Percutaneous closure of recanalised ductus arteriosus – a single-centre experience

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Abstract

Introduction: Restoration of blood flow through a previously occluded ductus arteriosus may occur in some patients. Treatment strategy in patients with such residual shunts has not yet been uniformly established.

Aim: To present single-centre experience and to attempt to establish a strategy of management of patients with residual ductus arteriosus shunts following percutaneous closure.

Methods: Of 352 patients who underwent percutaneous closure of ductus arteriosus, in 13 subjects complete closure failed (coils and Rashkind occluders were used in 10 and 3 patients, respectively). In these patients other percutaneous interventions aiming at total closure of residual shunt were attempted.

Results: In 12 patients coils were inserted (one patient received two coils). Introduction of implant in one patient failed, but total occlusion of the shunt was confirmed one day after the procedure. Trivial residual shunt was observed in one patient after one-year follow-up.

Conclusions: Percutaneous treatment of residual shunts within the ductus arteriosus is an effective and safe procedure. In our opinion identifying and treating such leaks is important, as it prevents complications and long-term need for antibiotic prevention of infective endocarditis. In the case of a small residual shunt, insertion of a coil seems to be the optimal therapy due to the low cost of the device, favourable design and high effectiveness. For patients in whom anatomy of the ductus arteriosus has been significantly changed, particularly in previously treated subjects, techniques using vascular loops or insertion using a catheter wedge may be helpful.

Key words: persistent ductus arteriosus, interventional catheterisation, ductus arteriosus recanalisation

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Introduction

Residual shunt through a previously occluded ductus arteriosus may be a result of suboptimal occlusion or recanalisation of a totally occluded ductus arteriosus. It may occur after either percutaneous or surgical intervention [1-4]. Most commonly residual shunts appear to be trivial and haemodynamically insignificant, but having various sizes. Regardless of flow rate, patients with a history of previous intervention have higher risk of future infection; thus each residual shunt requires reocclusion [5, 6].

The aim of this study was to present our experience and to attempt to establish a strategy of management of patients with residual shunts through the ductus arteriosus following its percutaneous closure.

Methods

Between October 1993 and March 2006 we performed 352 catheterisation procedures of persistent ductus arteriosus (PDA) closure. This group included 13 patients after percutaneous procedure performed to close the duct. In these patients coils

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Table I. Patients' clinical characteristics

Patient No.	Age (years)	Previous treatment (years)	PDA Diameter	Date (dd.mm.yy)	Murmur	Implant	Approach	Fluoroscopy (min)	Comment	Residual shunt		
										24 h	6 mo	12 mo
1	11.2	R – 1.2	1.0	12.09.96	Systolic	C 5/5	A	20	Loop	–	–	–
2	4	C – 1	1.0	30.09.97	Systolic	C 4/4	A	27		–	–	–
3	3.5	C – 1.1	1.0	04.11.97	Systolic	C 4/4	A	10	Wedging	–	–	–
4	5	C – 0.8	1.0	17.03.98	None	C 4/4	A	14	Wedging	–	–	–
5	9	C – 1.4	0.7	1703.98	None	–	–	25	Discontinued	–	–	–
6	9	C – 0.5	1.2	14.05.98	Systolic	C 4/4	A	11		±	–	–
7	3.5	C – 0.8	1.5	17.09.98	Systolic	C 4/3	A	11		–	–	–
8	22	R – 3.8	3.2	11.03.99	Continuous	2 × C	A and V	16		–	–	–
9	2	C – 0.8	2.5	11.08.00	Continuous	C 5/5	A	7		±	±	±
10	3.3	C – 1.1	1.3	22.01.01	Systolic	C 4/3	A	7	Wedging	–	–	–
11	16	R – 3	1.5	11.04.01	Systolic	C 5/5	A	6		–	–	–
12	3	C – 1.2	1.4	14.04.03	Systolic	C 5/5	A	6		±	±	
13	16	C – 0.8	1.4	5.04.04	Systolic	C 4/3	A	4		–		

Abbreviations: A – arterial-side access, V – venous-side access, R – Rashkind occluder, C – PDA-5/5 coil (diameter/loop number) or Jackson-4/4, 4/3 coils (length/diameter), loop – vascular loop formation, wedging – insertion of coil in wedge position

were implanted in 10 subjects and a Rashkind occluder was inserted in 3 patients. None of the patient with an Amplatzer occluder inserted had residual shunt. Patients' clinical characteristics are presented in Table I. Continuous systolic-diastolic murmur was audible in 2 patients, no murmur was detected in 2 patients and in the remaining 9 only systolic murmur was present. No patient had heart failure symptoms. Residual flow diagnosis was based on physical examination and/or echocardiography. The diagnosis was confirmed in each case by aortic angiography performed prior to scheduled intervention. It allowed the assessment of shape, diameter and length of the duct (following calibration related to catheter size). These procedures were performed 1 to 4.3 years (mean 2 years) after the first therapeutic catheterisation .

In all patients coils were used to close residual shunts (Figure 1). Selection of implant device was based on morphology and diameter of the ductus arteriosus and the following ones were used: six 5PDA5 coils, four Jackson MWCE 38-4-4 coils and three 38-4-3 coils. In all patients arterial access was used to insert the catheter into the PDA. In one patient (no. 8) two 5PDA5 coils were inserted: one from the venous side and the other from the arterial side. Direct insertion of the catheter into the ductus arteriosus was impossible in 5 patients. It was necessary to make an arterio-venous loop to advance the detachment system in one patient (no. 1). In 3 patients with narrow ductus arteriosus (patients no. 3, 4 and 10) insertion of the catheter into the pulmonary artery was unsuccessful while guidewires were introduced properly. The occluding coil was inserted through a catheter placed in the wedge position at the ductus stenosis. In one patient (no. 9) with tortuous and narrow residual flow (the narrowest in the study group, of 0.7 mm diameter) the wire could not be advanced through the ductus, despite numerous attempts using various catheters and guidewires; therefore the procedure was terminated without successful closure of the shunt.

Patients were discharged on the second procedural day and regularly followed at our outpatient clinic (physical examination, ECG and echocardiography with colour Doppler assessment). Mean follow-up was 4.6 (from 0.7 to 6.7) years.

Results

Closure of residual ductus arteriosus flow following prior percutaneous treatment was carried

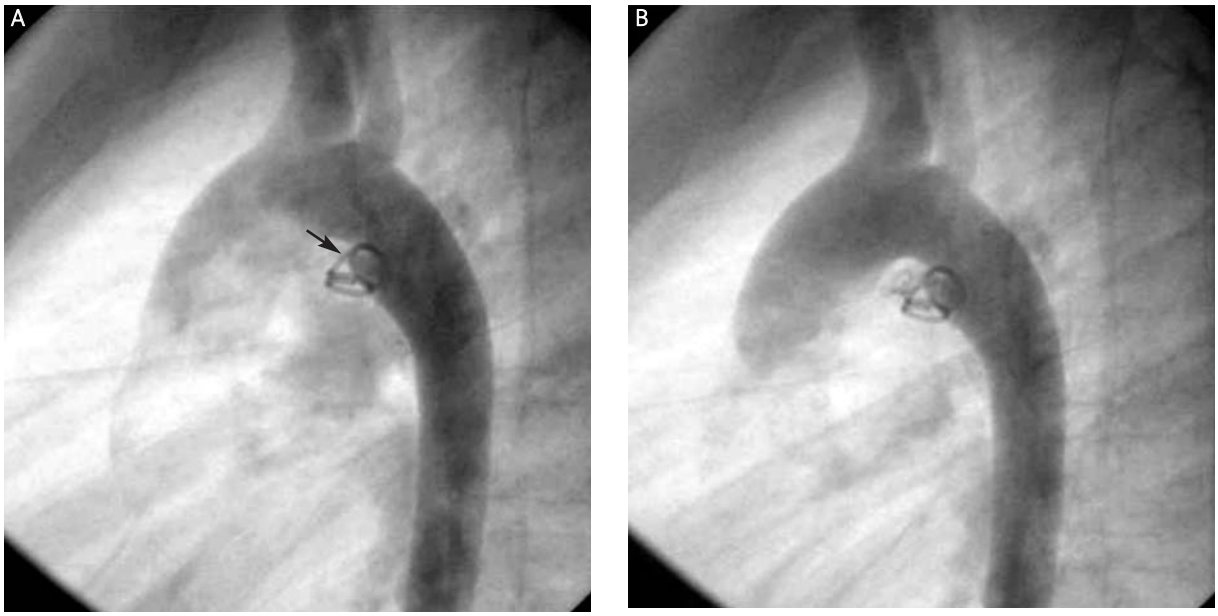

Figure 1. A. Residual flow through PDA previously occluded with coil (arrow). Aortic angiography in the lateral view. **B.** The same patient after closure of PDA with another coil

out in 13 patients (Table I). Neither deaths nor complications were observed in this group. In all patients pulmonary artery and aortic stenoses were excluded on echocardiography. Diameter of the ductus arteriosus ranged from 0.7 to 3.2 mm (mean 1.4).

In the analysed group of 13 subjects embolisation coils were inserted in 12 patients. No peripheral embolisation was observed during or after the procedure in all patients. One patient (no. 8) received two 5PDA5 coils due to wide, of 3.2 mm diameter, duct (Amplatzer occluders were not available at that time). The patient with failed closure during catheterisation (no. 5) was confirmed to have total occlusion of the shunt on the next day (also observed on follow-up investigations). In the study group total closure of the ductus immediately after the procedure was found in 10 out of 13 patients (77%). One year after the procedure minor residual flow was still present in one child (no. 9), but his parents did not give their consent for another intervention. In this patient, 2.5-mm ductus was treated with insertion of a 5PDA5 coil.

Fluoroscopy duration ranged from 4 to 45 (mean 13.9) minutes.

Discussion

Percutaneous treatment of PDA has almost entirely replaced the previous surgical approach, becoming the first choice therapy. The only group where surgery is still being used is premature new-borns. Regardless of the method applied the aim of the therapy is to reach complete and persistent occlusion of the ductus during a single intervention. Residual shunts represent a significant problem. There are no unambiguous guidelines available as to whether they should be closed or only regularly followed. In our opinion closure of the residual shunt is warranted as it prevents infective complications. There are limited published data on this issue even though such a treatment has been used for many years in our and other sites. In this paper we report our experience with the treatment of 13 patients with residual shunts following percutaneous occlusion of the ductus arteriosus.

These procedures were performed from 1993 to 2006. Enormous progress in the transcatheter treatment was made during these years, including the introduction of Rashkind occluders, embolisation coils and Amplatzer occluders into clinical practice. Currently, we use detachable embolisation coils to close minor residual shunts [7, 8]. Amplatzer occluders are preferred for the majority of larger shunts, although larger coils or two coils may also be used as well. However, in our opinion the latter option is inferior and should not be recommended due to significantly higher peripheral embolisation risk or persistence of residual flow.

The most common cause of residual shunt was the closure of medium-to-large ducts using embolisation coils. To avoid such complications we revised our approach and introduced one based on the diameter

and morphology of the duct; therefore sometimes for ducts of 2-2.5 mm diameter we use Amplatzer occluders. At our site the management of asymptomatic ducts requires percutaneous closure unless it is impossible to pass the guidewire through the ductus. We hope this would prevent calcification and possible dilation of these structures.

The prevalence of residual shunts after percutaneous treatment depends on the closure method used, follow-up duration, and the size and morphology of the ductus arteriosus, ranging according to different sources from 0 to 35% [8-12]. In our group of 352 patients with percutaneous closure, residual flow was observed in 3 of 25 (12%) patients after insertion of Rashkind occluders, 10 of 269 (3.7%) with embolisation coils inserted and in none of 58 patients with an Amplatzer occluder.

Percutaneous occlusion of residual shunts may sometimes be difficult because of significant changes in the PDA anatomy. These deformations result from stretching of PDA tissue by implants or uneven proliferation of endothelium. Thus, it may be necessary to apply special techniques of PDA cannulation and introduction of a delivery system such as a vascular loop (patient no. 1) or implantation of embolisation coils in a wedge position, mainly for smaller shunts, which involves passing the guidewire through the PDA and advancement of the catheter to the wedge position at the stenotic site without inserting it into the pulmonary artery (patients no. 3, 4 and 10). Quite interesting is the case of PDA occlusion in patient 5, in whom the procedure was terminated due to failed insertion of the guidewire and catheter into the PDA. Unexpected occlusion of PDA occurred most likely as a result of local induction of coagulation cascade provoked with numerous wire manipulations within the PDA lumen.

Conclusions

Percutaneous treatment of residual shunts in the PDA is an effective and safe procedure. In our opinion identifying and treating such leaks is important, as it prevents complications and long-term need for antibiotic of infective endocarditis prevention. However, further investigations are needed to test this hypothesis. In the case of small residual shunts, insertion of a coil seems to be the optimal therapy due to the low cost of the device, favourable design and high effectiveness. For patients in whom the anatomy of the ductus arteriosus has been significantly changed, particularly in previously treated subjects, techniques using vascular loops or insertion using a catheter wedge may be helpful.

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Przezskórne zamykanie rekanalizowanych przewodów tętniczych

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Streszczenie

Cel: Prezentacja doświadczenia jednego ośrodka oraz próba ustalenia strategii postępowania z pacjentami z rezydualnym przeciekiem przez przewód tętniczy po uprzednim leczeniu przezskórnym.

Metoda: Spośród 352 chorych poddanych zabiegom przezskórnego zamknięcia przewodu tętniczego u 13 nie udało się całkowicie zamknąć przewodu (u 10 zastosowano sprężynki wewnątrznaczyniowe, a u 3 parasolki Rashkinda). Chorych tych poddano kolejnym zabiegom przezskórnym, zmierzającym do zamknięcia resztkowego przecieku.

Wyniki: Sprężynki wewnątrznaczyniowe wszczepiono 12 chorym (jednemu – 2 sprężynki). U 1 chorego wprowadzenie implantu nie powiodło się, jednak następnego dnia po zabiegu stwierdzono całkowite ustąpienie przecieku. Rok po procedurze u 1 chorego pozostał śladowy przeciek resztkowy.

Wnioski: Przezskórne zamykanie resztkowych przecieków przez przewód tętniczy jest leczeniem bezpiecznym i efektywnym. W naszym przekonaniu identyfikacja i następcze leczenie tych przecieków jest istotne, gdyż zapobiega powstaniu powikłań oraz konieczności stosowania długotrwałej profilaktyki antybiotykowej. W wypadku małych rezydualnych przewodów tętniczych implantacja sprężynek embolizacyjnych wydaje się najlepszą metodą z powodu ich niskiego kosztu, przyjaznego kształtu i dużej skuteczności. W wypadku chorych z istotnie zmienioną anatomią przewodu, co szczególnie często ma miejsce po uprzednim leczeniu, pomocne są szczególne techniki, jak utworzenie pętli naczyniowych czy też implantacja w pozycji zaklinowania.

Słowa kluczowe: przetrwały przewód tętniczy, cewnikowanie interwencyjne, rekanalizacja przewodu tętniczego

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