

Hybrid Closure of Ventricular Septal Defects in Varying Scenarios - Qatar Experience

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Abstract

Hybrid closure of ventricular septal defects provide beneficial effects of surgical and percutaneous closure while avoiding major complications of a surgical procedure and limitations of percutaneous technique. We report a series of 4 patients who underwent periventricular device closure of muscular ventricular septal defects. The median age of the patients were 12 months (range 6 months to 34 months) and median weight 8.5 kg (range 4.5 kg to 11 kg). The median size of the device used was 10 mm (range 6 - 10 mm). All the 4 patients were successfully discharged home.

Keywords: Cardiac Surgery; Ventricular Septal Defects; Pediatric; Hybrid Procedure

Introduction

Muscular ventricular septal defects (mVSDs) constitute approximately 20% of the total ventricular septal defects [1]. Significant left to right shunt causes congestive heart failure and pulmonary hypertension. Percutaneous techniques have been developed in order to avoid the undesirable side effects of open heart surgery such as cardio-pulmonary bypass (CPB), aortic cross-clamping and surgical trauma. Although percutaneous closure of mVSDs has been employed safely and effectively in children, adolescents and adults, its application in small infants (weight < 5 kg) carry a higher risk for complications including arrhythmias, hemodynamic compromise, cardiac perforation, tamponade and death in addition to the limited vascular access [2]. Surgical closure is the gold standard for treatment of peri-membranous VSDs due to the high incidence of heart block (1 - 5%) associated with the device closure of these defects [3]. Incidence of residual VSDs remains high after surgery especially for VSDs located apically or anteriorly as they are difficult to identify when the heart is arrested on CPB. Periventricular closure of such defects, introduced by Amin and coworkers in the late 1990s, has become an attractive treatment modality. Hybrid procedures allow one to combine the beneficial effects of both forms of treatment and avoid the complications of a surgical procedure and limitations of percutaneous technique. Hybrid procedure is performed by the surgeon and cardiologist together in a hybrid room.

Material and Methods

We present a series of 4 patients who underwent periventricular device closure of muscular VSDs. The study was approved by our institutional review board with a waiver of informed consent. Patients with single or multiple muscular VSDs, either as isolated defects or accompanied by other cardiac lesions, who also might have undergone initial palliative treatment in the form of pulmonary artery banding with aortic arch repair in early infancy were included in the review. Informed consent was obtained from the parents after thorough discussion regarding the nature of the disease and the alternative forms of treatment available including the merits and demerits of each treatment. The study consisted of children with muscular VSDs with significant left to right shunts ($Q_p:Q_s \geq 1.6:1$), signs of LV overload

(LV enlargement, mitral insufficiency or left atrial enlargement) on ECHO. Patients underwent a thorough clinical evaluation with echocardiographic and a diagnostic cardiac catheterization assessment preoperatively.

Patients were prepared as for a classical cardiac surgical procedure. The location of the mVSDs is identified precisely with the help of transesophageal echocardiography with or without additional epicardial echocardiography. A purse string suture was then placed on the right ventricular free wall perpendicular to the mVSD. An optimal puncture site was chosen by gentle palpation of the right ventricular free wall. An appropriate needle was introduced into the RV cavity through which a guide wire was passed before removing the needle. The guide wire is then maneuvered through the mVSD. A sheath dilator is passed over the guide wire. The tip of the dilator must be followed at all times as injury to LV structures is a possibility. Under echocardiographic guidance the device is positioned carefully and the purse string suture is tied. A routine standard monitoring is used for all cases. The heparin infusion (Target APTT 60-90) is continued until an oral acetylsalicylic acid is administered (10 mg/kg body weight /day) and then the same is continued for 3 - 6 months.

Results

We retrospectively analyzed the medical records of 4 patients who underwent perventricular closure of muscular VSDs from January 2012 till end of 2016. The median age at the time of the procedure was 12 months (6 months to 34 months). The median weight of the patient was 8.5 kg (4.5 kg to 11 kg). Three patients had previous pulmonary artery banding with coarctation repair and were operated through median sternotomy while 1 patient having multiple VSD was operated through a limited sternotomy. The median size of the device used was 10 mm (range 6 - 10 mm). Concomitant atrial septal defect was present in 3 patients. In 1 patient 10 mm device occluder was used for closure of the concomitant atrial septal defect on a beating heart. Atrial septal defect was closed on cardiopulmonary arrest in 2 patients as the defect was not suitable for device closure.

Discussion

Although surgical closure is the gold standard for the treatment of mVSDs, the management of significant apical mVSDs for small babies especially with associated cardiac problems is a difficult decision. The main aim of this review was to evaluate hybrid approach as an alternative option in symptomatic small infants with concomitant abnormalities where multiple interventions may be required.

The first successful case of intraoperative perventricular device closure of muscular VSD on the beating heart in an infant was reported by Amin, *et al.* in 1998 [5]. Subsequently the device closure was used in post myocardial infarction VSDs as well. The prolonged radiation exposure associated with percutaneous procedure carries long-term undesirable and potentially detrimental side-effects [7,8]. Hybrid procedures help to avoid CPB and its complications. It also helps to avoid the necessity of vascular access with big sheaths in small babies for device implantation [6]. The hybrid approach offers the following advantages like a direct control during defect closure, without much hemodynamic compromise. The failure rates are less and any other co-existing defects can also be corrected. It is performed under echocardiographic guidance and hence radiation exposure is avoided. In our patients, other cardiac procedures like surgical closure of ASD or pulmonary artery de-banding were also done. The echocardiographer plays a very important role with imaging during safe catheter manipulation, device delivery and deployment and also assessment of the device position after release [9]. The LV dimension is very small in neonates and small infants making the space for device manipulation very limited.

The visualization of mVSDs can be difficult through a usual right atrial approach in an arrested heart as it could be hidden inside the right ventricular trabeculations. Though a left ventriculotomy approach gives a better visibility, it can cause significant undesired effects like left ventricular dysfunction, aneurysm and arrhythmias. Therefore, in some patients where the localization of muscular VSD using cardioplegic arrest is difficult, the heart function is "restored" and mVSD is closed perventricularly on the beating heart with a VSD occluder. The device used in our practice was the Amplatzer VSD Occluder (AGA Med. Corp., USA) with self-expandable double-discs made from nitinol wire mesh. The Amplatzer Duct Occluder II might suite the small hearts better because of its small discs.

Patients with multiple VSDs don't need multiple devices to close all the VSDs as shown by Gan., et al. where the smaller defects abolished after the largest and most central defect device closure [10]. This could happen by compression of muscle bridges between the defects by the device or the discs may partially cover the adjacent ones.

Smaller body weight less than 5 kg is thought increase the risk of complications in hybrid patients [2]. Our smallest patient was 4.5 kg, 6 months old baby with multiple mVSDs who had successful hybrid mVSD closure with 8mm and 6mm devices without any complications. Device embolization, cardiac perforation and even intraoperative deaths are reported following hybrid procedure. Bleeding, hypotension, hematoma, heart block and tachy arrhythmias, valve injury, stroke, and device-induced hemolysis are also reported [11-13]. Avoiding inlet type of defects can reduce heart blocks.

The major limitation of our review is the small number of patients and we did not follow up our patients for long term. Our promising results suggest the value of offering hybrid treatment to patients undergoing surgical procedure for other concomitant heart defects and for additional residual apical mVSDs detected after coming off bypass which are otherwise difficult to identify on arrested heart.

Conclusion

Hybrid closure of ventricular septal defects appears to be a safe procedure in selected subgroup of patients. We had a good success rate of closure of the VSDs without any mortality or major complications.

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