Patent Ductus Arteriosus with Persistent Pulmonary Artery Hypertension after Transcatheter Closure

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ABSTRACT

Objectives: To observe the change of pulmonary artery systolic pressure (PASP) of patients with persistent pulmonary arterial hypertension (PAH) after patent ductus arteriosus (PDA) occlusion.

Background: After occlusion of PDA with PAH, PAH can be persistent in some patients. **Methods**: A chest x ray, an electrocardiogram and an echocardiogram were performed on all patients at 24 hours, one month, six months and 1 year intervals serially.

Results: There was a significant fall ($p < 0.05$) in mean PASP after occlusion (to 59.3(12.7)mmHg). However, the aortic pressure and SaO2 changed slightly ($p>0.05$). During the follow up, there was a further fall of PASP in 5 patients (NO 1, 5, 6, 7 and 8). Four patients (NO 2, 3, 4 and 8) showed the evidence of worsening of the PAH and were treated with sildenafil. Patient 2 died from acute right heart failure after a period of 11 months from the time of TCC (Transcatheter closure), triggered by pulmonary infection.

Conclusions: Some patients with borderline hemodynamic data with PDA and PAH can deteriorate or keep sustained PAH after PDA closure. The treatment of permanent closure to these patients must be cautious.

Keywords: Follow-up, patent ductus arteriosus (PDA), pulmonary artery hypertension, transcatheter closure (TCC)

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INTRODUCTION

Patent ductus arteriosus (PDA) is one of the most common congenital heart defects, accounting for 5%-10% of all congenital heart disease in infants.(1) Transcatheter closure (TCC) of patent ductus began in 1971.(2) With the progress of technique and material, TCC of PDA with various occluders has been well established and become the treatment of choice for the majority of patients(3-10). However, whether to attempt TCC of PDA in patients with severe pulmonary artery hypertension remains as a challenging clinical problem, there is not much information on the immediate and long-term effects of TCC of a PDA in patients who already have PAH, especially in patients with persistent pulmonary artery hypertension after occlusion.

MATERIALS AND METHODS

Patients

From July 2006 to January 2011, nine patients with clinical and echocardiographic findings of a PDA and severe pulmonary hypertension underwent TCC with the Amplatzer duct occluder (ADO, AGA Medical Corporation, Golden Valley, Minnesota, USA). Pulmonary hypertension maintained after occlusion.

Their mean age was 24.2±8.2 years (range 16-42 years) and their median body weight was 53.6±7.8 kg (range 46-71 kg).

Interventional procedure

The technique of TCC of PDA using the Amplatzer duct occluder was similar to that described by Masura and colleagues (11). After a complete hemodynamic evaluation and descending aortogram in lateral or right anterior oblique view,trial occlusion with the

Amplatzer duct occluder (The size of the occlusion device that we chose was 4-6 mm larger than the narrowest size of the PDA) was performed for 30 minutes so that we obtained the change in hemodynamic and clinical data. If the pulmonary arterial pressure fell or did not increase, the aortic pressure did not decrease, and the signs and symptoms did not worsen, the PDA occluder was released. A repeat descending aortogram excluded moderate-to-large residual left-to-right shunt. Otherwise, it should be retracted into the delivery sheath. Prophylactic antibiotics were routinely given after the procedure for 3 days. All patients returned home after 2 days of observation in the cardiac ward.

Follow up

A chest *x* ray, an electrocardiogram and an echocardiogram were performed on all patients at 24 hours,one month,six months and 1 year intervals serially.

Statistics

Results were analysed with the SPSS 13.0 and expressed as mean (SD), with confidence intervals where applicable. Preocclusion and postocclusion data were compared using paired-samples t tests. A probability value of $p< 0.05$ was considered significant.

RESULTS

The clinical and haemodynamic data before and after occlusion of nine patients are shown in Table 1 Table 2. The PDA size was 8.9(3.0) mm (range 5–15 mm). The mean ADO diameter was 14.8(3.0) mm (11–20 mm). The ratio of pulmonary blood flow to systemic flow (Qp/Qs) was 2.2(0.7) (range 1.7–3.94). The mean pulmonary vascular resistance (PVR) at baseline was 6.4(2.8) Woods units (range 2.7–12.6 Woods).The mean pulmonary artery systolic pressure (PASP) and aortic systolic pressure at baseline were 106.7（21.5）mmHg (range

78-140 mmHg) and 137.1（8.1）mmHg (range 127-147 mmHg), respectively. There was a significant fall ($p < 0.05$) in mean PASP after occlusion (to 59.3(12.7) mmHg). However, the aortic pressure and SaO_2 changed insignificantly ($p > 0.05$).

The mean follow-up time was 3.6 years (range 0.9–7 years). During the follow up, PASP was obtained from echo/Doppler study. There was a further fall of PASP in 5 patients (NO 1, 5, 6, 7 and 8). Four patients (NO 2, 3, 4 and 8) showed the evidence of worsening of the PAH and were treated with sildenafil. Patient 2 died from acute right heart failure after a period of 11 months from the time of TCC, triggered by pulmonary infection (Table 3, Figure 1, Figure 2).

DISCUSSION

Transcatheter closure is now widely accepted as the first-choice treatment of PDA. The increasing experience allows PDA patients with pulmonary artery hypertension (PAH) to be evaluated for transcatheter device occlusion. The findings of present study indicated that TCC of PDA in patients with PAH is feasible, effective, and safe, even in severely symptomatic patients (12-17). However, a small percentage of patients with borderline hemodynamic data with PDA and PAH can deteriorate after PDA closure due to non regression of pulmonary hypertension, progressive pulmonary vascular disease, and right heart failure. Their natural history is similar to idiopathic PAH. In our study, the PASP of nine patients fell by >20% immediately after occlusion. During the follow-up, PASP of 5 patients fell further and another four patients' PASP became worse. The PASP of all 9 patients did not become normal. For patient 1 and patient 7, PDA diameter was only 5mm or 6mm. According to the clinical classification of pulmonary hypertension (18), this is

generally classified as PAH associated with small defects. But we cannot differentiate whether it is PDA with idiopathic PAH or not.

Whether to attempt TCC of PDA in patients with severe PAH remains as a challenging clinical problem. In this condition, the most important determinant of management and prognosis is whether the severe PAH is reversible. Clinical examination are used to evaluate the reversibility of severe PAH. However, decision to intervene is difficult if clinical examinations are equivocal and there are some limitations for calculating PVR in PDA. A multicentre study by Balzar et al, concluded that the use of vasodilators, including inhaled nitric oxide, has limited utility in deciding operability (19).Contrary to the popular belief, a recent study showed that pre-operative hemodynamic information does not correlate with post-operative outcome for various reasons (20).

Trial occlusion of PDA with device has been in use to decide on the contribution of left to right shunt and pulmonary vascular resistance to PAH (21-25). The criteria that we followed were: [1] a fall in the pulmonary artery pressure or no elevation; [2] no decrease in the aortic pressure and Sao2; and [3] no worsening of signs and symptoms. If all the criteria were satisfied, we considered the pulmonary arterial hypertension to be reversible. Otherwise, it was considered to be irreversible pulmonary arterial hypertension, and occlusion was abandoned. This is a reliable test to exclude patients with borderline hemodynamic data from undergoing device closure (21 22 26).

Sildenafil has been shown to improve exercise capacity, oxygen saturations, cardiopulmonary haemodynamics and WHO function class in patients with PAH, including patients with PAH-CHD (27-31). Longer-term studies have suggested sustained benefits. A larger randomised trial of 278 patients, including 7% with Eisenmenger syndrome, showed

significant benefit after 19 months (27).In our study, treated with sildenafil, the PASP of patients with PDA after closure decreased.

CONCLUSIONS

Transcatheter closure for PDA with severe PAH is currently the preferred method. However, some patients with borderline hemodynamic data with PDA and PAH can deteriorate or keep sustained PAH after PDA closure, although PAP decreased by > 20% immediately after trial occlusion. To these patients, the treatment of permanent closure must be cautious.

Study limitations

There are two main limitations in our study. First, the major limitation of the study was the small sample size which limited its power. Second, during the follow-up, pulmonary arterial pressure was only evaluated by ultrasound. No patients took catheterization again.

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Table 1: Clinical data of patients who underwent PDA occlusion (n=9)

Patient NO.	Sex	Age (years)	Weight (Kg)	PDA Diameter (mm)	Device Size (mm)
1	F	19	52	5	11
2	F	16	46	10	16
3	F	28	61	15	20
4	F	20	48	11	18
5	F	42	50	10	16
6	F	31	53	8	14
7	M	21	71	6	12
8	F	18	52	8	14
9	F	23	49	7	12
Total (n)=9		24.2±8.2	53.6±7.8	8.9±3.0	14.8±3.0

Table 2: Haemodynamic data of patients who underwent occlusion of PDA (n=9)

Patient NO.	PASP (mmHg)		Ao pressure (mmHg)		SaO2 (%)		Qp/Qs	PVR(Woods)
	baseline	PDO	baseline	PDO	baseline	PDO		
1	128	88	136	138	93	95	1.7	5.47
2	110	55	132	143	90	92	2.03	3.58
3	96	57	141	146	92	93	1.76	7.13
4	140	63	147	149	90	90	1.82	7.65
5	100	61	152	163	92	94	2.35	6.89
6	95	59	127	138	93	97	2.06	5.37
7	129	61	135	142	91	94	1.72	12.6
8	78	43	134	158	92	96	2.78	2.7
9	84	47	130	149	89	96	3.94	5.85
Total (n)=9	106.7±21.5▲	59.3±12.7▲	137.1±8.1	147.3±8.6	91.3±1.4	94.1±2.2	2.2±0.7	6.4±2.8

PASP: pulmonary artery systolic pressure; Ao pressure: systolic aorta pressure; SaO_2: systemic arterial oxygen saturation; PVR: pulmonary vascular resistance; Qp/Qs: pulmonary/systemic flow ratio; PDO:patent ductus occlusion.

▲:$p < 0.05$

Table 3: PASP changes during follow-up after TCC

NO	PASP(mmHg)											
	Before occlusion	After occlusion	1 month	3 months	6 months	1 year	2 years	3 years	4 years	5 years	6 years	7 years
1	87	82	69	58	56	62	52	49				
2	134	76	80	95	121#	※						
3	109	61	56	66	88	99	103#	72	51	49	51	47
4	111	81	58	83	105#	87	63					
5	140	70	76	68	70	53	52	46	37			
6	106	73	72	75	68	52	48	32	36			
7	128	83	86	78	71	63	49	45				
8	97	65	70	53	49	37	40	35	29	32		
9	109	92	102	89	78	80#	54	42	46			

#: add sildenafil

※: death

TCC:Transcatheter closure.

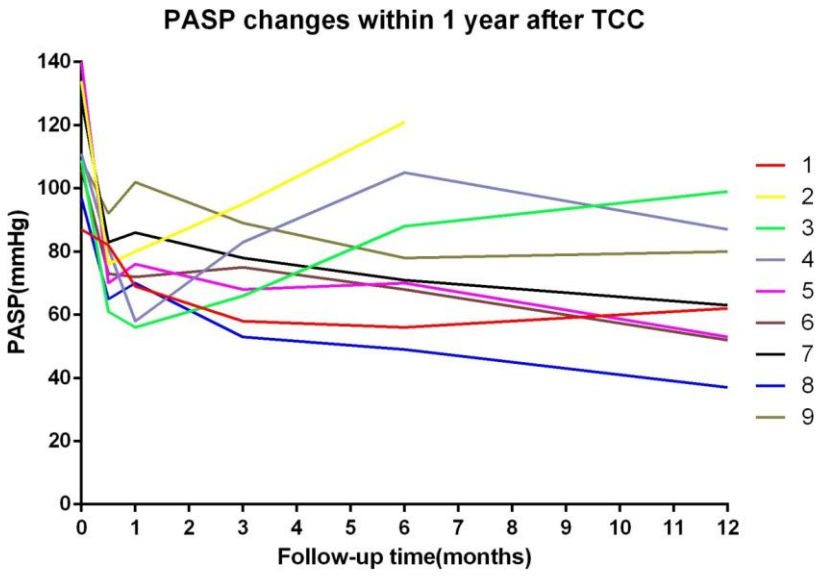

Fig 1: PASP changes within 1 year after TCC, PASP: pulmonary artery systolic pressure.

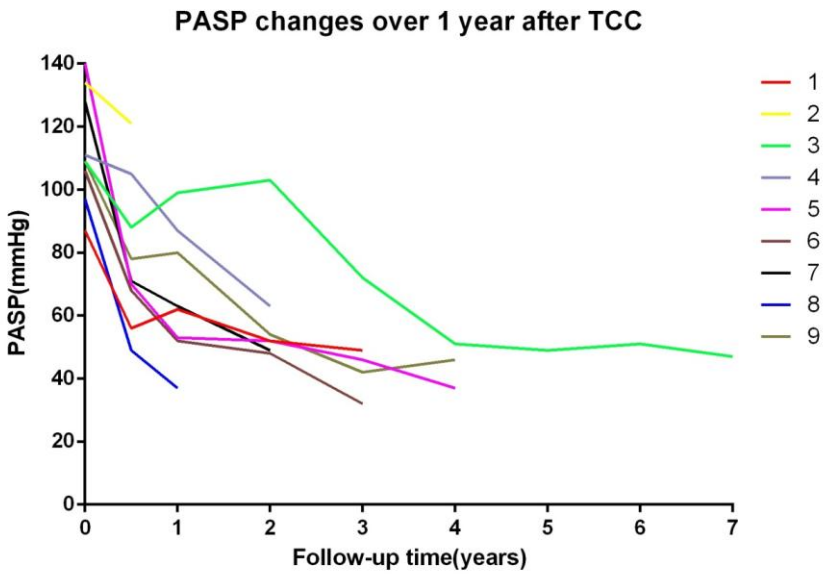

Fig 2 PASP changes over 1 year after TCC
PASP: pulmonary artery systolic pressure.