Percutaneous Closure of a Residual Perimembranous Ventricular Septal Defect After Surgical Repair

By Carlos AC Pedra, MD; Sergio C. Pontes, Jr., MD; Simone R.F. Pedra, MD; Juliana Neves, MD; M. Aparecida P. Silva, MD; M. Virginia T. Santana, MD; Valmir F. Pontes, MD

Introduction

Isolated perimembranous (PM) ventricular septal defect (VSD) is one of the most common congenital cardiac malformations. Surgery has been performed safely and effectively and has been regarded as the gold standard method of treatment for this disease. Although residual leaks are observed in up to 5-10% of cases, most of them are restrictive and well tolerated. Occasionally, they can result in significant left-to-right shunting with persistent left ventricular volume overload, which requires re-intervention. Recent publications have reported the feasibility, safety and efficacy of percutaneous closure of native PM VSDs with the use of the Amplatzer membranous VSD occluder (AGA Medical Corporation, Golden Valley, Minnesota). Controlled release coils made of a reinforced Nitinol wire (PFM, Cologne, Germany) has also been employed for transcatheter closure of such defects with encouraging results. In this paper, we describe a case in which a significant residual leak after surgical repair of a PM VSD was closed using transcatheter techniques.

Case report

This patient was a non-dysmorphic 4 year-old boy (weighing 15 kgs) with a large PM VSD who was referred from the countryside to our institution for surgical repair. He was symptomatic and receiving digoxin, furosemide and captopril. Classical findings of significant PM VSD with pulmonary arterial hypertension were encountered on physical examination, chest radiograph and ECG. Transthoracic echocardiography revealed a large PM VSD with inlet extension, measuring 14 mm at its maximal dimension (Figure 1A). There was significant left atrial and ventricular volume overload. Pulmonary arterial pressure was estimated at systemic levels. The child was taken to the catheterization laboratory for further hemodynamic assessment. A routine left and right catheterization was carried out under general anesthesia. Hemodynamics showed the

Figure 1. Echocardiographic pictures of the defect. (A) Four chamber view (pre-operative TTE). Large PM VSD with inlet extension measuring 14 mm at its maximal diameter. (B) Modified four chamber view (post-operative TTE). There is a residual VSD (red arrow) measuring 5-6 mm at the superior portion of the patch (light blue arrow), near the crux of the heart and the AV valves. (C) Long axis view (TEE during the percutaneous procedure). The left ventricular loops of the PFM Nitinol coil are protruding into the LVOT. (D) Long axis view (TEE during the percutaneous procedure). The Amplatzer membranous VSD occluder is well positioned after final release. There is a small residual leak through the superior aspect of the device.

Submit an Article to Congenital Cardiology Today

Send an email with your name, title, organization, address, and email along with a title and a 50 word description to:

Articles@CCT.bz
following pressures (in mm Hg): RA: 5; RV: 88/6; MPA: 88/21 (mean 58); Ao: 90/58 (mean 71); LV: 90/12. Pulmonary vascular resistance (PVR), Qp/Qs and PVR/SVR were estimated at 3.6 Wood Units, 2.9 and 0.23, respectively. After the administration of NO (40 PPM), PVR was 1.6 U Wood X m-2, Qp/Qs 4.9 and RVP/RVS 0.11. Left ventriculogram in long axial view showed a large PM VSD, measuring 13 mm at its maximal diameter (Figure 2A). Pulmonary arterial angiogram demonstrated progressive tapering of the pulmonary arteries with satisfactory opacification of the peripheral vessels. The capillary phase was homogeneous and there was rapid return of the contrast media to the LA. The child was subsequently referred to surgery, which was carried out under cardiopulmonary bypass using standard techniques. A pericardial patch was sutured at the edges of the defect with pledgets. The tricuspid valve was not removed for patch closure. Post-operatively, signs of persistent left-to-right shunting were detected invasively (SVC sat: 65%; PA sat: 82%) and confirmed by echocardiography. A 5-6 mm residual VSD was observed through the upper portion of the patch near the AV valves (Figure 1B). On the 8th post-op day the child was reoperated, however, the surgeon was unable to identify the site of the residual leak intra-operatively. After a month, a decision was made to attempt closing the residual leak using transcatheter techniques. Informed consent was obtained from parents. Under general anesthesia, vascular access was obtained with placement of a 5 Fr sheath in the left femoral artery and a 7 Fr sheath in the right femoral vein. Heparin sulfate (150 IU/kg) and Cefazolin (30 mg/kg) were given. Hemodynamics showed the following pressures (in mm Hg): RA: 8; RV: 50/10; MPA: 50/18; Ao: 90/50; LV: 90/15. The Qp/Qs was estimated at 1.8:1. Left ventriculogram confirmed the echocardiographic findings (Figure 2B). Using previously described techniques and under transesophageal echocardiographic guidance (TEE), the residual VSD was crossed retrogradely and an arterial-
venous loop established using a 260 cm Glide wire (Terumo Cardiovascular Systems Corporation, Ann Harbor, MI). A 7 Fr long, braided sheath (Flexor Cook Cardiology, Bloomington, IN) was advanced to the ascending aorta across the VSD from the vein. The latest version of a pre-mounted PFM coil (with reinforced Nitinol wire and Dacron fibers) (12 X 6 mm) was advanced through the long sheath until the tip of the delivery catheter was about 1 cm out of the long sheath. By pushing the core wire, the loops of the coils were exteriorized in the ascending aorta with the last 2 loops remaining inside the delivery catheter. The whole system was carefully brought back as a unit across the aortic valve until the loops abutted the interventricular septum. Keeping a gentle traction on the system and the tip of the long sheath close to the tip of the delivery catheter, the last 2 loops were delivered in the RV by withdrawing the delivery catheter and pushing the core wire. Final position of the coil was assessed by TEE (Figure 1C) and angiography (Figure 2C). Because the left ventricular loops protruded into the LVOT and there was significant residual leak, the device was recaptured inside the long sheath and removed out of the body. A decision was then made to attempt closing the defect using an 8 mm Amplatzer membranous VSD occluder (AGA). The VSD was again crossed in a retrograde fashion and an arteriovenous loop established using a Rope wire (AGA) as described in previous published protocols (6-8). An 8 Fr long sheath (TorqVue, AGA) was advanced to the ascending aorta and subsequently positioned near the left ventricular apex as described before. After removal of the Rope wire and dilator, the device was pushed through the long sheath and the left ventricular disc deployed within the left ventricular cavity with the radiopaque marker pointing downwards. The whole system was retracted as a unit until the left disc touched the patch. By pulling the long sheath and advancing the delivery cable, the right disc was deployed on the right side. Good device position was confirmed by both TEE and angiography. Aortic and AV valve function were preserved. After device release, a tiny residual leak was seen through the superior portion of the device (Figure 1D and 2D). The child was awakened in the catheterization laboratory and had an uneventful recovery. He was discharged home the following day on aspirin (5 mg/kg/day). A transthoracic echocardiogram revealed complete closure of the defect after a month. There was no AI or significant TR. The child remained in sinus rhythm with no signs of left or right bundle branch block. Medications were gradually discontinued.

Discussion

A significant residual VSD after surgical repair may occasionally require reoperation, resulting in increased morbidity and hospital stay. Although successful transcatheter closure of PM VSDs has been described recently, (8-10) there is limited experience with this approach for such residual defects. Since it has the potential to avoid a repeat cardiopulmonary bypass run, it may well be a safer therapeutic option. However, the issue of what type of residual defect that is amenable to transcatheter closure, including location, number and size, has yet to be clarified. This will only come with ongoing experience. In the case described herein, the residual defect was single and located at the superior edge of the patch, towards the crux of the heart. Despite being close to the AV valves, we felt there was enough room surrounding the defect to accommodate a device without interfering with AV valve function. Moreover, we decided to attempt the transcatheter approach because the child had undergone surgical repair twice unsuccessfully.

In regards to the types of devices used in this case, the PFM coil was employed initially under a study protocol to assess its safety and efficacy. Even acknowledging that clinical experience with it is still very limited, (8-10) (about 20 implantation procedures with the latest version; unpublished data; Dr. Trong-Phi Le, personal communication), it has theoretical and potential advantageous features. It requires lower profile sheaths (6 or 7 Fr) for implantation; due to the flexible central portion of the device, it can be exteriorized in the ascending aorta and pulled back safely across the aortic valve, with no need to place the long sheath near the left ventricular apex, and it is se-

Fifth International Pediatric Cardiovascular Symposium: Management of Complex Congenital Heart Disease From Infancy to Adulthood The Ritz-Carlton, Amelia Island, June 23-26, 2005
www.choa.org/forprofessionals/cme
or call Nancy Richardson 404-785-7843 or Kathy Murphy 404-785-6480

© Copyright 2005, Congenital Cardiology Today. All rights reserved www.CongenitalCardiologyToday.com
cured within the defect without exerting radial forces. Although it seems to work well for small to moderate defects, especially those associated with aneurysm formations, it may be unsuitable for larger defects. In the case described herein, the PFM coil remained in an inadequate position, protruding into the LVOT, probably because it approached the septum (patch) from above, coming from the aorta. If we had delivered the LV loops close to the left ventricular apex, it might have been possible to engage it within the patch, in a more favorable course towards the defect itself. Possible entanglement with the mitral valve apparatus could be an issue employing this approach. Coil recapturing and removal was feasible and safe, keeping in mind that the long sheath had to be kept close to the delivery catheter tip to avoid entanglement with the tricuspid valve apparatus. Subsequent use of the Amplatz membranous occluder was a natural choice. Initial clinical experience with this device has been encouraging. The rate of complete closure is high (>90%) and aortic and mitral valve function are preserved, at least in the short-to-mid term. However, complete heart block seems to occur with an incidence of 1-2%. Whether this is related to the radial forces exerted by the central waist of the device onto the defect edges or due to the endo-thelialization process is speculative. Other factors such as younger age, inlet extension of the VSD and crossing the VSD from the RV side may play a role in the development of this complication. In our experience, complete heart block did occur between 3-6 months after the procedure in a single case out of 33 implantation procedures (unpublished personal data). In the case presented herein, the Amplatz device worked nicely because it approached the patch at a proper angle, coming from the LV apex. Besides, the longer inferior portion of the LV disc engaged well within the patch with the waist remaining inside the residual defect itself, which was probably responsible for complete closure. Improvements on the design of this device and delivery system have been made by placing a female screw in the center of the left ventricular disc and a male screw at the tip of the rope wire. This enables to position the device more precisely because of the through-and-through cable-to-device-to-robe wire system, creating traction from both the venous and arterial sides. We anticipate that this system can be useful in difficult cases, such as some residual VSDs after surgical repair.

In conclusion, percutaneous closure of a residual PM VSD after surgical repair using an Amplatz membranous device was feasible, safe and effective in the selected patient presented herein. More experience is warranted before the widespread use of this technique is recommended.

References
and initial clinical results. Prog Pediatr Cardiol 2001; 14: 83-88.


Email comments on this article to JUNECP@CCT.bz

Corresponding Author:
Carlos AC Pedra-MD
Director, Catheterization Laboratory for Congenital Heart Disease
Instituto Dante Pazzanese de Cardiologia
São Paulo, SP, Brazil
Tel: (55) (11) 5085-4114
Fax: (55) (11) 5085-4101
cacpedra@uol.com.br
carlosacpedra@hotmail.com

SEPTEMBER CONFERENCE FOCUS

PICS/ENTICHS- 2005
(Pediatric Interventional Cardiac Symposium and Emerging New Technologies in Congenital Heart Surgery)
September 15-18, 2005, Hilton Buenos Aires
Buenos Aires, Argentina
www.picsymposium.com

PICS/ENTICHS-2005 will focus on the latest interventional catheter strategies and emerging technical advances in cardiac surgery for fetuses, children, and adults with congenital heart disease:

• Daily live case demonstrations including the latest technologies in devices, implantable valves, stents, balloons and more.

• Special didactic sessions including closure of all types of septal defects, percutaneous

• Live surgical cases focusing on hybrid intervention.

• Meet the Expert Sessions.

• "My Nightmare in the Cath Lab" case presentations.

The second annual meeting of The Congenital Cardiovacular Interventional Study Consorium (CCISC) will take place at PICS/ENTICHS 2005.

Course Directors: Drs. Ziyad Hijazi; Emile A. Bachs; William E. Hallenbrand; and John P. Cheatham.

Course Co-directors: Drs. Horacio Faletta, Mark Galantowicz, Miguel Granja, and Christian Kreutzer.

Guest Faculty Includes: Drs. Teiji Akagi; Luis Alcalyl; B.G. Alekany; Mazen Alw; Zahid Amin; Luigi Ballerini; John Bass; Lee Benson; Felix Berger; David Bichell; Philipp Bonhoeffer; Redmond Burke; Mario Comminati; Chin Chan; Gi-Ling Cao; Bharat Dalvi; Cesar Esteves; J.V. De Giovanni; Makram Ebeid; Jeffrey Feiststein; Craig Fleishman; Valmir Forites; Thomas Forbes; Ronald Grifke, MD; Filip Heusser; Frank Ing; Thomas Jonas; Charles S. Kleinman; Krishna Kumar; Michael Lanzo; Trong-Ph Le; Geoffrey K. Lane; Larry Latson; Jose Suarez de Lezo; Achi Ludominsky; Jozef Masura; Constantine Mavroudis; Joaquim Mio; John W. Moore; Charles E. Mullins; David Nykanen; Eustaquio Onorato; MD; Carlos Pedra; Jean-Francois Pichaud; MD; Alejandro Peinone; Shakeel A. Qureshi; MD; Wolfgang Radtke; P.S. Rao; MD; Mark Reisman; Carlos E. Ruiz; Satinder Sandhu; Horst Sievert; Basil (Vasilios) Thanopoulous; Hideki Tomita; Alejandro Torres; Wayne Trowczisky; MD; Michael Tyvan; Ross Ungereider; Kevin Walsh; Gilbert Wernovsky; James Wilkinson; Neil Wilson; Carlos Zabar; and Evan Zahn.

For more details, abstract submission and registration, please visit the website.

Accreditation: The University of Chicago Pritzker school of medicine is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to sponsor continuing medical education for physicians.