Hybrid closure of atrial septal defect: A modified approach

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ABSTRACT

A 3.5-year-old girl underwent transcatheter closure of patent ductus arteriosus in early infancy during which time her secundum atrial septal defect (ASD) was left alone. When she came for elective closure of ASD, she was found to have bilaterally blocked femoral veins. The defect was successfully closed with an Amplatzer septal occluder (ASO; St. Jude Medical, Plymouth, MN, USA) using a hybrid approach via a sub-mammary mini-thoracotomy incision without using cardiopulmonary bypass. At the end of 1-year follow-up, the child is asymptomatic with device in a stable position without any residual shunt.

Keywords: Device, hybrid, mini-thoracotomy, sub-mammary

INTRODUCTION

Transcatheter device closure of atrial septal defect (ASD) has been widely accepted as an effective alternative to surgery in patients with secundum ASD having suitable anatomy. However, in the presence of bilateral femoral venous obstruction or inferior vena cava interruption, the procedure becomes challenging, especially in young children where it is difficult to insert large sheaths into the jugular or hepatic vein. With technological advances, minimally invasive surgery can now be performed with excellent results. However, the patient has to undergo operative trauma and cardiopulmonary bypass (CPB) with its known adverse effects. Therefore in patients with suitable anatomy, but no venous access, hybrid closure of ASD using mini-thoracotomy approach appears to be the most optimum strategy since it is cosmetically superior and there is no use of CPB.

CASE REPORT

A 3.5-year-old girl was born preterm with stormy neonatal course requiring admission to neonatal intensive care unit (NICU) for 6 weeks. During this period, the child had a surgery for tracheo-esophageal fistula and she underwent transcatheter closure of patent ductus arteriosus (PDA) using Amplatzer duct occluder I through the right femoral vein. She had a moderately large ASD, which was left alone at that time with a view to close it electively at a later date if it continued to remain hemodynamically significant. During her stay in the NICU, her left femoral vein was also cannulated for a venous access. After her discharge from the hospital, she was minimally symptomatic with occasional respiratory tract infections but had suboptimum weight gain. At three and a half years of age, it was decided to close her ASD, which continued to remain moderately large, using a transcatheter technique. At this point of time, she weighed 10 kg and had developed esophageal stricture, a complication of trachea-esophageal fistula repair. Hence, it was decided to perform the transcatheter procedure with transthoracic echocardiography (TTE) guidance.

In the catheterization laboratory, the child was found to have obstruction of both the femoral veins with multiple collateral channels. Multiple attempts to cross the femoral venous blocks met with failure. The procedure was therefore abandoned.

The available options were either a trans-jugular approach or a trans-hepatic approach. As the defect was moderately large, measuring 17 mm, a minimum of 8-9 Fr sheath would be required to deploy the device. This may have been difficult through the internal jugular vein considering the age and weight of the child. Since we had no experience with a trans-hepatic approach, we were reluctant to use it for the first time in such a small baby. Further, this approach has its own complications such as hemobilia,

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retroperitoneal bleeding, cholangitis, liver abscess, pneumothorax, hepatic vein thrombosis and rarely pulmonary embolism.[1] Taking this into consideration, a minimally invasive hybrid approach through mini-thoracotomy was planned with the help of our surgical colleague.

An informed consent was obtained. The procedure was carried out in the catheterization laboratory under general anesthesia. The right atrium (RA) was approached via a right sub-mammary incision in the right fifth intercostal space [Figure 1]. After opening the pericardium, a 5'0' Prolene purse string suture was placed on lateral wall of RA close to inferior vena cava-RA junction. The RA was punctured with Seldinger needle in the centre of the purse string suture through the intercostal space in the anterior axillary line away from the sub-mammary incision [Figure 2]. Once the free flow was obtained from the RA, a 0.021" guide-wire was passed and a 5 Fr short sheath was introduced over the wire into the RA. A Judkin's 5 Fr right coronary catheter was introduced into the left atrium (LA) and subsequently into the left inferior pulmonary vein (LIPV) [Figure 3]. A 0.035" Amplatz super-stiff wire (Boston Scientific, Natick, MA, USA) was then passed through this catheter and parked into the LIPV. An 8F TorqVue 45^0 delivery sheath (St. Jude Medical, Plymouth, MN, USA) was passed over the super-stiff wire positioned in the LIPV [Figure 4]. An 18 mm Amplatzer septal occluder was delivered by the pulmonary vein deployment technique [Figure 5]. The device was released after confirming its position on fluoroscopy and TTE [Figure 6]. The sheaths were removed and RA puncture sight was closed with the purse string suture. The sub-mammary incision measuring 2 cm [Figure 7] was closed using absorbable suture. Post-procedure, she made an uneventful recovery and was discharged after 36 hours. At 1-year follow-up, the TTE confirmed that the device was in an optimum position. There was no residual flow and none of the neighboring structures were encroached upon. The RA and right ventricular (RV) volumes have reduced remarkably with normalization of inter-ventricular septal motion.

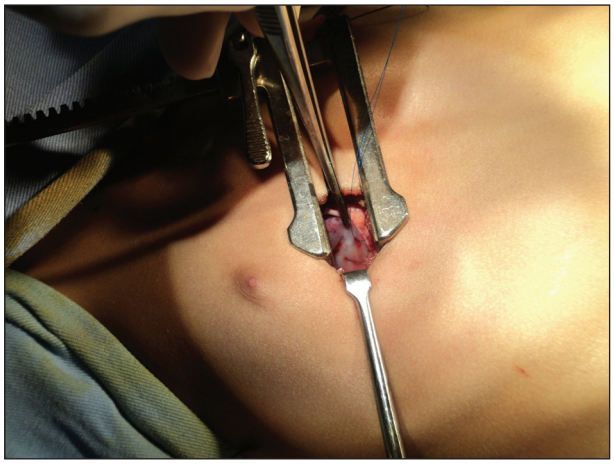

Figure 1: Purse string taken over right atrial wall through the right sub-mammary incision

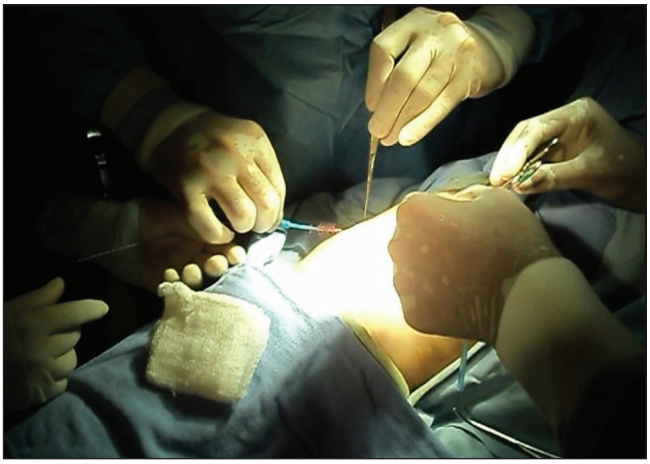

Figure 2: Puncture in the centre of the purse string suture through the intercostal space

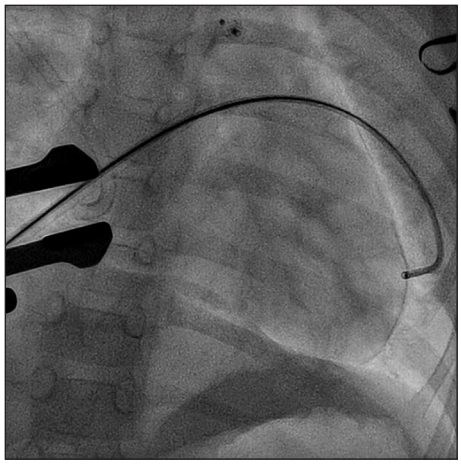

Figure 3: 5 Fr JR catheter placed in LIPV

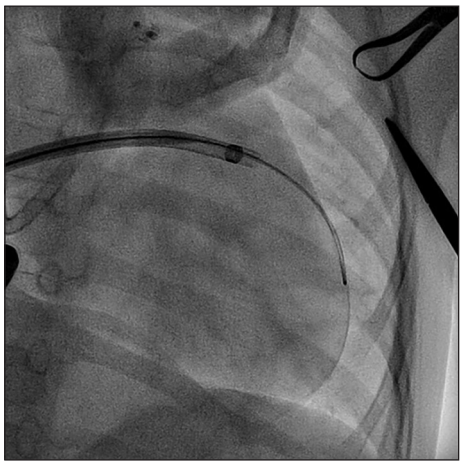

Figure 4: 8F TorqVue sheath being introduced over a superstiff wire into LA

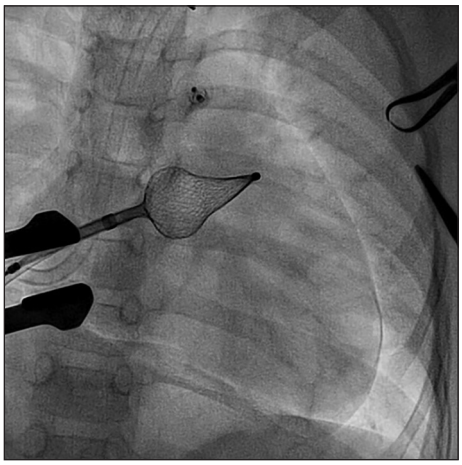

Figure 5: Deployment of 18 mm ASO by pulmonary vein technique

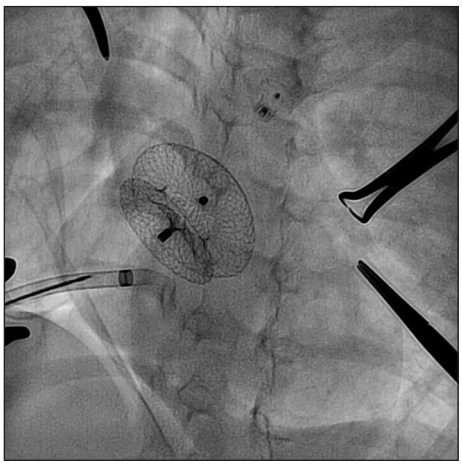

Figure 6: Final position of ASO after release

Figure 7: Scar (measuring 2 cm) as seen on the first postoperative day

DISCUSSION

In current era, surgical closure of ASD is performed with a very low morbidity, near zero mortality and with excellent long-term results.[2,3] However, operative trauma and a sternotomy scar can cause physical and psychological distress in patients. In addition, patients have to be subjected to CPB that has its own side effects.[4-7]

On the other hand, device closure can be performed only in patients with ostium secundum ASD with adequate rims. It is advantageous in terms of superior cosmetic results, less trauma, avoidance of CPB and a shorter hospital stay.[8,9] Although minimally invasive surgical approaches have been applied with better cosmetic results as compared to routine mid-sternotomy,[3] the restricted exposure of the heart converts a simple and safe operation into a technically difficult procedure that entails potential risks, such as injury to the great vessels and air embolism. It also does not take away the deleterious side effects of CPB.[4-7]

The advantage of hybrid procedure is that it offers good cosmetic outcome without the use of CPB. Moreover, there is no need for drainage tube and blood transfusion. Such an approach is less traumatic and therefore helps in quick recovery, shorter hospital stay and less pain. Our patient with suitable anatomy for device closure with limited access to the RA was thus most ideal for this approach. A large study by Li Hongxin *et al.*[10] has endorsed these benefits that were seen in our patient.

Technically, most of the hybrid procedures are done through the mid-sternotomy.[11] There is only one study, which has used mini thoracotomy incision in hybrid procedure to expose the RA.[10] In this study, the RA puncture and the subsequent procedure was also done through the same thoracotomy incision making manipulations a little cumbersome. Our modification includes use of lateral thoracotomy to only expose the RA and take a purse string suture. The subsequent procedure of puncturing the RA, passing the guide-wire, introducing the delivery sheath and deploying the device is done through an intercostal space in the anterior axillary line opposite the purse string suture [Figure 2] away from the mini-thoracotomy incision. This has two advantages viz., the ease of passing catheter, guide-wire, sheath and device as compared to passing them through the thoracotomy incision and second the plane of the inter-atrial septum is more perpendicular through this access. Both these advantages are evident in our case.

However, with this technique (as with others), there is a small risk of device embolization. If the device embolizes to RA or RV, the device can be retrieved through the same sub-mammary incision, after going on CPB. But if the device embolizes to LA or left ventricle, the strategy will have to be revised to midline sternotomy.

In conclusion, hybrid procedure for closure of ostium secundum ASD is a good alternative to conventional surgical repair in selected patients with adequate rims where access to RA is difficult.

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