

Transcatheter closure of Ventricular Septal Defects (VSD): Preliminary results in children weighing 10 kg or less

Abstract

In this review, we provide a brief description of recently published article on transcatheter closure of Ventricular Septal Defect (VSD) in children weighing less than 10 kg. Our aim is to provide a summary of the latest article published recently in another journal in this field. The articles address (1) Safety and feasibility for transcatheter closure of VSD in babies less than 10 kg as an alternative to surgical closure (2) Short- and long-term complications related with the procedure (3) Off label use of newer less traumatic devices meant to close other lesions safely to close VSD. (4) Focusing on meticulous pre procedure echocardiography and planning.

Keywords: Ventricular septal defect • Transcatheter • Safety • Less than 10 kg

Introduction

Ventricular Septal Defect (VSD): Treatment options

VSDs initially create a volume load to the left heart, and the magnitude of hemodynamic impact is directly related to the size of the shunt and afterload to the ventricles. Isolated VSDs are the most commonly encountered form of CHD in the paediatric population [1-3]. Surgical closure of VSD was first described by Lillehi et al. in 1954 and it continued to be regarded as the gold standard treatment. However, over the past 10 years percutaneous trans-catheter device closure has emerged as a safer alternative especially in case of muscular VSDs, though now significant number of Perimembranous VSDs are being closed percutaneously [4-8].

Literature Review

The present study was undertaken in newly established tertiary referral center and receives patients from adjoining districts. Relevant data were obtained retrospectively from the case files and the catheterization records and data was analyzed for total 50 patients with VSD weighing 10 Kg or less were taken to Cath lab for percutaneous VSD closure out of which 45(90%) had successful transcatheter closure and 5 (10%) cases were unsuccessful and subsequently send for surgical closure.

Inclusion criteria

Patients were selected according as per the surgical indications for isolated VSDs: Hemodynamically significant VSD, refractory heart failure with medications; repeated respiratory infection; Failure to thrive, evidence of left-heart volume overload which was considered as per (LA/LV size z score ≥ 2) and $Q_p/Q_s > 2.0$. Any patient with ≤ 10 kg with VSD amenable for device closure and meeting the above criteria were taken up for the study.

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Exclusion criteria

Malaligned VSD especially those with inlet extension, VSD with aortic valve prolapse with any degree of AR, VSD with any other associated heart defect that needs surgical closure otherwise.

Procedures

All the parents were informed about the procedure; its complications and written consent were taken from each of them before the procedure. The procedure was performed under conscious sedation in 30 patients and only in 3 patients under General Anaesthesia (GA) where the VSD was approached *via* Right Internal Jugular (RIJV) route. A single dose of intravenous antibiotic was administered 30 minutes prior to procedure. The Right Femoral Vein (RFV) and Right Femoral Artery (RFA) access was taken percutaneous in all 45 cases while in only 3 cases additional Right Internal Jugular Vein (RIJV) was also taken in addition with RFV and RFA. Right heart catheterization was performed and basal systemic and pulmonary arterial pressures were taken and ratio of pulmonary to systemic blood flow (Qp/Qs) were calculated (Qp/Qs>2.0 were considered significant and was considered for closure). LV angiogram was done in LAO-30/CRA-20 and LAO-60/CRA-30 to define the VSD as per unit policy. In patients with severe PAH reversibility testing was also done and VSD was closed only if it is reversible. Selection of device was done based on the measurement on echo and angiography. The VSD was crossed from the LV side (retrogradely) in all 37 cases. After crossing with Terumo Guide Wire M 0.035" 260Cm J Angled Tip (RF*GA35263M) AV loop was formed in 20 cases while in 25 cases VSD devices were deployed in retrograde fashion without forming AV loop. Device was delivered as per the standard technique under fluoroscopic and echo guidance (TTE and also TEE in few cases). Post procedure, the patients were monitored in the intensive cardiac care unit for 24 hrs. A close monitoring was done for any evidence of intravascular haemolysis and device embolization. Patients were discharged after 48 hours of observation. All cases were followed at 1 month, 3 months, 6 months at 1 year post procedure and every year thereafter as per policy of the Unit. Improvement in functional class and weight gain was noted. The patients were evaluated clinically for any evidence of worsening. At follow up echocardiography, the position of the device was confirmed and residual shunt if any was noted. The presence of AR, TR was looked for and TR gradient was recorded along with LA and LV dimensions.

Discussion

Among these 45 patients, 19 were females, 26 were male and the mean age was 27.5(4- 48 months). The mean weight in this study was 7.46 Kg (2.3-10 Kg). Mean VSD size was 5.46 (3-12mm), 25 patients had VSD sizes between 3 to 5mm, 16 had between 5- 10 mm and 4 with more than 10 mm. Among types of VSD, 32

cases were having Perimembranous, 7 were upper muscular, 2 were mid while 2 were lower muscular and only 2 had outlet muscular VSDs. Simultaneous measurements of Pulmonary artery (PA) pressure and Aortic pressure was done which revealed 18 patients with normal PA pressure (No PAH), 11 patients (24.4%) with PA pressure>2/3rd of systemic pressure (Severe PAH) which was reversible on oximetry testing, while other 3 patients were having PA Pressure between 1/2to 2/3rd of systemic pressure (Mild and moderate PAH). Mean Qp/Qs was 3.5((2.5-6.5). As far as route for device deployment is concerned 25 devices were deployed in retrograde fashion *via* femoral artery through 5F Guiding JR (ADO-II), in 17 cases we have deployed devices in ante grade fashion *via* Right femoral vein and in 3 cases with mid muscular and lower muscular VSD we have used Right Internal Jugular vein to deploy the devices. Amplatzer Duct Occluder (ADOI) was used in 16 cases, 26 were closed with Amplatzer Duct Occluder (ADO2) and the 3 were selected for closure with Amplatzer Muscular VSD occluder. Transthoracic Echocardiography (TTE) in immediate post intervention period revealed all these devices in situ with no or minimal residual flow which subsided within 24hrs period in these 45 cases. As far as complications are concerned, we had 2 device embolization noted in our study and also one rhythm complication Complete Heart Block (CHB) which has discussed separately in detail under unsuccessful attempts. Tricuspid regurgitation TR was noted at the time of discharge and in 4 patients but subsided after 48 hours in 3 patients while Aortic regurgitation was noted (Trivial) in one case which is under close follow up and not increasing in severity after 6 months follow up.

Transcatheter closure of VSD is increasing become popular alternative to surgery, however both the procedures are not free from adverse effects like systemic inflammatory reactions from CPB, intra-operative cardiac arrest, and blood products transfusion for cardiac surgery can cause significant morbidity in children. Likewise thin peripheral vessels in low-weight infants and radiation exposure for trans-catheter intervention are major deterrents. For infants with low body weight, catheters are difficult to manipulate, leading to increasing cardiac catheterization time and radiation, trauma while manipulations causing significant aortic or tricuspid insufficiency or sometimes injury to the conductive system leading to various degrees of heart block.

In this study we aimed to share the experience of our center and to show that percutaneous closure of VSDs with device in small children by weight is a safe and effective method with low complication rates. The most common defect in our study was Perimembranous VSD and majority of it was closed with ADO II septal occluder and we did not face any conduction issue in any of the case, this could be due to the design of the ADO II device which is soft in nature with no polyester material that does not apply a direct force on conduction system as shown by Vijayalakshmi et

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al in their study [9]. Rest of the defects were closed with ADO I device and all the defects were having some degree of aneurysm; this device was designed for PDA closure. The first report that described that ADO could be used for VSD closure was by Tan et al., 2005 also Dilawar et al., 2008 reported three cases which were closed with ADO I [10,11].

Most tricky one was the closure of outlet VSD, we have excluded the sub arterial doubly committed outlet VSD which does not have any tissue between upper margin of the defect and semi lunar valve, besides these defects are very prone aortic cusp prolapse and development of AR. The closure of outlet muscular defect was done with ADO II device, again with above obvious reason. ADO II has low-profile retention discs that can sit better in the defect without disturbing the aortic as well as tricuspid valve. Kanaan et al in their study has reported a success rate of 93.5% with closure with ADO II [12]. The closure of the defect also protects against the aortic valve prolapse which has a high incidence in outlet VSD. There was no immediate complication but long term follow up is required for the final outcome.

As for the muscular VSDs most of them are relatively far from the AV valve, so amenable for device closure also there are less chances of conduction abnormalities with the device deployment. Besides some of the muscular VSDs, especially those in the apical or anterior region of the ventricular septum, direct surgical repair with CPB and cardioplegic arrest can present significant difficulties. In our study we were able to close quite larger muscular defects, especially in a 2yr old with severe PAH whom we close it with a 14mm Amplatzer muscular device.

Device closure of Perimembranous VSD is gaining popularity with less morbidity and comparable results to surgery. A recent meta-analysis from 54 publications with 6762 patients had showed nearly 98% success rate with the residual shunt (15.9%) and rhythm abnormalities (10.3%) as the commonest complications [13]. With new improved and even customized devices for each patient this procedure is likely to gain more acceptance.

Study limitations

Limitations of the present study are the lack of long term follow up. More studies with a larger number of patients and a long term follow up is required to analyze the safety and efficacy of transcatheter closure of VSD in this age group.

Conclusion

Although surgical repair of VSDs is a safe, widely accepted procedure but it is associated with morbidity, discomfort and a scar. As an alternative to surgery transcatheter closure of VSD

with different devices is a good option with better results. With the current availability of devices for VSD closure, transcatheter closure of VSD can be considered as safe and efficacious in children weighing 10kg or less with good mid-term outcome though a long term follow up is still needed. The procedure had a low rate of complications even with the initial experience at a newly established catheterization laboratory.

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