Late Migration of a Paravalvular Leak Closure Device
Emergency Percutaneous Retrieval and Subsequent Successful Leak Closure in a Patient with Cardiogenic Shock and Multiorgan Failure

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Summary
Paravalvular leak (PVL) is a serious complication of surgical valve replacement, often affecting elderly, multimorbid, high-risk patients. The risk of surgical intervention is often prohibitive in these cases, and so percutaneous PVL closure emerged as a feasible and effective management strategy, with a low complication rate. Specific devices for closure of PVL’s are currently not widely available, and so PVLs are closed using generic vascular closure devices, which may result in residual paravalvular regurgitation or even closure device displacement. Although rare, late displacement of the closure device with prosthetic impingement can be life threatening, requiring urgent intervention.

We present a case of a seventy-year-old gentleman with rheumatic heart disease and multiple previous mechanical aortic and mitral valve replacements. After repeated admissions for decompensated heart failure, secondary to paravalvular mitral regurgitation, a percutaneous paravalvular leak closure was performed with successful reduction of the leak. He represented 30 days later with cardiogenic shock and multiorgan failure secondary to torrential central mitral regurgitation caused by late displacement of the closure device with mitral prosthesis impingement. Due to an excessively high surgical risk, his case was successfully managed percutaneously with retrieval of the displaced device and closure of the PVL using two Amplatzer Vascular Plug III devices. At the six-month review, he remains asymptomatic.

Percutaneous PVL closure is an effective strategy for patients with prohibitive surgical risk. Late closure device displacement can be a life-threatening complication. Our case demonstrates that percutaneous management of this complication is feasible even in patients presenting in extremis.

Case Report
Our case is that of a 70-year-old man with permanent atrial fibrillation and rheumatic valvular heart disease requiring mechanical aortic (AVR) and mitral valve replacement (MVR) in 1979. He presented with two subsequent replacements in 1988 (due to prosthesis dysfunction) and 2003 (due to infective endocarditis). His current prostheses were a St Jude 27 mm and 21 mm in the mitral and aortic position, respectively. Sternal dehiscence occurred after his last surgery and prolonging his recovery. He presented with worsening dyspnea (NYHA III) and evidence of decompensated heart failure requiring two successive admissions within three months. Tranesophageal echocardiogram (TEE) showed two mitral paravalvular leaks, one major located posterolaterally with a semilunar shape, an area of 0.99 cm² and a maximum diameter of 14 mm. A second, smaller leak was located anteromedially, with an area of 0.3 cm², resulting in severe paravalvular mitral regurgitation (PVMR) (Figure 1A and B).

His case was discussed at the multidisciplinary Heart Team meeting in our institution. Given his multiple previous surgeries and the complications encountered after his last surgery, he was considered at high surgical risk and...
Figure 1. Baseline transesophageal echocardiogram revealing posterolateral (A) and anteromedial leaks with severe mitral regurgitation (B). C-F: Intraprocedural echocardiogram showing normal prosthetic MVR function after VSD occluder device deployment within the PVL (C-E) and moderate-severe residual paravalvular mitral regurgitation after VSD occluder device (asterisk) deployment (F). 2D- and Doppler-images at readmission showing prosthetic disk obstruction (white arrow) by displaced VSD device (red arrow) causing severe mitral regurgitation (G and H), and 3D-images of MVR disk position in diastolic and systolic phase, respectively (I and J). 3D-TEE images are displayed in surgical orientation.
the consensus opinion was that a TEE guided percutaneous PVL closure should be performed. A strategy using an anterograde approach through a transeptal puncture, without arteriovenous loop, was undertaken to avoid compromising the aortic mechanical prosthesis. An 8.5 Fr Agilis steerable introducer (Abbott Vascular, Abbot Park, Illinois) was advanced into the left atrium, and a 14/5 mm Amplatzer Vascular Plug III (AVP III, Abbott Vascular, Abbot Park, Illinois) was implanted with only a modest reduction in PVMR. This device was therefore retrieved. Then, a 14 mm Amplatzer Muscular Ventricular Septal Defect occluder (VSD, Abbott Vascular, Abbot Park, Illinois) was implanted using an 8F Amplatzer TorqVue 45° delivery sheath (Abbott Vascular, Abbot Park, Illinois) achieving a stable position as seen on the TEE. Partial closure of the defect with improvement in the PVMR was achieved (Figure 1C-F). Although his admission was complicated by acute renal failure and hemolytic anemia, he was ultimately discharged stable and significantly less symptomatic (NYHA II) but with residual moderate PVMR.

He was readmitted with cardiogenic shock 30 days post the initial procedure. He presented with worsening dyspnea (NYHA IV), hypotension (70/50 mmHg), signs of congestive heart failure, and anuria. Laboratory testing showed hemolytic anemia (Hemoglobin 9.1 g/dL, reticulocytes 7%, LDH 4600 U/L, haptoglobin 2.1 mg/dL), hyperlactatemia (lactate 2.9 mmol/L), acute liver and renal failure (creatinine of 4.4 mg/dL) and NTproBNP of 63755 pg/mL. He was commenced on norenaline, dobutamine, and hemodialysis. TEE confirmed a displaced VSD device with MVR disk impingement causing torrential central MR (Figure 1G-J). An urgent Heart Team discussion again concluded that the patient presented a prohibitive surgical risk, and so a percutaneous approach was agreed.

Via right femoral venous access, a transeptal puncture was performed. A 12 Fr, 81 mm FlexCath Advance Steerable Sheath (Medtronic, Minneapolis, Minnesota, United States) was advanced into the left atrium, and the displaced VSD device snared and retrieved with restoration of normal MVR function (Figure 2A). Subsequently, a 5 Fr multipurpose catheter and guidewire6 were advanced within the FlexCath across the PVL. The guidewire6 was exchanged for an extra-stiff guidewire over which the FlexCath was advanced across the PVL. A first 14/5 mm AVP III device was advanced unsheathed within the FlexCath and deployed within the defect. A Destination3 sheath with a second 14/5 mm AVP III was advanced also within the FlexCath and positioned in the residual leak (Figure 2B, C). Both devices were released simultaneously once an adequate position without MVR interference was confirmed on TEE (Figure 2D-F).

Then, he was transferred to the Intensive Care Unit where his condition stabilized and he was successfully weaned from vasoactive agents. His hemolytic anemia resolved over the subsequent days, as did his acute kidney injury, and he no longer required renal replacement therapy. A subsequent TEE revealed well-seated AVP devices, a normally functioning MVR with minor residual PVL from the anteromedial defect. At the 12-month follow-up, he remains asymptomatic and NYHA class II.

Discussion

Patients with PVL are often elderly with complex medical co-morbidities. Previously, surgical intervention was the only option, leaving many patients with prohibitive surgical risk, untreated. However, over the last number of years, transcatheter closure of PVL emerged as a feasible strategy for these patients who are high-risk and for those considered to have a short prognosis. Although data regarding the efficacy of transcatheter PVL closure are sparse, when compared to surgery, the rate of complications is relatively low with high procedural success.5 Complications can include cardiac tamponade, prosthesis thrombosis, access site bleeding, and intravascular hemolysis. Prosthetic disk obstruction by the closure device (4%) and embolization (<1%) are the most feared complications and are more common when larger closure devices are used.5 Furthermore, as dedicated PVL closure devices are not yet widely available, Interventional Cardiologists must use vascular plugs designed for other purposes to close the PVL, which may be ill-fitting and subsequently dislodge and embolize. Early device displacement occurring during the index procedure is often due to an ill-fitting device and is quickly recognized and retrieved. Late device displacement may be the result of device instability or device induced widening of the PVL caused by radial forces exerted by the closure device on the friable and vulnerable tissue surrounding the PVL.6 Late displacement is less quickly recognized, and, although thankfully rare, it can be a life-threatening complication frequently requiring surgical treatment. Thus, careful follow-up is necessary even in the presence of uneventful procedure.

While early device displacement and retrieval is relatively frequent at the index procedure, late displacement is a less frequently reported complication. To the best of our knowledge, seven previous cases exist reporting late spontaneous displacement of PVL closure devices. Mandegar, et al. report the only case with prosthetic valve malfunction due to interference of an Amplatzer device implanted 5 months earlier ultimately requiring surgical removal.4 Two further cases of late occluder displacement into the left atrium are described by Ussia, et al. and Yuan, et al.8,9 Again, both required surgical management, but prosthetic valve interference by the occluder was not a feature in these cases. In all three cases, the patient presented with worsening NYHA class and hemolytic anemia.

Four further cases were reported of late extra-cardiac embolization of devices to the aortoiliac axis.6-11 One patient was managed conservatively in accordance with his wishes and died a number of days later.10 Cruz-Gonzalez, et al. described a case of late displacement of a closure device at 6 months post implantation to the left iliac artery which was successfully retrieved percutaneously,8 while Godinho, et al. described a case requiring surgical retrieval from the femoral artery after an unsuccessful percutaneous attempt.9 An attempt at percutaneous retrieval of a partially displaced AVP III device from the left atrium by Arzamendi and colleagues resulted in its distal...
embolization and ultimate percutaneous retrieval from the iliac bifurcation.11)

Although many of these cases demonstrate percutaneous retrieval of embolized devices from peripheral arteries, successful percutaneous retrieval of a displaced device located within one of the cardiac chambers is less frequently reported. Additionally, late displacement of an occluder device causing prosthetic valve impingement, managed entirely percutaneously, as in our case, has not been previously described. The resulting hemodynamic instability posed a significant challenge, requiring not only the retrieval of the displaced device but also placement of two new devices to close the PVL within the same procedure and stabilize the patient.

A number of technical aspects to our case are worthy of mention. The percutaneous retrieval of the previous closure device as well as the deployment of two new AVP III devices was facilitated by the use of the 12 Fr FlexCath Steerable Sheath, normally used for electrophysiology procedures. Its novel use in our case provided three functions. Firstly, its steerability allowed it to be manipulated into position within the defect. Secondly, the 12 Fr diameter allowed retrieval of the displaced device and successful simultaneous deployment of two AVP III closure devices. Lastly, its short length (81 cm) allowed for its use as a ‘mother and child catheter’ with the Destination® catheter (90 cm) being advanced further into the defect to deliver the second AVP III. Finally, the use of two AVP III devices, with their more rectangular shape, provided a better fit in the paravalvular defect than the previous VSD closure device, which is more circular in shape.

Although a demonstration of the successful use of
two AVP III devices to close a PVL, our case highlights an important unmet need for these patients, namely the paucity of specific devices designed for PVL closure. The often-irregular size and shape of PVL make designing a specific PVL device difficult. However, the emergence of 3D printing may hold great promise in this regard with the potential to produce ‘made to measure’ devices for individual patients.

Conclusion

PVL is a serious complication of mechanical surgical valve replacement. Patients who are high-risk can benefit from percutaneous closure of PVL’s with minimal risks. Dislodgement of devices used to close PVL’s can impinge on the prosthetic valve resulting in serious and life-threatening consequences. We demonstrated the feasibility of percutaneous retrieval of a displaced device and subsequent successful closure of a PVL, using two AVP III devices in a patient with cardiogenic shock and multiorgan failure. Our case also highlights the need for device development for this specific indication.

Disclosure

Conflicts of interest: None.

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