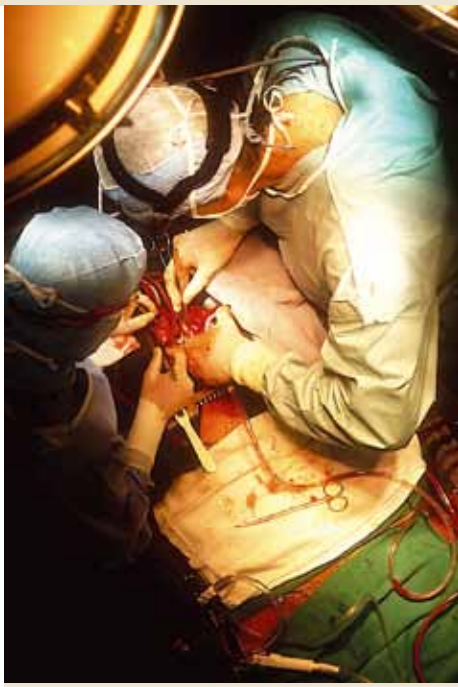
Investigation of Pulmonary Valve Replacement Cases after Previous Tetralogy of Fallot repair



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Abstract

Background: The aim of this study was to investigate pulmonary valve replacement cases after previous TF repair.

Methods: This study conducted in Rajaei cardiovascular medical and research center during 2004 -2011. We collected the information including CI (cardiac index)،(left ventricular ejection fraction)LVEF،(left ventricular end systolic volume index) LVESVI،(left ventricular end diastolic volume index)LVEDVI،(right atrial pressure) RA pressure، RVEF(right ventricular ejection fraction) ،(right ventricular end systolic volume index)RVESVI، RVEDVI (right ventricular end diastolic volume index) ،tricuspid regurgitation grade، Net forward flow and Pulmonary regurgitated fraction

Results: Totally there were 28 cases of PVR. There were 18 and 10 cases of mechanical and biological valves. In comparison between PVR and non PVR cases, the severity of right ventricular dysfunction was higher in PVR cases. The transanular patch was the most commonly used method for repairing TOF, it was used 69.7% and 47.4% in PVR and non PVR cases respectively, and this difference was significant. There were significant improvements in severity of pulmonary stenosis before and after PVR, severe PS were 35.7 and 20% before and after PVR respectively. There were also significant improvements in PAP after PVR(21.3 and13.5 before and after PVR respectively)

Conclusion: It seems that using transanular patch in repairing TOF is a risk factor for PI which leads to PV. Delay in PVR operation can increase the severity of RV dysfunction and frequency of arrhythmia.

Keywords: transanular patch, PVR, TOF

Introduction

Tetralogy of Fallot (TF) is one of the most common congenital heart disorders which comprise a prevalenceof0.26 to 0.8per 1000 live births. In recent fifty years, surgical correction for this problem was used achieving the best possible outcomes[1-2].However, in most patients with this anomaly,pulmonaryvalve, stenosis or insufficiency remains even after correction. The extent of remaining stenosis depends on the primary size of defect, type of surgical operation and also on the right ventricular function[3-5].In addition, end-systolic and end-diastolic volume of the right ventricle results in considerably reduce right ventricle function with increased susceptibility tocardiacarrhythmias[6-7]Therefore,inpatientswithrightventricular dilatation due to significant pulmonary valve insufficiency, pulmonary valve replacing(PVR)is the most effective treatment to restore the right ventricular function and reduc-

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ing the length of the QRS complex [8-10].
Despite evidences of PVR benefits in patients with TF, little information about the outcomes of surgical procedures is available. Since RAJAEI Heart Hospital is one of the major referral heart centers,in the current study, we aimed to retrospectively review our experiences about the outcomes of patients who had previous TF repair and then underwent to pulmonary valve replacement.

Methods and Materials

Population Study

In the current cross-sectional study, we retrospectively reviewed medical records of patients who had previous TF repair and then underwent to pulmonary valve replacement over a 7-year period from 2003-2010. All patients were operated in Rajaie Cardiovascular, Medical and, Research Center, one of the leading referral centers of cardiovascular diseases nationwide.
Corrective surgery was done indifferent ways such as pulmonary Valvotomy, shaving the hypertrophied muscles, obstructive right ventricular outflow patch and transannular patch.
Reviewing the medical records, we collected the demographic data including age, sex, drug history, echocardiographic parameters as LVEF, right ventricular dysfunction, TAPS, pulmonary regurgitation, severe pulmonary valve stenosis, gradient pre-and post-operative. The other data, including clinical symptoms such as shortness of breath, exercise intolerance, palpitations and arrhythmia were extractedfrompatientrecords.Otherinformationduringcatheterization such as RVSP (Right ventricular systolic pressure), RASP (Right atrial systolic pressure) PAP (pulmonary arterial pressure) and PI PHT were taken before and after PVR.
This study was approved in the research center of our institution. Informed consent was exempted by the board due to the retrospective nature of this research.

Statistical Analysis

Statistical analysis of the data was performed using SPSS version20. Results for quantitative variables expressed as mean and standard deviation(mean ± SD). Results for qualitatively variables expressed as frequency and relative frequency. Comparisons of qualitative variables were made using Pearson's chi-square or Fisher's exact test when necessary. Quantitative variables comprised using the test or Mann-Whitney U test. P values less than 0.05 were considered statistically significant.

Results

Patients after TF Repair

Totally, we enrolled 361patients with TOF who had undergone previous surgical repair of this anomaly. The mean age of the patients at the surgery was 5.86 ± 6. 09 years(rang: 1-39). 58.9% of patients were male. Surgical technique was transannular patch in 177 patients (49%), Pulmonary Valvotomy in 14 patients(3.9%), left pulmonary artery (LPA) patch in 16 patients (4.4%),right pulmonary artery (RPA) patch in 3 patients (0.8%) and RVOT shaving in 219patients (60.7%). The initial symptoms of patients are shown in table 1.The concomitant cardiac

Table1-The initial symptoms of all patients

Pvalue	None PVR group		PVR group		Initial Symptoms
	percentage	frequency	percentage	frequency	
0.81	44.1%	147	46.4%	13	clubbing
0.38	68.8%	229	60.7%	17	cyanosis
P<0.00	0.9%	3	21.4%	6	dyspnea
0<0.00	0.0%	0	7.1%	2	palpitation
P<0.00	3.3%	11	14.3%	4	arrhythmia
0.15	22.2%	74	10.7%	3	Free of symptoms

anomalies and other repairs are shown in table2.

Comparison of Patients with PVR and Patients without PVR

In total, 28 patients (7.8%) had undergone PVR surgery. Among them 18 patients (64%) received mechanical-valveand10 patients (36%) had a biological. The mean age was significantly higher in the PVR group (10.5±6.5 versus 5.4±5.9).

Regarding the surgical technique, Transanular patch was more used in patients with PVR (9.67% vs. 4.47). Other techniques performed similarly in both groups of patients. Some initial clinical symptoms, such as dyspnea (Pvalue<0.00), palpitations (Pvalue<0.00), and arrhythmias(Pvalue<0.00) more observed in patients in PVR group. In the terms of right ventricular function, the moderate and severe dysfunction was significantly higher in PVR candidates. The severity of PI was higher in patients with PVR and the severity of PS had a significant difference between two groups. In the other side, LVEF was significantly lower in PVR group (Pvalue=?). The evaluation of PIPHT index, the index of mean PI and PS showed no significant difference between two groups. The values for the index of preoperative and postoperative valvular PS were similar betweenthe two groups. In the assessment of right ventricular mean systolic RVSP and diastolic RVSP Index, significantly increase was seen in the group of candidate for PVR (Pvalue=?). Also, the initial systolic PAP was significantly higher in patients undergoing PVR. Other ventricular parameters were similar between the two groups. Cardiac volume indices before PVR are shown in table 3.

Comparison of Cardiac Volume Indices before and after PVR

The severity of PI and PS after PVR significantly improved. TAPSE index showed a significant decrease in PVR group. Systolic and diastolic values of RVSP indices significantly decreased after surgery. The mean value for PAP was significantly improved after PVR. Significant changes in other parameters were not observed. Comparison of cardiac volume indices before and after PVR is shown in table 3. Before the surgery 21.3%of patients were free of symptoms that increased to 51.2% after surgery.

Discussion

It has been revealed that PVR, in patients who had previous TF repair, reduces RV volume overload resulting in improved RV function, reverse clinical status, better exercise capacity and lower incidence of symptomatic arrhythmias both in childhood and adolescence[11-13]. In the other study, Shiokawa et al, showed significantly improvement of cardiothoracic ratio from 61.0 ± 5.2 % before PVR to 56.2 ± 4.8 % after PVR (P < 0.001). The New York Heart association functional class had significant increase from 2.4 ± 0.8 preoperatively to 1.2 ± 0.4 postoperatively and also left ventricular ejection fraction improved significantly [14]. Normalization of the ventricular volumes after PVR have usually been defined as restoration of RV function [15]. In the present study, we evaluated the cardiac volume indices in patients with

Table2-The concomitant cardiac anomalies and other repairs

None PVR group		PVR group		Contaminant Anomalies and repairs
percentage	frequency	percentage	frequency	
0.9%	3	3.6%	1	CoronaryAnomaly
3.0%	10	0.0%	0	Tricuspid repair
1.5%	5	0.0%	0	Mitral valve repair
2.1%	7	0.0%	0	Stenosis of right and left pulmonary arteries
21.6%	72	10.7%	3	Previou shunt
11.1%	37	0.0%	0	PDA
18.6%	62	10.7%	3	Pulmonary valve comiserotmy
5.1%	17	3.6%	1	Pulmonary valve stenosis
40.2%	134	46.4%	13	Oval orifice repair
11.1%	37	7.1%	2	Interatrial orifice repair
1.5%	5	3.6%	1	tricuspid valve insufficienc

TF history before and after PVR. In a previous study by Quail et al the majority of patients have received at the normal RV end-diastolic volume and end systolic volume after PVR [16]. Also Jang et al found RV end-diastolic and end-systolic volume were obviously dropped during the follow-up time[17]. Thus, in line with previous studies, our study clearly confirms that PVR in patients with pulmonary insufficiency after the repair of TOF can lead to significant improvements in RV performance indicators.

It has been reported that RV ejection fraction (EF) has a strong association with LVEF after TOF repair[18]. The effect of severe pulmonary regurgitation (PR) on LV systolic function has been explained by Frigiola et al as ventricular-ventricular interaction [5]. Therefore, other adverse events such as progressive heart failure and death may be followed by significant right heart disease [18-19]. The impact of PVR on the left heart late after TOF repair was investigated by Tobler et al[20]. They showed that LVEF increased significantly in all patients and in those with moderate impairment received a better results than those with sever dysfunction.

With the advances in surgical techniques early mortality of TOF repair has become very low.[17, 21-22]However TOF repair through transannular opening is often necessary to relieve RV outflow stenosis which can result in PR over long-term periods. It has also been reported that PR after a TOF repair may lead to ventricular arrhythmias and sudden cardiac death. Major corrective technique in our TF patients who required to PVR was transannular patch. Inline with our study, in a study by Tsang et al , of 16 patients who underwent PVR , 11 had previous transannular patch(68%)[23]. However Therrien et al reported 39% of transannular patch in PVR patients[24]. In another study transannular patch was used in 44% of the patients[25].

Although some evidences confirm early intervention to pulmonary valve recovery lead to better return of the RV function [26-28] but there are still concerns about homograft dysfunction over years. [29-30]. In our study, the mean age of our patients at PVR surgery was 20years. The mean age of patients in Tsang study was 6 (SD, 5) years when they underwent TOF repair and 24 (SD, 13) years

Table3- Cardiac volume indices in two groups before PVR

Pvalue PVR(before) and none PVR	PVR group						None PVR	
		Pvalue Before and after PVR	After		Before			
		SD	mean	SD	mean	SD	mean	
0.00	---	---	---	(10.50)	24	(6.95)	10	Age
0.57	---	---	---	(11.44)	80	(11.04)	85	O2saturation
0.00	---	---	---	(11.73)	56.7	(8.25)	62	LVEF
0.85	0.037	0.00	12	(3.31)	10	0.00	20	Diastolic PAP
0.36	---	(7.50)	21	(8.50)	14	(8.78)	16	PAP
0.25	0.79	(0.00)	30	(10.60)	27.5	(27.71)	32	Systolic PAP
0.41	---	---	---	(35.63)	57	(52.24)	76	PIPHT
0.76	---	---	---	(7.78)	27	(17.35)	30	PS
0.34	---	---	---	(2.47)	16	(3.03)	19	RA area
0.96	0.99	0/50	2.25	(0.95)	2.25	(1.38)	3.3	Diastolic RASP
0.103	0.006	0.71	5	(1.48)	3	(1.84)	4	Mean RASP
0.59	0.009	4.04	9	(2.31)	5.3	(2.87)	6.6	Systolic RASP
0.134	0.078	0.00	0	(4.11)	2.8	(1.3)	0.3	Diastolic RVSP
0.76	0.041	2.40	10.82	(2.71)	7.8	(12.53)	12.2	Mean RVSP
0.216	0.00	19.69	48.8	(25.31)	111	(8.75)	103	Systolic RVSP
0.00	---	----	---	(8.70)	9.2	(2.18)	1.7	TAPSE
0.18	---	---	---	(36.61)	46	(15.81)	31	valvular PS

when they underwent PVR. In another study by Jang et al, PVR was performed at a mean age of 14.8 ± 6.7 years. Other authors' reported various age of PVR between 12 and 34 years old[31] and the time of this intervention is in controversy.

Conclusion

In patients with pulmonary insufficiency after previous TOF repair, PVR can effectively improve right ventricular performance indices. However, it should be considered before RV dilation. Thus, the proper timing of surgery is very important, especially patients who have received transannular-patch. They must be visited and evaluated for PI and its complication in shorter time. This process depends on the knowledge of patients and availability of skilled medical team for follow up.

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