Complete atrioventricular block after transcatheter closure of perimembranous ventricular septal defect: a few comments based on our own experience

To the editor We read with great interest the recent article by Weryński et al,[1] published in the February 2021 issue of *Kardiologia Polska* (*Kardiol Pol*, *Polish Heart Journal*). The authors analyzed 44 publications on results of transcatheter closure of ventricular septal defects (VSDs) from the years 2014 to 2020. The meta-analysis included a total number of 4050 patients, mostly children. Twenty papers described the results of Chinese-made device use (13 publications from China and 7 from other countries). The vast majority of procedures were conducted to treat perimembranous VSD (pmVSD; n = 3812); procedures for the treatment of muscular VSD (mVSD) constituted a minority (n = 66). The technical success rate was considerably high and amounted to nearly 98%. A residual shunt was observed in 22.5% of patients immediately after the procedure, and its rate decreased during further follow-up to 2.11% (n = 92). Complete atrioventricular block (CAVB) related to the intervention was the most severe complication noted. The pooled estimated rates were 0.64% for transient CAVB and 0.32% for permanent CAVB. In studies from China, transient CAVB was observed in 13 out of 1437 patients, and permanent CAVB, in 3 out of 1437 patients, that is, in 0.9% and 0.2% of patients, respectively. In the European registry, the incidence of CAVB after percutaneous closure of pmVSD was reported to be as high as 5%.[2]

In our practice, we applied Chinese-made devices to treat VSD percutaneously in several patients but abandoned their use after complete CAVB occurred 5 months after hybrid pmVSD closure in an infant in whom we used a modified symmetrical device (MDO, LEPU Medical, Inc., Beijing, China).[3] Our experience in the use of 2 different types of Amplatzer occluders to treat pmVSD—namely, an asymmetrical device designed to treat pmVSD (pmVSDO1) and a symmetrical device designed to treat mVSD (mVSDO)—was described elsewhere.[4] The major difference (among others) between pmVSDO1 and mVSDO is the length of their stenting waist—1.5 mm and 7 mm, respectively. In our previous article,[4] we analyzed 18 patients: 9 treated with pmVSDO1 (group 1) and other 9 treated with mVSDO (group 2). The latter device was used when the distance between the defect and the aortic valve was larger than or equal to 4 mm. In group 1, CAVB occurred in 2 patients during the first week after pmVSDO1 implantation; in a single patient, it resolved after steroid therapy, and another patient needed pacemaker implantation. In group 2, no conduction disturbances were observed. We suspected that the length of the occluder waist can be an important factor for the occurrence of CAVB after transcatheter closure of pmVSD.[5] This finding was recognized by Graham as one of the most interesting observations concerning interventional cardiology in congenital heart disease in 2007.[6] It prompted Professor Kurt Amplatz from Minneapolis, Minnesota, United States, and Professor Yongwen Qin from Shanghai, China, to design new occluders to treat pmVSD (with longer waists), called perimembranous VSD occluder type 2 (pmVSDO2) and MDO, respectively.

Recently, transcatheter closure of mVSD has become a widely accepted method of treatment; however, most mVSDs close spontaneously in early childhood. Device closure of mVSD poses low risk of CAVB, as the defects are located far from the conduction system.

According to our experience, special attention should be paid to transcatheter closure of mVSD located in the inlet part of the septum. The device deployed in close proximity to the tricuspid valve may cut its chordae tendinae and result in severe regurgitation, as it happened in one of our patients (the cited article includes an interesting comment made by Professor Kurt Amplatz) [7].

The decision to deem the patient eligible for transcatheter pmVSD closure should be preceded by a detailed analysis of defect morphology. In particular, the presence of interventricular septum aneurysm appears to reduce the risk of CAVB, as the device remains distant from the conduction system. It is supported by our experience in the use of Amplatzer Duct Occluder II Additional Sizes in 4 patients with pmVSD with small aneurysms, in whom no CAVB was observed (however, this device can be implanted only in pmVSDs of smaller diameters).[8] We would like to ask our colleagues what is their experience regarding percutaneous VSD closure.

ARTICLE INFORMATION

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Authors' reply We would like to thank our colleagues for their comments on our meta-analysis of transcatheter closure of ventricular septal defects (VSDs). They explained technical differences between VSD devices and their impact on the risk of atrioventricular block incidence. In response to their question, we present our experience regarding percutaneous VSD closure.

We used 2 types of devices to treat VSDs in pediatric and adult populations.[1] On one hand, a symmetrical muscular VSD occluder (mVSDO) was used to close muscular and perimembranous VSDs. On the other hand, the PFM LeVSD device was used for the closure of left ventricular–right atrial shunts as well as muscular and perimembranous VSDs. In a group of 56 patients, 69 septal defects were closed; 45 of them (65.2%) were perimembranous VSDs, and there were 16 muscular VSDs (23.2%) and 8 cases of left ventricular–right atrial shunts (11.6%). The successful rate depending on the device used was 100% for mVSDO and 98% for the PFM LeVSD device. Residual shunts were present only after procedures performed with PFM LeVSD devices, in 67% of patients, immediately following the treatment. At further follow-up, residual shunts were reported only in 3 patients (4.3%). Other residual shunts disappeared spontaneously. During one procedure of closing a perimembranous septal defect without aneurysm, left bundle branch block occurred, thus, we abandoned the procedure. No case of complete atrioventricular block was reported during 5-year follow-up. Only a single patient with left ventricular–right atrial shunt had transient hemolysis that required blood transfusion and steroids early after the procedure. In other patients, we observed transient arrhythmia. We would like to emphasize differences in the construction of the PFM LeVSD device. Unlike other devices, which are a nitinol structure of 2 discs connected by a waist that closes a septal defect, the PFM LeVSD device has properly profiled coils. The first part of this spiral is available in sizes ranging from 8 to 16 mm. It closes the defect from the left ventricle, and the rest of the spiral (6 or 8 mm in diameter) is placed from the right ventricle and stabilizes the implant. A coil with a distal diameter at least 2-fold larger than the minimal diameter of the VSD on the right ventricular side and equal to, or 1 to 2 mm greater than, the diameter of the VSD at the left ventricular opening is appropriate and should be selected. This unique design makes the PFM LeVSD device flexible, adaptive to different anatomies of the interventricular septum and ventricular cavities, and exerts less pressure on the surrounding tissues, including the conduction system, which eliminates the risk of complete atrioventricular block.[2-4] The flexibility and adaptability of this device is useful for closing atypical defects such as left ventricular–right

atrial shunts, which accounted for as much as 11.6% in our study. We have also demonstrated the usefulness of PFM LeVSD implants in closing multiple muscular septal defects of the so-called Swiss cheese type.[5] These implants are very useful for closing defects with a very small aortic rim, in which, thanks to the flexible design, they can be implanted almost directly under the aortic valve leaflet, with no risk of causing its dysfunction. The advantages of the construction of the set advocate its use for closing other atypical leaks.[6] Due to the different design, the PFM LeVSD device is associated with a higher frequency of residual leakage immediately after implantation, which disappears during follow-up. Transient intravascular hemolysis, which usually resolves spontaneously, is a known, reported complication after PFM LeVSD device implantation.

In our opinion, percutaneous VSD closure is an effective and safe method of treatment provided that an appropriate set is selected; the size of the defect and proximity to the conduction system and heart valves are precisely determined; and the team performing the procedure has necessary experience.

ARTICLE INFORMATION

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