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MINI-FOCUS ISSUE: TRANSCATHETER INTERVENTIONS

INTERMEDIATE

CASE REPORT: CLINICAL CASE

Second Percutaneous Mitral Valve Implantation to Treat Acute Hemolysis Complicating Mitral Valve in Ring Implantation

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ABSTRACT

We report the case of acute hemolysis after percutaneous transmitral valve implantation in a failed mitral valve repair. Transthoracic echocardiography revealed a high velocity mild mitral regurgitation that could be responsible for the hemolysis. The implantation of a second 26-mm SAPIEN 3 valve (Edwards Lifesciences, Irvine, California) allowed complete regression of the hemolysis. (**Level of Difficulty: Intermediate.**) (J Am Coll Cardiol Case Rep 2020;2:1124–8)

HISTORY OF PRESENTATION

An 85-year-old woman was referred to our institution for pulmonary edema. She had previously undergone mitral valve repair with a 26-mm Physio II annuloplasty ring (Edwards Lifesciences, Irvine, California). Transthoracic echocardiography revealed a severe mitral regurgitation (MR) related to a failure of the mitral valve repair. Given the high surgical risk (according to the European System for Cardiac Operative Risk Evaluation [EuroSCORE] 2, 17%) and the extreme frailty of the patient (body mass index <16 kg/m^2), the heart team concluded that the risk of re-surgery was prohibitive. Because of a complete restriction of the posterior leaflet, a MitraClip (Abbott Laboratories, Abbott Park, Illinois) procedure was not an option and it was decided to perform a mitral valve-in-ring (ViR) implantation.

After comprehensive cardiac computed tomography analysis, a 26-mm SAPIEN 3 (Edwards, Irvine, California) prosthesis was chosen (**Figure 1**). The procedure was performed under general anesthesia and with transesophageal echocardiogram (TEE) guidance as previously described. After valve implantation and catheter removal, only mild MR was observed and the final mean gradient was 3 mm Hg (Video 1). Within 12 h after the procedure, the patient presented an anuric acute kidney injury associated with acute anemia, whereas her cardiac and hemodynamic conditions remained stable.

LEARNING OBJECTIVES

- "Frame-related" hemolysis is a potential complication of valve in ring implantation.
- Optimal positioning of the prosthesis is mandatory during valve in ring implantation.
- "Valve-in-SAPIEN" implantation is effective in treating this complication.

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The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the *JACC: Case Reports* author instructions page.

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MEDICAL HISTORY

Her extracardiac medical history included chronic obstructive pulmonary disease, chronic kidney disease (creatinine, 200 μmol/l; estimate glomerular filtration rate, <10 ml/min), cystocele, hysterocele cure, and right ovariectomy. Cardiovascular risk factors were hypertension, dyslipidemia, and type 2 diabetes.

DIFFERENTIAL DIAGNOSIS

Differential diagnosis included mechanical hemolysis, toxic hemolysis, and acute hemorrhage.

INVESTIGATIONS

A mechanical hemolysis was suspected and confirmed by the presence of circulating schizocytes and the increase in plasmatic lactate dehydrogenase (LDH) and unconjugated bilirubin. The initial conservative strategy became rapidly ineffective with the need of weekly blood transfusion and worsening of renal function (increase in creatinine level up to 450 μmol/l) (Figure 2). In this setting, a new TEE was performed to address the mechanism of hemolysis. The SAPIEN 3 valve appeared to be positioned too proximal (i.e., "too atrial") and was responsible for a high-velocity regurgitation through the frame with no increase in the severity of the residual leak nor bioprosthesis migration. The length of prosthesis present in the atrium was 10 mm, and therefore, neither the outer nor the inner skirt was effective in sealing the ring (Figure 2).

Circumferential cells created by the frames present between the Physio II annuloplasty ring and the skirt of the SAPIEN 3 valve created multiple residual leaks that were very likely to be responsible for the hemolysis (Figure 2B).

ABBREVIATIONS AND ACRONYMS

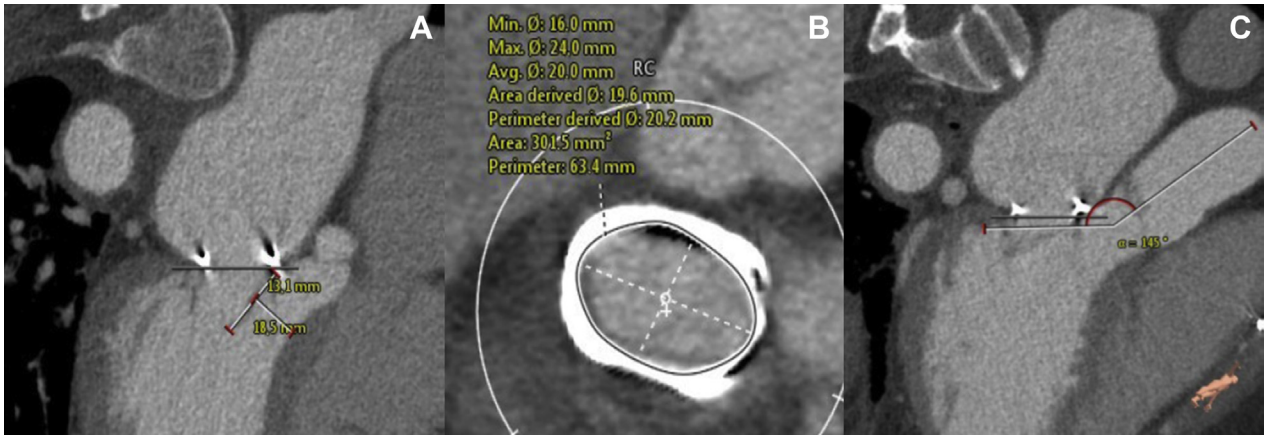
LDH = lactate dehydrogenase
MR = mitral regurgitation
TEE = transesophageal echocardiography
ViR = valve-in-ring

MANAGEMENT

Eventually, we decided, to implant a second 26 mm SAPIEN 3 prosthesis with a more anterior/ventricular position than the first prosthesis while remaining in the plane of the Physio-2 ring to prevent the risk of left ventricular outflow tract obstruction. We hypothesized that the outer skirt of this second prosthesis would seal the gap between the ring and the skirt of the first prosthesis and thus reduce residual leak. In addition, we thought that the leaflets of the first SAPIEN 3 prosthesis would participate in the sealing after they were locked in the open position by occluding the cells of the frame. Because of the atrial shortening of the SAPIEN 3 prosthesis during its expansion, we planned to position the second prosthesis between the landmarks 7 mm and 9 mm (Figure 3).

The bailout procedure was performed under general anesthesia with TEE monitoring. A second 26-mm SAPIEN 3 prosthesis was successfully

FIGURE 1 Computed Tomography Scan Analysis



(A) Measurement of the anterior mitral leaflet length. **(B)** Measurement of the 26-mm Physio II annuloplasty ring using planimetry at 301 mm^2. **(C)** Measurement of the mitro-aortic angulation.

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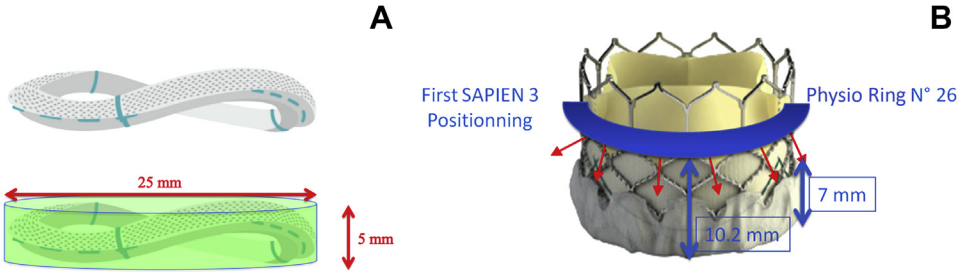
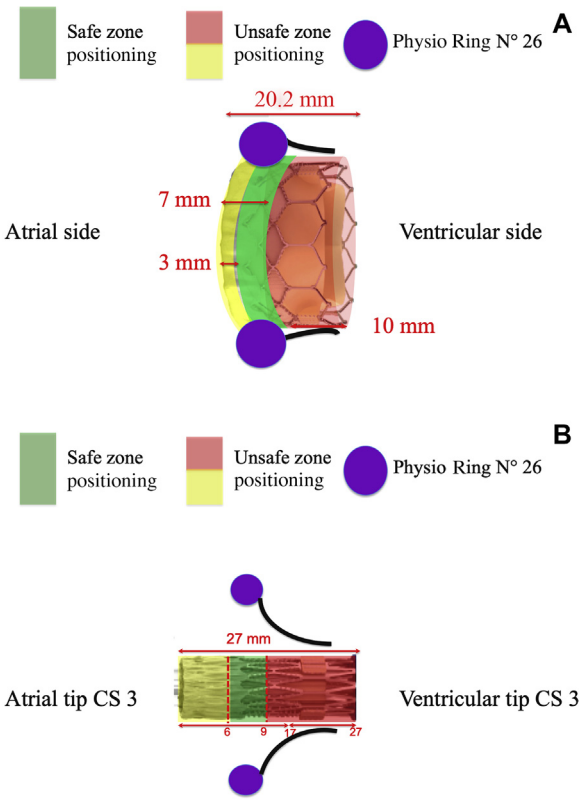
FIGURE 2 Physio 2-26 mm Saddle Shape Circular Ring and Mechanism of Hemolysis



(A) Physio 2-26 mm saddle shaped circular ring. Average saddle height and inter-commissural diameter are 5 mm and 25 mm, respectively. The **green box** represents the "tube graft" sealing cylinder: the positioning of the Sapien-3 prosthesis should aim to seal this part with the skirt of the prosthesis. (This **green box** is also shown in Figure 3.) **(B)** Mechanism of hemolysis. Mechanical hemolysis related to the regurgitation between the Physio II annuloplasty ring and the SAPIEN-3 Frame. **Red arrows** show leakages.

FIGURE 3 Positioning of the SAPIEN-3 Valve



(A) Landing zone (the surgical annulus: **purple circle**) should be aligned within the **green box,** which represents the "safe position" landmark on the deployed SAPIEN-3. **Yellow/red box** zone represents hazardous positioning. **(B)** Ventricular length of the device remains stable during balloon inflation. Positioning of the prosthesis considering atrial shortening. Landing zone (the surgical annulus: **purple circle**) should be aligned within the **green box** which represents the "safe position" landmark on the crimped SAPIEN-3. **Yellow/red** zone represents hazardous positioning. Safe delivery requires at least 7 mm between the annuloplasty ring and the atrial tip of the crimped device to avoid "ventricular positioning." A 9 mm distance between the annuloplasty ring and the atrial tip of the crimped may prevent "atrial positioning."
CS3 = Crimped SAPIEN 3.

TABLE 1 Case Management

	First Valve Implant Follow-Up				Second Valve Implant Follow-Up		
	Day 0	Day 1	Week 1	Month 2	2nd Valve Implant	Week 1	Month 3
Platelet (/mm^3)	114	108	110	136	113	90	NA
Hemoglobin (g/dl)	9.9	7.1	7.7	8.3	8.2	9	10.6
Schizocytes	NA	+	+	++	-	-	-
Reticulocytes (%)	NA	4	7	NA	NA	NA	NA
Bilirubin total (mg/l)	NA	38	NA	80	81	19	19
LDH (U/l)	NA	230	2,471	4,962	4,186	1,214	293
Haptoglobin (g/l)	NA	NA	0	0	0	0	1.3
Serum creatinine (μmol/l)	170	194	387	395	350	319	173

LDH = lactate dehydrogenase; NA = not available.

implanted in the first one, at the desired position. All residual leaks regressed after valve implantation (Video 2). Consistently, mechanical hemolysis rapidly disappeared with a normalization of haptoglobin, bilirubin, and LDH and the disappearance of circulating schyzocytes. Finally, renal function recovered to its baseline level (creatinine level 150 μmol/l) (**Table 1**).

DISCUSSION

Transcatheter mitral valve replacement for bioprosthetic valve degeneration and ring annuloplasty failure has been described as a safe technique with a high technical success (1). This case highlights a potential severe complication of transmitral valve implantation (TMVI), which has not been described to date (2–5). One may argue that a second SAPIEN 3 implantation during the index procedure would have prevented this mechanical complication. Nevertheless, TEE monitoring during procedure showed only mild MR and a second implantation to prevent hemolysis had not been described before. Moreover, no bedside tests assessing the risk of hemolysis after valve implantation of paravalvular leak closure have yet been developed.

We hypothesize that the mechanical hemolysis was related to the mechanical traumatism suffered by the red blood cells during the passage through the stent of the Edwards Lifesciences' prosthesis. This hypothesis is strengthened by the concomitant regression of the residual leaks and the hemolysis in this patient. Consistently, we never experienced hemolysis after valve-in-valve procedures in our institution, probably because in that case, the SAPIEN 3 frame is entirely covered by the surgical bioprosthesis, thus providing a better as compared to 3-dimensional saddle shape of the Physio II annuloplasty ring. Therefore, hemolysis may be more frequent after VIR than after valve-in-valve technique.

FOLLOW-UP

The 3-month follow-up examination confirmed the good result without significant MR and acceptable transmitral gradient (4 mm Hg).

CONCLUSIONS

The VIR technique is a relatively new technique that may lead to several complications including mechanical hemolysis. "Valve-in-SAPIEN" implantation seems to be safe and effective for the treatment of "frame-related" mechanical hemolysis. This case emphasizes the importance of meticulous positioning under TEE monitoring. It also highlights the importance of a perfect immediate result, as even a small RL can cause hemolysis.

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REFERENCES

1. Muller DWM, Farivar RS, Jansz P, et al. Transcatheter mitral valve replacement for patients with symptomatic mitral regurgitation: a global feasibility trial. J Am Coll Cardiol 2017;69:381–91.

2. Eleid MF, Whisenant BK, Cabalka AK, et al. Early outcomes of percutaneous transvenous transseptal transcatheter valve implantation in failed bioprosthetic mitral valves, ring annuloplasty, and severe mitral annular calcification. J Am Coll Cardiol Intv 2017;10:1932–42.

3. Urena M, Himbert D, Brochet E, et al. Transseptal transcatheter mitral valve replacement using balloon-expandable transcatheter heart valves: a step-by-step approach. J Am Coll Cardiol Cardiovasc Intv 2017;10:1905–19.

4. Urena M, Brochet E, Lecomte M, et al. Clinical and haemodynamic outcomes of balloon-expandable transcatheter mitral valve implantation: a 7-year experience. Eur Heart J 2018;39:2679–89.

5. Yoon S-H, Whisenant BK, Bleiziffer S, et al. Transcatheter mitral valve replacement for degenerated bioprosthetic valves and failed annuloplasty rings. J Am Coll Cardiol 2017;70:1121–31.

KEY WORDS acute hemolysis, transcatheter mitral valve implantation, SAPIEN 3, failure of mitral valve repair

APPENDIX For supplemental videos, please see the online version of this paper.