Rescrewing the embolized duct occluder using the delivery cable

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INTRODUCTION

Percutaneous closure of patent ductus arteriosus (PDA) was first reported by Portsmann et al., in 1971.[1] Transcatheter closure of PDA using duct occluder (DO) is an established procedure associated with negligible but important complications.[2] Early and late spontaneous embolizations of DO into pulmonary artery (PA) and descending aorta have been reported.[3-5] Several reports showed successful retrieval of various occluders either surgically or by transcatheter technique using goose neck snare or bioptome.[3-6] We report our attempts at re-screwing of embolized DO in three children by modified sheath in sheath technique using delivery cable.

CASE REPORTS

Case 1

A 10-year-old boy weighing 26 kg was diagnosed to have a large PDA with left to right shunt. The clinical evaluation showed high volume pulse and continuous murmur on auscultation. The electrocardiogram showed left ventricular hypertrophy by standard voltage criteria and chest X-ray showed cardiothoracic ratio of 0.6 with increased vascularity. The transthoracic echocardiogram (TTE) showed a large PDA with continuous left to right shunt.

Transcatheter closure of PDA was planned as per the protocol. Descending aortogram in lateral view showed a long tubular ‘type C’ PDA with narrowest diameter measuring 8.8 mm [Figure 1a].[7] The calculated Qp/Qs and the mean PA pressure were 3.2:1 and 45 mmHg, respectively. The PDA was crossed using a 5F multipurpose catheter (Cooks Medical, Bloomington, USA) and exchanged for 8F delivery sheath (AGA Corporation, Minnesota, USA). A12/10 DO (AGA Corporation, Minnesota, USA) was chosen for the closure. The check angiogram did not show any significant residual shunt after the deployment [Figure 1b] and the mean PA pressure was dropped to 24 mmHg. The device was successfully deployed and child was observed in the recovery room for 6 hours. TTE after 24 hours showed patent arterial duct. Fluoroscopy confirmed the embolized device in descending aorta with retention screw facing caudally [Figure 2a]. A trial of re-screwing of the device was thought of, since the position of the device appeared favorable for the retrieval. A 9F long arterial sheath- ‘primary sheath’ (Cook Medical, Bloomington, USA) was positioned in the descending aorta. The sheath was gradually advanced over the retention screw using both anteroposterior and lateral fluoroscopy views. A 6F delivery sheath- ‘secondary sheath’ was introduced and advanced in the previously positioned primary sheath up to the retention screw. The secondary sheath could be easily positioned around the retention screw. Then the delivery cable was advanced inside the sheath close to the retention screw. The delivery cable was manipulated to fall in the slot of retention screw. Then the cable

ABSTRACT

We report the successful re-screwing of the embolized duct occluder (DO) in three children for retrieval and to attempt redeployment. The DO was embolized into descending aorta immediately after the deployment in one child and within 24 h after the procedure in two further patients. The DO was re-screwed back by the DO delivery cable, using “sheath in sheath” in all three cases; however, successful retrieval could be done only in two. Repositioning in the patent ductus arteriosus (PDA) was done using the same device in those two children and surgical removal was needed in third child with perimembranous ventricular septal defect.

Keywords: Device embolization, device retrieval, duct occluder, patent ductus arteriosus
was rotated gently in clockwise direction to re-screw the device [Figure 2]. The device was retrieved using a secondary sheath into 9F primary sheath. An 8F Muller’s check-flow sheath (Cook Medical Inc, Bloomington, IN, USA) was positioned across the PDA. Then the same DO was repositioned obliquely to cover the entire length of the arterial duct. A check angiogram showed no residual shunt [Figure 3]. The device was successfully redeployed. The follow-up after 1 year showed well-positioned device in situ.

**Case 2**

A 3-year-old boy weighing 12 kg was diagnosed as congenital complete heart block (CHB) with a moderate PDA. The clinical evaluation showed heart rate of 70 bpm and continuous murmur on auscultation. The electrocardiogram (ECG) showed narrow QRS CHB. The TTE showed a 3 mm PDA with continuous left to right shunt. The aortogram in lateral view showed a 2.8 mm type ‘A’ PDA with good ampulla. The PA pressures were normal. A 6F delivery sheath was placed in the descending aorta and a 6/4 Amplatzer duct occluder (ADO) was used for the closure. The device was positioned in the ampulla and planned to release in right anterior oblique view [Figure 4]. The ADO was embolized into descending aorta instantaneously. Careful subsequent evaluation revealed improperly positioned device as there was gap between the aortic retention disc and ampulla.

The device retention screw in the descending aorta was facing cranially and felt unfavorable for the retrieval. And hence, a pigtail catheter was used from the pulmonary artery through PDA into descending aorta to manipulate the device keeping an 8 mm inflated Tyshak balloon (NuMED Canada Inc, Cornwall, ON, Canada) below the device to avoid further dislodgment. The device was manipulated to direct the retention screw to face caudally. A 7F long primary sheath was exchanged in the femoral artery and gradually advanced close to the retention screw using anteroposterior and lateral fluoroscopy views. Now a 6F secondary sheath was taken into the previously placed sheath and advanced gradually into the retention screw. A 3F delivery cable was advanced in the sheath and re-screwed the device gradually by clock-wise rotation like in the case 1. Now the same retrieved device was taken and repositioned properly with a constant pull into the PA. The angiogram in lateral view showed well-positioned device [Figure 5]. The follow-up assessment showed no residual shunt or malposition of the device.

**Figure 1**: (a) Aortogram in lateral view showing a large tubular PDA. (b) Positioning of DO before final deployment. PDA = Patent ductus arteriosus, DO = duct occluder

**Figure 2**: Cine fluoroscopy showing retrieval of embolized DO. (a) Embolized DO into descending aorta. (b) Lateral view showing re-screwing the device by the delivery cable; broken arrow - delivery cable, thin arrow - secondary sheath, thick arrow - primary sheath. (c) Re-screwing of DO. (d) Retrieval of DO into the sheath, additional guide wire in the femoral artery to secure the access

**Figure 3**: (a) Repositioning of the device well into ductus arteriosus. (b) Final angiogram showing obliquely positioned device

**Figure 4**: Aortogram in lateral view showing small PDA (a) right anterior oblique view showing position of DO before delivery (b)
**Case 3**

A 2.5-year-old boy weighing 9.2 kg referred for retrieval of embolized device from another hospital. He underwent transcatheter device closure of perimembranous ventricular septal defect using 8/6 Cocoon DO (Vascular Innovations Co. Ltd, Nanthaburi, Thailand) elsewhere. He became unstable few hours after the procedure due to device embolization. The fluoroscopy at our hospital showed embolized device into descending aorta with retention screw facing superiorly. As the position was felt unfavorable; a 6F Judkin’s right coronary guide catheter was introduced into descending aorta and manipulated the device to face retention screw caudally [Figure 6]. An 8F long flexor (Cook Medical Inc, Bloomington, IN, USA) primary sheath was positioned into the retention screw and a 6F Judkin’s right coronary guide catheter introduced as a secondary sheath. The device was re-screwed successfully using 3F delivery cable and attempted to pull the device into the primary sheath. But the device could not be retrieved into the primary sheath as the device became bulkier. Hence, the DO was again released into descending aorta by counter clockwise rotation [Figure 7]. Further attempts could not be considered using larger sheaths as the child’s weight was only 9.2 kg, with significant risk of causing vascular problems; this child was referred for surgical retrieval and management.

**DISCUSSION**

Portsmann et al., reported the first transcatheter closure of the PDA in 1971.[1] Thereafter various closure devices, occluders, and coils have been used to close by transcatheter technique. However, they had some limitations such as high incidence rate of residual shunting, complex, and large delivery sheaths.[8] ADO was introduced in 1999 which can be delivered through a relatively smaller delivery system.

It had been shown that the use of the DO was safe and the success rate of procedure was relatively higher than those with other devices. The published literature[3,4] showed occlusion rates of 100% with minimal complication rates of 2–3%. The multicenter trial of ADO showed major events like death, device embolization in 2.3%, and minor complication were 5% including hematoma of groin, transient arrhythmia, loss of pulse.[8] Embolization of DO device either into PA or descending aorta is one of the complications during transcatheter closure. It was mainly thought to be associated with undersized devices.[4,5]

Various techniques are used for retrieval of embolized occluders using goose neck snare and bioptome in routine practice. Ilyisoy et al., had described retrieval of embolized device into PA by goose neck snare.[6] Snaring may be challenging at times due to difficulties in catching...
the retention screw and a possibility of device distortion is always present. Moreover, the potential damage to the surrounding structures is a major concern. Surgical retrieval is probably safe in some of these situations where device embolization into PA in young children. Device embolization into descending aorta is probably due to improper position and anatomically abnormal arterial duct (type C and D). It may be possible in some cases to retrieve the ADO using the delivery cable if the position is favorable.

In our three cases, the embolized device could be re-screwed to the delivery cable successfully, but removed out of the body in two patients. The probability of negotiating the larger lumen sheaths into the retention screw is higher because of wider lumen; whereas, re-screwing is difficult within the wider diameter sheaths because of problems with approximation between the retention screw and delivery cable. The secondary sheath with lesser internal diameter alone may be difficult to position within the retention screw; whereas, can be easily approximated to retention screw when advanced through a larger lumen primary sheath which is already placed close to the device. We suggest based on our experience; to use ‘maximum permissible primary sheath for the femoral artery and minimum possible secondary sheath which takes the delivery cable’. The major limitation is to have a favorable position for the cable to re-screw the device back. The retention screw of the device should face caudally for this maneuver. Sheath in sheath position provides cable fixation adequately with the device. Otherwise roomy aorta will not allow cable to fix exactly on to the screw. The other disadvantage of this method is use of higher size arterial sheath which may not be permissible in small children like in our case 3.

In conclusion, retrieval of embolized DO into descending aorta is possible with delivery cable using sheath in sheath technique. This method prevents device distortion or injury to vascular structures if done meticulously.

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