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Editorial

Hybrid muscular ventricular septal defect closure: *Surgeon or physician*!!

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Webster dictionary defines, "hybrid is a union or offspring of two distinct species either animal or plant". Some may argue that surgeons and interventional cardiologists are definitely two different species (John P. Cheatham).

Perventricular device closure is performed by both surgeon and cardiologist in hybrid suit or operating room combining catheterization and surgical techniques have been described elsewhere.[1] This hybrid procedure is useful in a subset of infants, who are otherwise at high risk for surgery or interventional closure. Amin et al first reported successful perventricular device closure in an infant with post operative residual mVSD.[2] The indications and guidelines for hybrid perventricular device closure have not been clearly described in literature. However, most of the published data suggests that small babies lesser than 5 kg, children with muscular ventricular septal defects (mVSDs) and other associated cardiac defects requiring simultaneous repair, who are otherwise at high risk for surgical closure are probably ideal for perventricular device. There is no absolute contraindication to this technique. The present series in this issue by Thakkar et al is probably one of the largest single centre series of perventricular device closure in young children. The authors are congratulated for the nice piece of work in this difficult subset of population. Their study elaborates the technique, complications and outcome of the procedure.[3]

The basic question is 'why a perventricular device closure should be performed'? When surgery or intervention alone are not giving any satisfactory result for a given problem or when the combination of two fields become less traumatic to the patient with a better final outcome. The major advantages are: *from surgeon's view;* i) easy accessibility of mVSD even in difficult locations ii) no palliative pulmonary artery banding or ventriculotomy required to close the apical mVSD iii) no ill effects of CPB; *from cardiologist's view;* i) no limitation for vascular access and sheath size ii) no hemodynamic instability due to arterio-venous looping iii) septum can be approached from anterior (perpendicular angle) but, not from a lateral (tricuspid valve) plane.

The patient population of present study in this issue by Thakkar et al is much younger with a mean weight of <5 kg in less than 6 months of age. The surgical closure of mVSD in younger infants carries higher risk for residual VSD and ventricular dysfunction due to ventriculotomy. Yeager et at reported as high as 7.8% mortality in their series.[4] The subset of population in the current series seems to be ideal for perventricular device closure. They have successfully closed the defect in 21 of 24 patients. However, the complications include – two procedure related deaths, esophageal tear and development of complete heart block. The authors of this study included only isolated muscular VSD however; this hybrid method is useful especially in closing difficult VSDs associated with complex congenital heart defects like double outlet right ventricle, D-Transposition of great vessels.

Technical issues of the perventricular device closure include; first the optimal puncture site on the right ventricle to have a favorable perpendicular angle to cross the defect with a guide wire, second the placement of introducer sheaths. Identification of puncture site on free wall of right ventricle is an important step for the success of perventricular closure. Crossland et al, described indentation of the right ventricle by the surgeon's finger until echo demonstrates a bulge perpendicular to the VSD.[5] The puncture area should be free from any coronary artery and second the indentation by the index finger should correspond to the mVSD. This will give perpendicular angle and paves easy route for insertion of sheath and deployment of the LV disc. A close collaboration

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between surgeon and interventional cardiologist is utmost necessary to achieve superior results at this point. Bacha et al, described transcatheter crossing of VSD and snaring by perventricular approach in difficult mVSD.[6] One of the drawbacks of transcatheter closure is malalignment of the device during deployment due to lack of control on the delivery sheath and it can be overcome by this method. The authors of the present study followed the traditional method of pre-soaking the device in the patient's own blood to prevent immediate intra-device shunt. This practice is no longer followed due to the quantum of transient shunt is insignificant.

The authors of this study took all steps to reduce the cost significantly by doing first 18 cases in operating room and subsequently in cardiac catheterization laboratory after gaining experience. At present, there are hardly any hybrid suits in the country performing procedures essentially, because of the cost and lack of infrastructure. Development of indigenous hybrid suits and accurate planning of the space will probably solve some of these problems.[7] The muscular occluder used in the present study was Cardi-O-Fix (Starway Medi Tech, Inc. Beijing, China) has similarities with Amplatzer mVSD occluder. This was preferred again, probably because of its low cost. Moreover, less ventilator time and hospital stay reduces the expenditure. This procedure is devoid of ill effects of CPB.

The complication rate appears to be minimally higher however; the subset of patient population is much younger and all presented either with heart failure, respiratory infection or malnutrition. Twenty-one of 24 were successfully treated with this hybrid procedure and only three patients were converted surgically after an initial attempt of perventricular closure. Important steps to be taken to prevent injury to the cardiac structures are viz., the dilator tip should not be inserted too deep to injure the left ventricular (LV) posterior wall. The sheath-dilator length within the heart should never be more than the measurement of distance from the right ventricular (RV) free wall to LV internal dimension by echocardiogram. The introducer and dilator are stiff instruments designed for percutaneous puncture. The dilator can easily straighten the glide wire and cause perforation of the LV posterior wall. Marking on the sheath which corresponds to distance from external surface of RV free wall to internal dimension of LV will help to prevent excess insertion of the sheath-dilator assembly. The other useful markings on sheath and cable are distance from the free wall to mVSD, so that the device can be released approximately at the LV side of the septum. With utmost precautions, the authors could manage to position the sheath and device accurately in most cases. The LV disc should be released away from the mitral apparatus under TEE monitoring. Rarely, bulky device in a small baby may produce LV outflow tract obstruction. Careful selection of the cases will prevent these rare but significant complications.

The mechanisms of CHB in the present series are unknown hence; close follow up is needed even in mVSD. Two patients developed CHB needing permanent pacemaker in one. The stress by the device beyond the perimembranous septum probably produced conduction disturbance. Ventricular arrhythmia is an interesting complication of the study and the authors have documented electrolyte distur bance as a provocative factor; the irritation by the device could have triggered the arrhythmia in this child in the presence of hypokalemia. The electro thermal energy released during the trans-esophageal echocardiogram (TEE) always should be taken into consideration especially in younger children. The duration of TEE is important apart from the size of the TEE probe to produce esophageal tears. Hemodynamic instability and blood loss during the procedure are other complications of perventricular device. On contrary, transcatheter closure of mVSD is not totally devoid of complications, Holzer et al, in their multicenter study showed major complications in 10.7% of population such as device migration, wire perforation and hemodynamic compromise due to arrhythmia, and the overall incidence rate was as high as 45%.[8] Most of the patients in the present series were benefitted and showed improvement in heart failure and malnutrition on follow up.

The fundamental question to be asked while balancing the judgment before doing perventricular device is *what is the risk benefit ratio to the patient?* Bach et al, in their multicenter study showed good results in three groups of patients. They did not encounter any complications and all 12 patients were asymptomatic at median follow up of 12 months.[9] Nevertheless, the risk of surgery or interventional closure should be weighed against the minimally invasive perventricular closure in this subset of patients.

REFERENCES

1. Bacha EA, Cao QL, Starr JP, Waight D, Ebeid MR, Hijazi ZM. Perventricular device closure of muscular ventricular septal defects on the beating heart: technique and results. *J Thorac Cardiovasc Surg*. 2003;126:1718–1723.
2. Amin Zahid, Berry James M, Foker John E, Rocchini Albert P, Bass John L. Intraoperative closure of muscular ventricular septal defect in a canine model and application of the technique in a baby. *J Thorac Cardiovasc Surg*. 1998;115:1374–1376.
3. Thakkar B, Patel N, Shah S, et al. Perventricular device closure of isolated muscular ventricular septal defect in infants: A single center experience. *Indian Heart J*. 2012;64:559–567.
4. Yeager SB, Freed MD, Keane JF, Norwood WI, Castaneda AR. Primary surgical closure of ventricular septal defect in the first year of life: results in 128 infants. *J Am Coll Cardiol*. 1984;3(5):1269–1276.
5. Crossland DS, Wilkinson JL, Cochrane AD, d'Udekem Y, Brizard CP, Lane GK. Initial results of primary device closure of large muscular ventricular septal defects in early infancy using perventricular access. *Catheter Cardiovasc Interv*. 2008;72:386–391.
6. Bacha Emile AM, Hijazi Ziyad M. Hybrid procedures in pediatric cardiac surgery. *Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu*. 2005;8:78–85.
7. Anuradha S, Subramanyan Raghavan, Agarwal Ravi, Pezzella A Thomas, Cherian KM. Hybrid stage I palliation for hypo-plastic left heart condition without a hybrid suite: suggestions for developing nations. *Indian Heart J*. 2012;64(4):333–337.
8. Holder R, Balzer D, Cao QL, Lock K, Hijazi ZMAmplatzer Muscular Ventricular Septal Defect Investigators. Device closure of ventricular septal defects using the Amplatzer muscular ventricular septal defect occluder: immediate and mid-term results of a U.S. registry. *J Am Coll Cardiol*. 2004;43:1257–1263.
9. Bacha EA, Cao QL, Galantowicz ME, et al. Multi center experience with perventricular device closure of muscular ventricular septal defects. *Pediatr Cardiol*. 2005;26:169–175.