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Case Report

Transcatheter closure of patent ductus arteriosus – experience with the 'Direct duct technique'

Anil Madan Potdar, Devendra Vijay Patil, Jivtesh Singh Pahwa, Ankur Ulhas Phatarpekar

HJ Doshi Hindu Sabha Hospital, Ghatkoper, Mumbai, India

ABSTRACT

Transcatheter closure of a patent ductus arteriosus (PDA) is a frequently undertaken interventional procedure. The crossing of PDA is an important step during this procedure. We present our experience with the 'Direct duct technique' – a novel simpler technique of crossing a PDA using a multipurpose catheter parked at the inferior vena cava and right atrium junction.

Key words: PDA crossing, novel technique, multipurpose catheter

Correspondence:

Dr. Devendra Vijay Patil

1004, Lakeside CHS, Raheja Vihar, Chandivili, Powai, Mumbai - 400076

devendrapatil161185@gmail-com

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INTRODUCTION

The transcatheter closure of patent ductus arteriosus (PDA) is frequently undertaken. We present our experience with the direct duct technique – a novel simpler technique of crossing a PDA using a multipurpose catheter parked at the inferior vena cava and right atrium junction.

METHODS

Patients with suspected PDA underwent thorough clinical examination, chest radiography and transthoracic echocardiography evaluation to determine their suitability for transcatheter closure of PDA. From January 2014 to January 2016, 42 patients (25 female and 17 male) aged between 4 to 12 years with isolated small to moderate sized restrictive PDA were included in this study. None of the patients had other associated lesions that warranted treatment or intervention. Transthoracic echocardiography was done to demonstrate the PDA, its size and shape. The aorto-pulmonary gradients were estimated using modified Bernoulli equation. All patients underwent transcatheter PDA closure using the 'direct duct' technique. Patients were taken for transcatheter closure under suitable anaesthesia/sedation. A right femoral venous and arterial access was established. A 5F Pig tail catheter was advanced over the arterial access and parked just distal to expected aortic end of the PDA. A motorised pump angiogram was done in the lateral projection to define the size and shape of PDA. Occasionally, the more leftward oriented PDA was better profiled in rightward angulated projections. PDA measuring less than 2.5 mm at their narrowest diameter was not included in this study. The device size intended was 2 mm larger than the narrowest diameter. A 5F/6F multipurpose catheter was advanced over the venous access and parked at the junction of the inferior vena cava and the right atrium. With the catheter facing towards the left shoulder, a 300 cm (double length) 035' inch hydrophilic Terumo guide wire (Terumo Medical Corporation, Tokyo, Japan) was advanced and probed towards the right ventricular outflow and subsequently through the ductus into the descending aorta. **(Figure 1) (Online Video Supplement 1)** The Multipurpose catheter was exchanged for the device delivery sheath over the already parked guide wire. This delivery sheath was then guided across the PDA over the guide wire. Care was taken that the exchange is done under close fluoroscopic guidance to avoid guide wire-backout and loss of access across the PDA. The guide wire and delivery sheath dilator were then withdrawn. A suitable size Cocoon duct occluder (Vascular Innovation Co., Nonthaburi, Thailand) was then duly deployed. A final distal aortic arch angiogram was done to confirm the final position of the device. The pigtail catheter was then used to demonstrate pullback gradients across the aorta. A transthoracic echocardiography was done to confirm the final device position, residual shunt and complications if any. The procedural and fluoroscopy time were noted.

The length and diameter at the narrowest point of the PDA ranged from 3 to 10 mm (median 6.2 mm) and from 2.5 -4 mm. The pre-crossing aortogram revealed megaphone (Krichenko type A) ducts in 38 patients (90%) and tubular (Krichenko type C) ducts in the remaining 4 patients. 40 patients (95%) underwent successful crossing of the duct using the novel technique. We had to resort to the standard technique in 2 patients (5%). In 26 (62%) patients the PDA was crossed in the first attempt, while in 14 (33%) patients, two attempts were needed. There were no procedure related complications. Temporary loss of peripheral pulses was noted in one patient. There were no technical difficulties in advancing the delivery sheath over the guide wire in any patient. There was one occasion a patient wherein the guide wire was unable to support the delivery sheath but gentle manipulation prevented significant back-out and loss of access. There was procedural success in all 42 patients. No patient had significant hemolysis, left pulmonary artery and aortic obstruction due to the device. 3 patients had mild residual shunt which was not seen a month later on echocardiography. There was no procedural mortality.

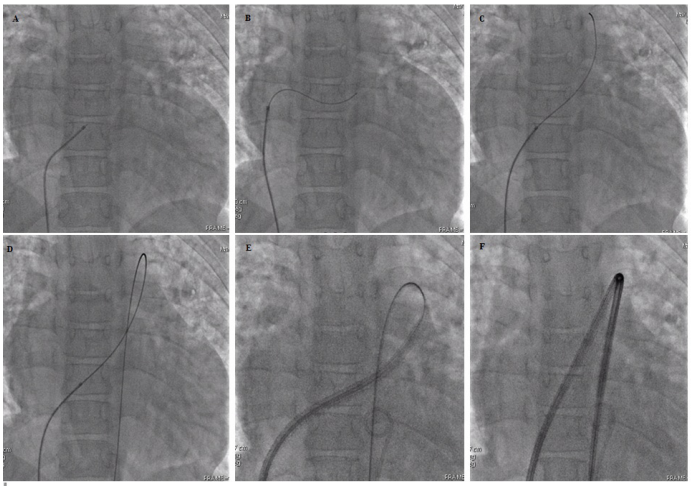

Figure-1: Fluroscopic still frame images showing (A) the multipurpose catheter parked in the right atrium at the IVC junction facing the left shoulder. (B) Probing in the direction of left shoulder using a hydrophilic guide wire and (C) reaching the pulmonary artery across the right ventricular outflow tract (RVOT) and finally (D) across the patent ductus arteriosus (PDA) into the descending aorta. (E) Advancing the delivery sheath over the hydrophilic guidewire first across the RVOT and then (F) across the PDA into the descending aorta.

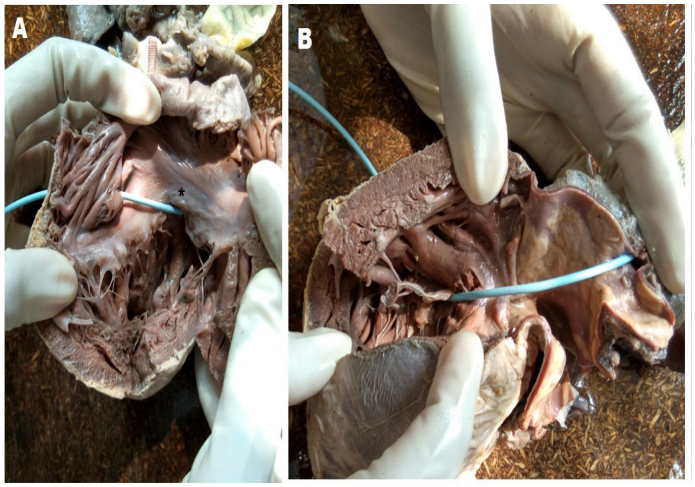

Figure-2: Pathological specimen of heart (A) showing the right atrial and ventricular structures with a catheter positioned across the inferior vena caval aperture and passing across the junction of septal and anterior tricuspid leaflet (marked as *) from the right atrium to the right ventricular outflow tract (RVOT). (B) the same specimen with catheter now advanced across the RVOT and the patent ductus arteriosus.

DISCUSSION

Transcatheter closure of PDA is a safe and effective therapeutic modality.[1-3] It has largely replaced surgical ligation in different age groups. Currently, surgical intervention is restricted to premature babies or small infants with large symptomatic PDA, when there are associated other cardiac defects requiring surgical intervention or patients with unfavorable duct anatomy. The technique of crossing a PDA while attempting transcatheter closure generally requires probing a straight tip guide wire across the PDA retrograde to the flow. However, antegrade crossing has also been described. The complication rates are quite low include residual shunt, left pulmonary artery (LPA) obstruction, protrusion of the device into the aorta, and embolization of the device.

During transcatheter intervention, a Judkins right coronary catheter is parked in the main pulmonary artery. This needs negotiating the catheter into the right ventricle across the tricuspid valve and requires use of a pre-shaped guide wire to cross the tricuspid valve. The catheter is then rotated anticlockwise to face the right ventricular outflow tract and advanced across the pulmonary artery. A 300cm (double length) straight tip guide wire in probed in the direction of PDA to cross it. In our study, we could demonstrate an easier technique to cross the PDA that obviates the need for a catheter to first enter the right ventricle and then its outflow tract. A multipurpose catheter was placed at the inferior vena cava and right atrium facing laterally towards the right ventricle outflow tract. The probing towards the left shoulder using the straight tip guide wire first crosses the tricuspid valve at the junction of the anterior and septal tricuspid leaflet to enter into the RVOT. It then gets reflected from the septal aspect of the RVOT and crosses the pulmonary valve. **(Figure 2)** A PDA is oriented posteriorly, inferiorly and leftward to reach its aortic end. The unique and favourable anatomy of the PDA falls in line of the advancing guide wire. Though the possibility of the guide wire entering the left pulmonary artery remains, it is slightly more leftward. In our experience, the PDA was crossed in the first attempt in 62% patients, and at the second attempt in 33% of patients. Embryonically, the right ventricular outflow tract is in line with the ductus. This facilitates right ventricular output to majorly cross the ductus to reach the descending aorta with minimal energy loss. Probably, it is this anatomy and the hydrophilic nature of guide wire that comes to our advantage while crossing the PDA. Also, the guide wire provides adequate support to advance the delivery sheath. Francis et al[4] in their study have used a similar technique in preterm infants but using a right Judkins catheter instead of a multipurpose catheter. We believe that the primary curve of the multipurpose catheter aligns more in the direction of RVOT than a right Judkins catheter in children and adolescent patients. Our technique obviates the need of multiple guide wire exchanges and therefore the fluoroscopic time needed to cross the PDA.

LIMITATIONS

This is a single centre experience in a small patient population and lacks control group. The standard technique of transcatheter closure of PDA is relatively straightforward and safe and hence a large patient group would be needed to demonstrate significant differences. The hemodynamic significance of PDA was assessed clinically and using transthoracic echocardiography. Invasive hemodynamic assessment prior to crossing the PDA was not

done. Post device deployment, angiograms in caudal angulations to demonstrate left pulmonary artery ostial stenosis was not done and transthoracic echocardiography to assess this complication. Our patient subset did not include adult and different types of PDA.

CONCLUSION

Crossing a PDA using the 'direct duct' technique is feasible, safe and reasonably easy to perform.

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CONFLICT OF INTEREST

None.

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