

Original Article

Transcatheter Closure of Patent Ductus Arteriosus using Gianturco Coil: Jordanian Experience

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ABSTRACT

Objective: To assess the immediate and mid-term results of transcatheter closure of patent ductus arteriosus (PDA) less than 4 mm in diameter using single or multiple Gianturco coils.

Settings: Queen Alia Heart Institute, a tertiary center for cardiac patients, Amman, Jordan.

Patients And Methods: From December 1977 to January 2002, 32 patients (21 female, 11 male) underwent a transcatheter closure of a small PDA less than 4 mm in diameter in our institution as an alternative to standard surgical ligation. The patient's mean age was 8.4 years (range 1-27 years); their mean weight was 26.5 kg (range 8-81 kg). All patients were asymptomatic. Gianturco stainless steel coils (Cook) with thrombogenic strands attached to them were used for closure. The mean follow-up period was 2.1 years (range 0.5-4).

Results: The mean narrowest PDAdiameter was 2.8 mm range (1.4-4), the mean pulmonary/systemic flow ratio was 1.57 range (1.22-2.5). A single coil was used in 24

patients (75%), four patients (12.5%) needed two coils, four patients (12.5%) needed three coils to achieve complete closure of the PDA. The patients who had two or three coils, had larger shunts with PDA's narrowest diameter more than 3.5 mm. There were two incidents of coil migration to the left pulmonary artery, which were retrieved with a gooseneck snare. There was immediate and complete closure in 28 patients out of 32 (87.5%) as confirmed by post-closure descending aortogram. Four patients had residual shunt, which disappeared after 24 hours. All patients were discharged home one day after the procedure.

Conclusion: Coil occlusion of PDA less than 4 mm was safe and effective. Immediate success rate was high. Residual shunts were commonly observed immediately following coil occlusion, but spontaneous closure occurs in all patients. The risk of coil embolization was less in PDA less than 4 mm in diameter. No complications have been encountered during the first four years of follow up.

KEYWORDS: aorta, Gianturco coil, PDA, pulmonary artery, transcatheter closure

INTRODUCTION

In 1939 Gross *et al* began the era of congenital heart surgery when they reported the first successful ligation of a patent ductus arteriosus PDA^[1]. In 1966, Porstman *et al*, were the first to successfully apply a new method by which a PDA was closed by Ivaon foam plug via a combined femoral artery and vein approach^[2]. The Rashkind device (1979), the buttoned device, the batallo occluder device, coils and the Amplatzer duct occluder have been used extensively for transcatheter closure of PDA, with variable degrees of successful deployment and an incidence of residual shunt varying between 3% and 38%^[3-13]. Moore *et al*^[7] and Liloyd *et al*^[9] reported the use of a single Gianturco coil delivered retrogradely to close small PDA in many centers^[11,14-16]. In this report, we described our experience with transcatheter closure of PDA less than 4 mm in diameter using Gianturco coils.

PATIENTS AND METHODS

From December 1997 to January 2002, 32 patients (21 female, 11 male) underwent an attempt at catheter closure of a small PDA less than 4 mm in diameter in our institution as an alternative to standard surgical ligation. Informed consent was obtained from patients or parents as appropriate. All patients had clinical and echocardiographic findings of PDA. The patient's mean age was 8.4 year (range 1-27); their mean weight was 26.5 kg (range 8-81 kg). All patients were asymptomatic, but had evidence of left atrial and ventricular volume overload. One patient had Down's syndrome. Gianturco stainless steel coils (Cook) with thrombogenic standards attached to them, originally designed to occlude renal arteries^[17], were used. We selected 0.038" diameter wire coils of sufficient length to produce three or five loops.

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Closure Protocol

The protocol we used has been described previously patients^[10,11,18-20]. The procedure was performed using 4 F delivery sheath and the patients were given Ketamine analgesia during the procedure, the retrograde approach was used in 26 patients (81%), the delivery sheath being positioned in the aorta. The antegrade approach was used in six patients (19%) with the delivery sheath positioned in the pulmonary artery. An attempt is always made to close the PDA completely while the patient is in the catheter laboratory. All patient had descending aortogram at the end of the procedure to assess the closure and the position the coil. Figure A 1 & 2 show the pre-and post-closure PDA angiogram using single coil. Figure B shows multiple coils closing the PDA. Echocardiogram and chest X-ray were routinely performed after 24 hours of closure and during the follow up at six months, 1, 2, 3, and 4 years. The mean follow-up period was 2.1 years (range 0.5-4).



Fig. 1 & 2 A: Descending aortogram showing the PDA before and after the closure using the single coil technique



Fig. 1 & 2 B: Multiple coils closing the PDA

RESULTS

The mean narrowest PDA diameter was 2.08 mm range (1.4-4), the mean pulmonary/systemic flow ratio was 1.57 range (1.2-2.5). Using the PDA classification adopted by Krichenko et al^[21], 30 patients (94%) had type A PDA (well defined ampulla at the aortic end) and two (6%) patients had type C PDA (tubular ductus). Single coil was used in 24 patients (75%), 4 patients (12.5%) needed two coils and four patients (12.5%) needed three coils, to achieve complete closure of the PDA. The patients who had two or three coils, had large PDA with the narrowest diameter more than 3.5 mm. The total number of coils used in our study was 44 coils (Table 1).

There was immediate and complete closure in 28 patients out of 32 (87.5%) as confirmed by post closure descending aortogram. Four patients had residual shunt, which had disappeared after 24 hours. No patients required blood transfusion; there were no femoral arterial or venous complications. There were two incidents of coil migration to the left pulmonary artery, which were

Table 1

Coil sizes and the number of loops used

No. of Patients	%	Size of Coil	Number of Loops
26	(59.1)	8/5	5
8	(18.2)	5/5	3
6	(13.6)	8/8	3
4	(9.1)	10/8	4

retrieved with gooseneck snares. One patient had PDA size 4 mm and the other had PDA size 3.6 mm. There was no evidence of obstruction of the left pulmonary artery or the descending aorta, as confirmed by angiography, and by 2-D echocardiography on the following day and on follow-up. All patients were discharged home one day after the procedure. No PDA recanalization has been seen during the follow-up period by 2-D color Doppler echocardiography.

DISCUSSION

Coils have been very successful in closing small to moderate PDA with high occlusion rate in children^[9-11,22-24]. In this study we report our experience in using both retrograde and antegrade approach to close PDA less than 4 mm in diameter as well as single or multiple coil deployment technique. The immediate success rate was 87.5%. If the PDA size was more than 3.5 mm more coils needed to close it as was recommended by Hijazi and Geggel^[24].

The residual shunt had disappeared spontaneously in all patients. Our results were consistent with the study of Shim et al^[23], which concluded that residual shunts are commonly observed immediately following coil occlusion procedure, but spontaneous closure occur in the majority and patients with smaller minimal duct diameter are more likely to achieve immediate occlusion following placement of single coil. The most common complication of transcatheter closure of PDA using coil is embolization of the coil to the distal pulmonary arteries, reported incidence varied from 6% to 20%^[10-11,20-24]. In our experience it happened in two patients out of 32 (6%) and the embolization occurred only in patient with ductus diameter more than 3.5 mm. So, we agree with Wang et al^[25] in his recommendation that Amplatzer duct occluder, buttoned device or controlled release coil could be superior to multiple coil technique in patients with diameter more than 4 mm.

In our experience we used longer coils making five loops in 60% of the procedure to provide more loop stability. One important advantage is the cost of procedure^[24]: a package of two coils costs about \$ 35. Therefore the cost of coil embolization technique is much less than open surgical

approach, and also much less than other techniques.

CONCLUSION

Coil occlusion of PDA less than 4 mm is safe and effective. Immediate success rate is high. Residual shunts are commonly observed immediately following coil occlusion, but spontaneous closure occurs in all patients. The risk of coil embolization is less in PDA less than 4 mm in diameter. No complications have been encountered during the first four years of follow-up.

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