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**Case Report** 

# Misadventure During Balloon Mitral Valvuloplasty, a Complication Despite All Precautions

Hatim Al Lawati, MD, FRCPC, FACC, FSCAI,<sup>a</sup> and

Mohammed B. Al Riyami, MD, MRCP(UK)<sup>b</sup>

<sup>a</sup> Cardiology Unit, Department of Medicine, Sultan Qaboos University Hospital, Seeb, Oman <sup>b</sup> Adult Cardiology, National Heart Centre, The Royal Hospital, Muscat, Oman

Accidental aortic puncture is a much dreaded and potentially serious complication of transseptal catheterization and was recognized in the initial description of the technique by J. Ross Jr and colleagues in 1958.<sup>1</sup> However, inadvertent puncture of the pulmonary artery, although theoretically possible and despite the vast experience with transseptal balloon mitral valvuloplasty, has never been described. We present a unique case in which balloon mitral valvuloplasty in a pregnant patient was complicated by puncture of the right main pulmonary artery. We also discuss possible mechanisms and approach to management.

A 40-year-old woman with grand multiparity  $(G_9P_8L_8A_1)$ was referred to our institution for severe rheumatic mitral stenosis. All her previous pregnancies were unremarkable. However, into the second trimester of her current pregnancy, she was becoming increasingly dyspneic at mild to moderate levels of physical exertion. At 18 weeks of gestation, a transthoracic echocardiogram revealed normal left ventricular dimensions and systolic function. The right ventricle was normal. The left atrium (LA) was severely enlarged. The mitral valve (MV) was rheumatic and severely stenotic. The MV area (MVA) was measured at 1.4 cm<sup>2</sup> using the pressure half-time method, and at 1.5 cm<sup>2</sup> on planimetry. The mean MV gradient was 12 mm Hg at a sinus rate of 100 beats per minute. The Wilkin's score was 7 out of 16 points. The pulmonary artery (PA) pressure was moderately elevated, with an estimated PA systolic pressure (PASP) of 51 mm Hg. The main and branch PAs were dilated. She remained dyspneic despite taking of furosemide and bisoprolol, and she was therefore referred for balloon mitral valvuloplasty. At this time, she was past 30 weeks of gestation. Transesophageal

E-mail: hatimaah@squ.edu.om

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echocardiography (TEE) revealed an MVA of 1.4 cm<sup>2</sup> using the pressure half-time method. The mean MV gradient had increased to 18 mm Hg at a sinus rate of 110 beats per minute. She now had a moderately dilated right ventricle with moderate to severe tricuspid regurgitation and severe pulmonary hypertension, with an estimated PASP of 65 mm Hg. In anticipation of a difficult transseptal access, TEE was briefly used during the procedure to guide the transseptal puncture. The initial hemodynamic measurements are summarized in Supplemental Table S1. Transseptal puncture was attempted using a BRK needle (BRK Transseptal Needle, St. Jude's Medical, Belgium) and an 8.5 Fr SL-0 sheath (Swartz SL-0, St. Jude's Medical, Plymouth, MA). This procedure proved quite challenging, and after multiple attempts, the interatrial septum (IAS) was pierced in a more superior location. Upon connecting the end of the BRK needle to a manometer, a PA arterial pressure tracing was obtained (Fig. 1). This tracing was confirmed with a gentle contrast injection though the tip of the dilator (Video 1 , view video online). A 0.032" guide wire was advanced through the dilator and appeared to course down the left main PA. No anticoagulation had been administered yet. Given that the TEE probe had already been withdrawn, a bedside echocardiogram was performed and revealed a new small circumferential pericardial effusion without signs of tamponade. The dilator was slowly and gradually withdrawn back into the LA. Serial echocardiograms reassuringly confirmed stability of the effusion. Given that the operators still had access to the LA, a standard LA wire was secured in a double loop within the LA cavity (Video 2 End, view video online). At this point, unfractionated heparin was administered. The effusion remained unchanged throughout the procedure. The MV was then dilated with a 26-mm balloon (INUOE-BALLOON, Toray Industries, Tokyo, Japan) with a significant reduction in transvalvular gradient (Supplemental Table S1). After the procedure, the patient remained in the hospital for 5 days for monitoring. A detailed echocardiogram obtained the following day revealed a small residual pericardial effusion. The MVA was measured at  $1.8 \text{ cm}^2$  on planimetry, with a mean MV gradient of 5 mm

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Corresponding author: Dr Hatim Al Lawati, Senior Consultant, Interventional Cardiology & Structural Heart Disease, Associate Professor, Department of Medicine, Sultan Qaboos University Hospital, P.O. Box 287, Postal Code 123, Al Khoudh, Muscat, Oman. Tel.: + 968-9783-9782.

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#### **Novel Teaching Points**

- A horizontally rotated heart predisposes a patient to inadvertent LA roof puncture and injury to the overlying vascular structures.
- A low transseptal puncture guided by TEE or intracardiac echocardiography and using a more acutely angulated transseptal needle or needle-on-wire guidewires might avert this complication.
- Various strategies can be implemented in treating this complication, including surgical repair or the use of a septal occluder to obliterate the iatrogenic track.

Hg. Only a mild degree of mitral regurgitation was seen. A significant reduction in tricuspid valve regurgitation also was observed (mild to moderate), as well as the PA pressure, with an estimated PASP of 30 mm Hg. No flow was seen across the IAS on color Doppler.

Three weeks later, the patient presented with chest pressure and increasing dyspnea and was found to have a moderate to large circumferential pericardial effusion with tamponade. At 34 weeks of gestation, she underwent an urgent caesarean section with bilateral tubal ligation. The pericardial effusion was drained surgically and yielded serous fluid. Intraoperative inspection of the LA and PA revealed no tear or laceration. Three days later, a contrast cardiac computed tomogram showed a diverticulum in the supero-anterior aspect of the LA roof immediately adjacent to the IAS (Fig. 2). Minimal contrast extravasation was managed conservatively. At 1 month, a repeat echocardiogram revealed no reaccumulation.

#### Discussion

Transseptal puncture is associated with adverse events in 1:100 cases. Commonly described complications include cardiac tamponade, inadvertent aortic puncture, systemic and cerebral embolism, and persistence of an iatrogenic septal defect.<sup>2</sup> Aortic puncture is rare but life-threatening, and it occurs in 0.05% of the cases. It usually happens in situations in which excessive rotation of the heart distorts the usual relationship between the aortic root and fossa ovalis and the corresponding fluoroscopic landmarks.

This distortion was likely the main mechanism of PA injury in our case. The 30-week gravid uterus displaced the diaphragm upwards, and confounded by further cephalad migration of the diaphragm by the supine position required for the procedure, resulted in the myocardium being more horizontally placed. As a result, the already rightward bulging IAS was now tilted to a more horizontal configuration, positioning the fossa ovalis farther away from the transseptal assembly dropping from the superior vena cava, consistently biasing it to a more superior location along the IAS, or causing it to slip superiorly if it engaged at all in the mid-septum. The needle penetrating the IAS would immediately encounter the root of the LA, and in our case, readily exited into the dilated right main PA coursing over the LA. Perhaps one beneficial modification to the septal puncture technique would be to use a more angulated needle (eg, BRK-1 or BRK-2), which would engage a lower position in the IAS. Potential difficulties in crossing the MV due to a low puncture could be overcome using the over-the-wire technique.<sup>3</sup>

Recently, specialized devices have been introduced to refine the technique of transseptal access and allow for a more controlled puncture. Among these are needle-on-wire devices, such as the SafeSept Transseptal Guidewire (Pressure Products, Houston, TX) or the radiofrequency-based VersaCross guidewire (Baylis Medical, Montreal, QC). Once the needle tip punctures the septum, and as it advances without dilator support, these guidewires assume an atraumatic curved shape, rendering them incapable of further penetration.<sup>4</sup> Unfortunately, neither of these specialized guidewires was available to us at the time.

We followed the same principle described in the literature on managing aortic punctures.<sup>5-7</sup> A 0.032" guidewire was secured into the distal left PA, and a slow and gradual withdrawal of the dilator was performed into the LA cavity.



**Figure 1.** Simultaneous systemic (aortic) and pulmonary arterial pressure tracings. The aortic pressure recorded through a 5 Fr pigtail catheter in the aortic root measuring 105/64 mm Hg with a mean of 79 mm Hg. The pulmonary arterial pressure was recorded through the SL-0 sheath from the tip of the dilator measuring 52/23 mm Hg and a mean of 40 mm Hg.



Figure 2. Contrast cardiac computed tomogram showing a diverticulum in the supero-anterior aspect of the left atrium roof immediately adjacent to the interatrial septum.

Conceivably, the flap raised in the PA could have been aligned parallel to the direction of blood flow and, in conjunction with the near systemic PA pressure, sealed the localized perforation. Several bailout options could be considered, including surgical repair, and the use of a septal occluder to close the LA-PA track. In our case, the track fortunately sealed spontaneously, allowing us to complete the valvuloplasty. A point worth mentioning is that the second presentation with cardiac tamponade was due to a reactive pericardial effusion developing in response to the original hemopericardium. This finding was confirmed intraoperatively when a nonhemorrhagic serous collection was drained.

#### **Ethics Statement**

This case report was conducted in compliance with the institutional ethics committee regulations and guidelines and received the committee's approval.

## **Patient Consent**

The authors confirm that patient consent has been obtained prior to submitting this work and all efforts were made to protect their identity.

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## **Disclosures**

The authors have no conflicts of interest to disclose.

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## **Supplementary Material**

To access the supplementary material accompanying this article, visit *CJC Open* at https://www.cjcopen.ca/ and at https://doi.org/10.1016/j.cjco.2023.04.008.