one of our patients in the follow up period that was 6 months for all patient and 24 months for 48 of them, needed re-intervention for either residual gradients over RVOT or residual shunt.

Study limitations and recommendations

TOF represents one of the most common congenital heart diseases encountered in Egypt and has the highest frequency among children undergoing surgical repair. The need to establish a multicenter study involving large number of patients is crucial to try to determine the most suitable surgical approach in individual patients.

A long term follow up is also needed to try to elicit morbidities that are known to develop after years of operation namely postoperative ventricular arrhythmias and progressive RV dilatation and failure secondary to severe PR.

Recent modalities in assessment of the RV function like 2D strain and 4D volume rendering and function assessment were not readily available at the time the protocol of this study was put forward. Further studies to assess the RV function post TOF repair using these modalities are ongoing

Conclusion

We concluded that it is possible to operate on patients with TOF with very low mortality and

morbidity but in order to achieve the best results, it is necessary to individualize the surgical approach to each patient based on the anatomical variables and nature of the RVOT obstruction. . Every effort should be made to avoid injury to the RV or limit the Ventriculotomy incision as much as possible whenever needed.

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