Transcatheter Closure of Aorta to Left Atrium Fistula during Active Prosthetic Valve Endocarditis as a Bridge for Surgery: A Case Report

Hesham Abdo Naeim, MD, FASE, Reda Abuelatta, MD, Osama Alamodi, SBC, Waleed Saeed, Fellow SBC, Hala Elmohamady, MD, Abeer Mahmood, SBC, and Ibraheem Alharbi, SBC, *Madina, Saudi Arabia*

INTRODUCTION

The first reported connection between the aorta and the cardiac chambers was described in 1924 as an incidental finding on autopsy.[1] The etiology of aorto-left atrial fistulas (ALAFs) may be (1) secondary to infective endocarditis or aortic dissection; (2) iatrogenic during cardiac catheterization, ablation, or valve replacement; or (3) traumatic or congenital.[2] The clinical presentation of ALAFs depends on the fistula size and the pressure difference between the aorta and the left atrium (LA).[3] Due to the significant difference in pressure between the aorta and LA, a sizable ALAF leads to high LA pressure with persistent pulmonary edema. Immediate diagnosis and treatment are mandatory to avoid mortality.[4] Surgical repair has been the standard treatment; however, percutaneous closure is an alternative. To the best of our knowledge, transcatheter closure of ALAF in the setting of active infective endocarditis as a bridge to surgery has not been reported before.

CASE PRESENTATION

History

A 49-year-old man with a history of rheumatic heart disease since childhood underwent mechanical mitral valve (MV) replacement 30 years prior. Nine years earlier, he had had another surgery with a mechanical aortic valve (AV) replacement. He had chronic atrial fibrillation that was controlled by medication. He had regular follow-up, with an international normalization rate kept to around 3, and he adhered strictly to his medication regimen. He presented to the emergency room with a history of fever, productive cough, and difficulty breathing for the last 3 days.

Examination

The patient was tachypneic, 25 breaths/minute, and tachycardic, 110 beats/minute. On auscultation, there was a continuous murmur with maximum intensity at the left sternal border that propagated all over the pericardium. He had another ejection systolic murmur at the right sternal edge that spread to the neck. His arterial blood gases showed hypoxemia and respiratory acidosis. His initial blood test showed mild anemia, elevated white blood cells, and an international normalization rate of 10. The samples for cultures were extracted from the blood, urine, and sputum before starting antibiotics.

Echocardiography

Bedside transthoracic echocardiography (TTE) revealed a high gradient on the aortic and mitral mechanical prosthesis with questionable mobile masses on both valves. The patient underwent transesophageal echocardiography (TEE), which revealed a large aortic root abscess fistulating to the LA with a large shunt (Figure 1B and Video 1). There was a continuous flow into the LA (Figure 1C, 1D, 1E, Videos 2 and 3), Three dimensional TEE full volume with color showed the flow of ALAF (Video 4). The mean pressure gradient (PG) at the MV was 20 mm Hg (Figure 1F); however, the MV was opening well, so this high gradient was due to high flow from the fistula. There was a systolic reversal in the left upper pulmonary vein (Figure 1G). The left ventricular ejection fraction was 50%. Vegetation was seen attached to the mechanical MV (Figure 2A and Video 5). The mean PG at the mechanical AV was 59 mm Hg (Figure 2B).

All culture results showed no bacterial growth, so antibiotics were modified to cover atypical organisms. The consensus was urgent surgery for double valve replacement. Due to active endocarditis, hemodynamic unstability, and worsening chest condition, the surgery was postponed until the improvement of his pulmonary status. Unfortunately, the patient deteriorated with persistent pulmonary edema and white lung that resisted medical treatment (Figure 1A). He was started on mechanical ventilation. He developed renal impairment with decreased urine output. The treating physician decided to try emergency percutaneous closure of the ALAF as a bridge to surgery.

Procedure Description

The patient was transferred to the catheterization room for fistula closure with intraprocedural TEE guidance. The procedure was planned by combined arterial access and left atrial access via transseptal puncture. The fistula was first crossed from the aortic side using a multipurpose 5 F catheter and 0.035 F glide wire (Figure 2C and Video 6). The wire was snared using a triple-loop snare (EN Snare), size 45 mm, and exteriorized from the femoral vein, creating an AV loop (Figure 3B and Video 7). A 7 F Torque-Vue sheath crossed

From the Madina Cardiac Center, Madina, Saudi Arabia.

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VIDEO HIGHLIGHTS

Video 1: The mechanical AV is partially rocking, with a large abscess cavity at the aortomitral curtain.
Video 2: Continuous color flow in LA; note the mechanical MV is opening well.
Video 3: Continuous color flow of big ALAF.
Video 4: Three-dimensional full volume with color showing the flow of ALAF.
Video 5: Midesophageal view showing vegetation on mechanical MV; note both leaflets are moving well.
Video 6: The wire passes from the aorta to the LA through the fistula.
Video 7: Wire snaring from the venous side to create an arteriovenous loop.
Video 8: Muscular VSD 10 mm device stuck to AV leaflet.
Video 9: Interlocking deployment of both vascular plugs, one from the transseptal and the other from the aortic approach.
Video 10: Second device release; the fistula closes completely.
Video 11: Postclosure, no flow in LA.
Video 12: TTE after 1 year of surgery; both mechanical valves are well functioning.

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from the venous side toward the LA and through the fistula to the ascending aorta. An 8 mm muscular ventricular septal defect device was initially deployed; unfortunately, it trapped one leaflet of the mechanical AV (Figure 3C and Video 8). The device was recaptured, and we considered another type of occlusive device with a smaller aortic skirt. We selected two vascular plugs of size 10 mm (AVP II St. Jude Medical). Two wires were passed through two 6 F sheaths, one from the aorta and one from the LA. The two devices were interlocked together by simultaneous deployment, one deployed through the aortic side and the other deployed through the atrial side (Figure 3D and Video 9). Both devices were released (Figure 3E, 2F and Video 10), and the fistula was closed with no residual flow and no entrapment of any aortic leaflets (Figure 2D and Video 11). Immediately after fistula closure, the pulmonary venous flow improved, with no more systolic reversal (Figure 2F). The mean PG at MV decreased to 7 mm Hg (Figure 2G). Normal coronary angiography was documented at the same time.

We recommend having access with two wires across the fistula in case there is a need to add another device; recrossing beside the deployed device is difficult. All deployed devices should be kept connected to their cables until all devices are in place; then they should be released one by one. In this way the risk of device embolization is low.

After 1 day, the patient improved dramatically; the chest x-ray showed resolution of pulmonary congestion (Figure 2E), and the renal function went back to normal. On the 19th day, the patient was transferred to the theater, the aortic root was debrided, and a new mechanical aortic prosthesis was implanted successfully. The valve and tissues sent for culture showed no growth for any organism. The MV was functioning well, so the valve was cleaned and left in place. The patient was extubated on the fifth postoperative day. After 2 weeks, the patient was discharged from the hospital in good condition and seen in the outpatient clinic after a few days. At 1-year follow-up, both valves were functioning well (Video 12).

DISCUSSION

We recommend TEE in all patients with prosthetic valves with hemodynamic compromise. TTE can detect fistulous tracts in 50% of cases; however, with TEE, the detection rates increase to 97%.[5] TEE is

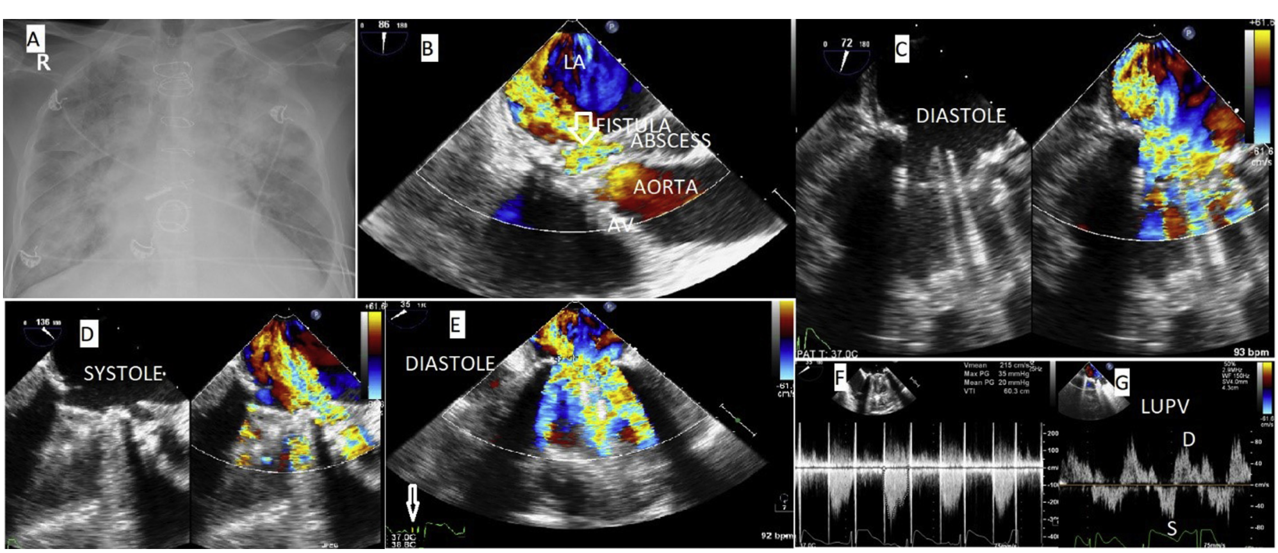

Figure 1 **(A)** Chest x-ray shows resistant pulmonary edema. **(B)** TEE shows the aortic root abscess with a significant fistula to the LA. **(C)** Diastolic frame as the MV opened and the color flow in the LA in diastole. **(D)** Systolic frame as the MV closed and the color flow in the LA in systole. **(E)** This color flow is not from the MV (the *arrow* points to the frame at end diastole); in addition, the MV is opened with the forward color flow. **(F)** The mean PG at MV is 20 mm Hg; however, the MV is opening well, and the increased PG is due to high flow from the fistula. **(G)** Clear systolic reversal in the left upper pulmonary vein due to the flow of the fistula.

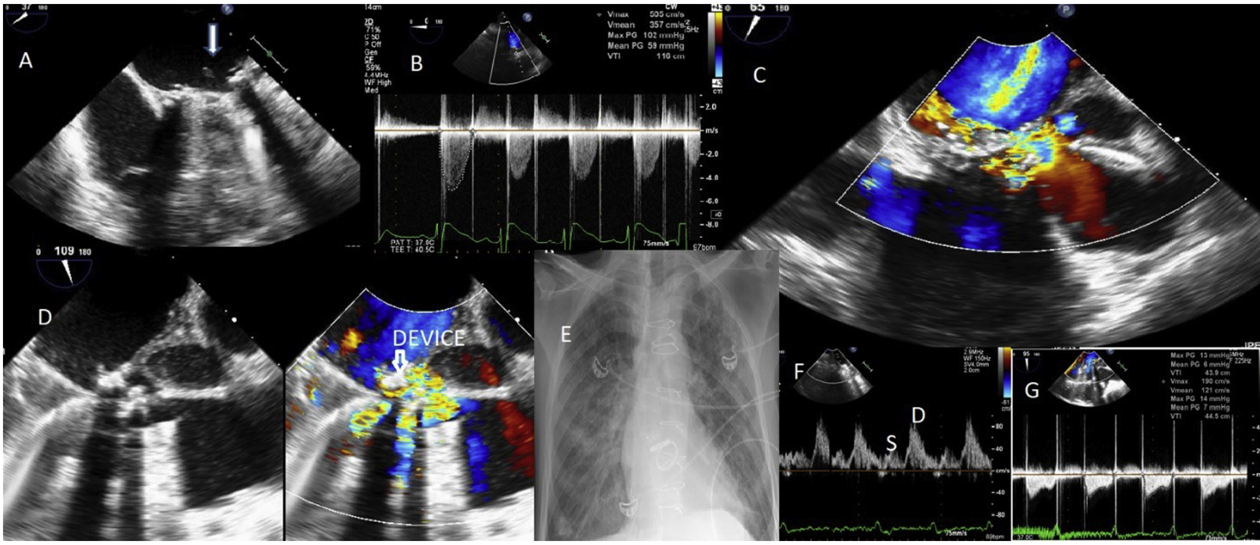

Figure 2 **(A)** A small vegetation moving through the mechanical MV. **(B)** The mean PG across the mechanical AV is 59 mm Hg, indicating severe aortic stenosis. **(C)** The wire passing from the aorta to the fistula to LA during the closure. **(D)** After the closure of the fistula, there is no more flow to the LA. **(E)** Improved pulmonary congestion 1 day after fistula closure. **(F)** Improved pulmonary venous flow; no more systolic reversal immediately after closure. **(G)** The mean PG at MV decreased to 7 immediately.

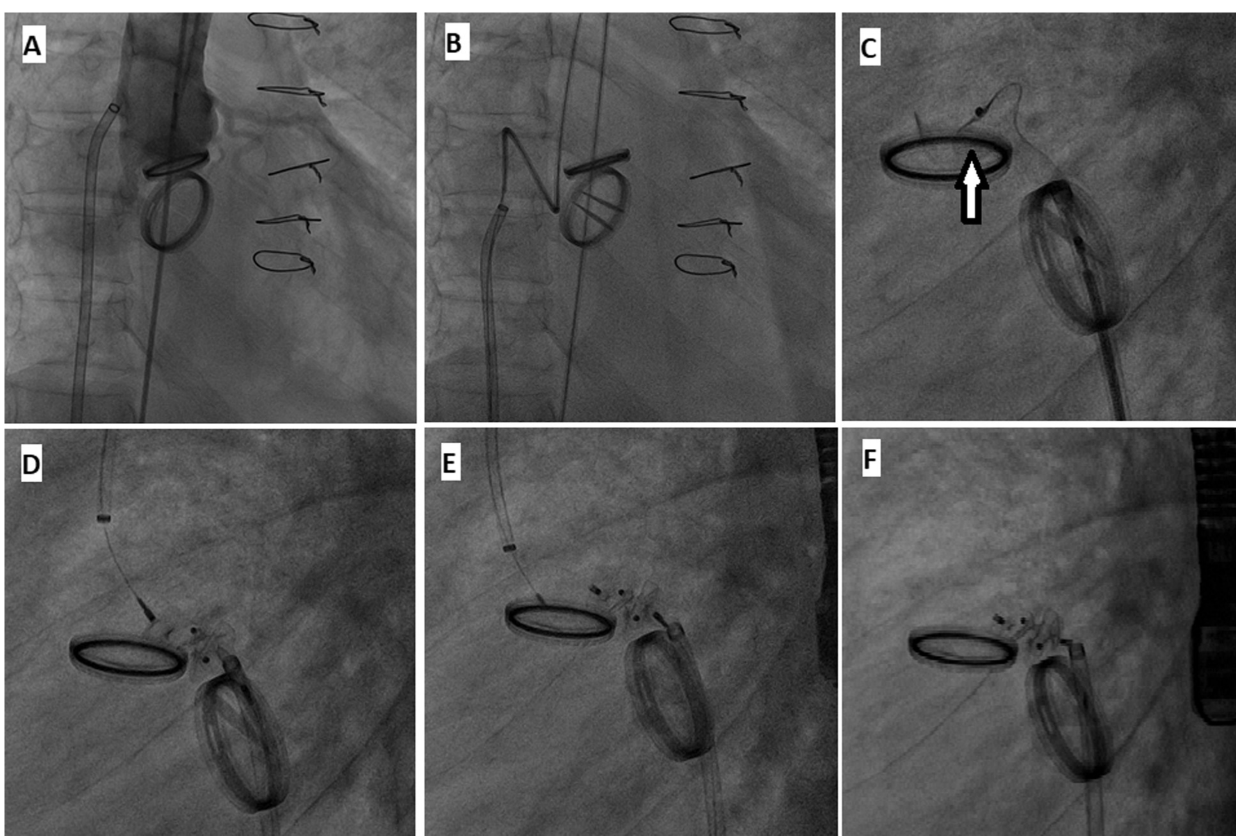

Figure 3 **(A)** Aortic root injection showed the flow to the LA from the aorta. **(B)** Wire snaring to create an arteriovenous loop. **(C)** Muscular ventricular septal defect 10 mm stuck to AV leaflet (*arrow*). **(D)** Interlocking deployment of both vascular plugs, one from the septal and the other from the aortic approach. **(E)** Release of the transseptal vascular plug. **(F)** Release of the transaortic vascular plug.

mandatory during transcatheter closure of the fistula to guide the procedure, decide the size of closure devices, and detect any leaflet entrapment.

During AV surgery, injury to the membranous septum and excessive debridement of calcium may lead to ALAF.[6] During mitral and tricuspid valve surgeries, deep sutures can lead to ALAF.[7]

Fierro *et al.*[2] collected four cases of intraoperative ALAFs, two cases during MV surgery and two cases during AV surgery; all cases were treated with redo surgery. Fierro *et al.*[2] also collected 29 case reports of aortoatrial fistulas in the setting of infective endocarditis; all the cases were treated surgically.

Intervalvular fibrosa is an avascular area; any infection with abscess formation can erode this area with fistula formation. Surgery is the standard treatment for ALAF. The surgical intervention consists of repairing the affected aortic segment, replacing the prosthesis, annular debridement in the setting of abscess, and suture of the fistula.[8]

It has been reported that the occurrence of ALAF in the context of infective endocarditis is 1%-2%.[9] The bacteria associated with aortoatrial fistulas are the *Staphylococcus* species in 58% of cases, followed by *Streptococcus* species in 28%, and *Enterococcus* species in 7%, with 7% of cases being polymicrobial.[10]

Our case showed negative culture endocarditis even from the surgically removed valve. The nature of the pathogen has not been shown to affect prognosis.[11] Fistulas lead to a high rate of complications, with >60% of patients developing significant heart failure and >40% ending in death.[12] Early intervention is indicated to avoid mortality. Usually those patients are unstable and not responding to medical treatment. In our case report, we raise the issue of stabilizing the patient with transcatheter closure of the fistula even in the setting of active infection with abscess and dehiscent valve as a bridge for surgery. The patient improved after plug placement; he was not a surgical candidate prior to plug placement, but after plug placement, he improved to the point that he was a viable surgical candidate. Thus, surgery could never have happened without percutaneous closure first.

The review of the literature revealed successful transcatheter closures of aortoatrial fistulas with good short-term outcomes; no long-term data are available.

CONCLUSION

Early diagnosis of ALAFs and immediate management is mandatory to reduce mortality. In hemodynamically unstable patients with an active infection, abscess, and dehiscent valve, transcatheter closure of ALAF is an option to stabilize the patient as a bridge for surgery.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found at https://doi.org/10.1016/j.case.2019.08.004.

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