Case Report

Perioperative Management of Transcatheter, Aortic and Mitral, Double Valve-in-Valve Implantation During Pregnancy Through Left Ventricular Apical Approach

Abstract

Pregnant women with stenotic degeneration of bioprosthetic cardiac valves may require another valve replacement procedure when their symptoms deteriorate with progression of pregnancy, but fetal mortality is higher with cardiac surgery done on cardiopulmonary bypass. Transcatheter valve-in-valve implantation may help to improve the fetal and maternal outcomes in these situations. Double valve-in-valve implantation is rare and has not been reported in a pregnant patient. We report, for the first time, the case of a pregnant woman with stenotic bioprosthetic valves in the mitral and aortic positions, who underwent a successful concomitant, transcatheter, double valve-in-valve implantation through the left ventricular apical route during the second trimester of her precious pregnancy.

Keywords: *Left ventricular apical approach, transcatheter double valve-in-valve implantation, valve-in-valve implantation during pregnancy*

Suresh Chengode, Rahul Vijaykumar Shabadi, Ram Narayan Rao, Nasser Alkemyani, Hilal Alsabti[1]

Department of Anaesthesia, Division of Cardiac Anaesthesia, Sultan Qaboos University Hospital, [1]Department of Surgery, Division of Cardiac Surgery, Sultan Qaboos University Hospital, Muscat, Oman

Introduction

Bioprosthetic valves may be preferred for cardiac valve replacement in women of childbearing age group to avoid the complications of warfarin anticoagulation during pregnancy and parturition.[1,2] Unfortunately, degeneration of a bioprosthetic valve is accelerated in these young patients and may result in early prosthetic valve stenosis or incompetency.[3] A pregnant woman with a stenotic prosthetic valve may decompensate during the course of her pregnancy and would require another intervention for the stenotic valve. Transcatheter valve implantation is a promising alternative to hitherto recommendation of surgical valve replacement.[4] We describe the case of a pregnant woman with stenotic bioprosthetic valves in the mitral and aortic positions who underwent a concomitant, transcatheter double valve-in-valve implantation through the left ventricular apical route during the second trimester of her pregnancy. To the best of our knowledge, this case is the first of its kind to be reported.

Case Report

A 34 year old lady who had undergone double valve replacement eight years prior with Carpentier-Edwards Perimount Magna valves (Edwards Lifesciences Corp, Irvine, CA, USA) of 21 and 27 mm. sizes in the aortic and mitral positions, respectively, presented with symptoms of progressive effort intolerance. A transesophageal echocardiography (TEE) revealed stenotic degeneration of aortic and mitral bioprosthetic valves with peak/mean gradients of 96/46 and 18/10 mmHg, respectively, and the absence of thrombus in the left atrium (LA). During the preoperative evaluation for a surgical double-valve replacement, she tested positive for pregnancy screening. Since she had spontaneous abortion of three previous pregnancies and was yet to have a child in the past 10 years of her married life, she decided to continue her precious pregnancy and refused any intervention for the diseased valves. Toward the end of first trimester, her symptoms worsened to New York Heart Association Class III. A multidisciplinary team of medical specialists agreed to escalate antifailure treatment to get her into the second trimester and then she could decide either to undergo a surgical double-valve replacement or a transcatheter double valve-in-valve implantation, if required. At 21 weeks,

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Address for correspondence:
Dr. Suresh Chengode, Department of Anaesthesia, Division of Cardiac Anaesthesia, Sultan Qaboos University Hospital, PB 38, PC 123, Muscat, Oman.
E-mail: sureshchen@hotmail.com

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her symptoms deteriorated requiring admission to the Intensive Care Unit (ICU), and at that point, she requested for an intervention. The pros and cons of a surgical valve replacement on cardiopulmonary bypass (CPB) and a transcatheter valve-in-valve implantation through a limited thoracotomy, during pregnancy, were explained to her and she opted to undergo transcatheter double valve-in-valve implantation. A transthoracic echocardiography (TTE) at that time showed a peak/mean gradient of 148/66 and 20/15 mmHg across the aortic and mitral valves, respectively. Mitral valve area was 0.8 cm^2 (by pressure halftime) and aortic valve area was 0.7 cm^2 (by continuity equation). Both prosthetic valves and the native tricuspid valve had mild-to-moderate degree of incompetency. Calculated pulmonary artery systolic pressure (PASP) was 72 mmHg. Right ventricle (RV) showed minimal dilatation, and tricuspid annular plane systolic excursion measured was 16 mm. Left ventricle (LV) showed moderate degree of concentric hypertrophy with an ejection fraction of 50% and no regional wall motion abnormality (RWMA). LA had a maximum diameter of 5.8 cm with no obvious thrombus inside. She was in sinus tachycardia and was receiving an oral beta blocker, intravenous (IV) diuretics, and oxygen supplementation. At 22 weeks of pregnancy, it was decided to proceed with transcatheter valve-in-valve implantation of both the aortic and mitral valves through the LV apical approach.

On the day of the procedure, the patient received only IV ranitidine as premedication. In the hybrid operating room, she was positioned supine with a 15° of left uterine displacement and 15° of head elevation. CPB machine was primed and kept ready. All standard ASA monitors, invasive blood pressure monitor, a cardiotocograph, and external defibrillator pads were attached. Modified rapid sequence induction was done using IV propofol, remifentanil, and rocuronium and intubated with a single lumen endotracheal tube. Anesthesia was maintained with sevoflurane, remifentanil infusion, and boluses of rocuronium. A 7 Fr triple lumen central venous catheter and a 6 Fr venous sheath were inserted into the right internal jugular vein through separate punctures. A balloon-guided pacing catheter was introduced through the venous sheath. A lead abdominal shield was placed on the patient to reduce radiation exposure to the fetus. TEE confirmed the earlier echo findings [Video 1] and excluded a thrombus in the LA appendage. Left femoral artery and right femoral vein were cannulated with 5 Fr sheaths to expedite placement of transcutaneous cannulae to initiate CPB, if required. TTE was used to identify the LV apex, and a 6 cm thoracotomy incision was made exactly over it. Inspiratory tidal volume was reduced to 6 ml/kg and rate adjusted to achieve a normal $EtCO_2$. Ten thousand units of IV unfractionated heparin achieved an activated clotting time of 300 s. Epicardial echocardiography was used to identify the true LV apex to prepare for the placement of the device introducer sheath. Guidewires and device assembly were positioned across the prosthetic valves using TEE guidance. Fluorography was used earlier for identifying the working views of aortic and mitral valves and latter for the proper alignment of the radio-opaque markers of the device assembly during balloon deployment of the valves. Fluorography power was set at "LOW" and a frame rate of 9 fps was used. The total duration of fluorography was just 3 min and 06 s with air kerma of 16 mGy. Sapien XT valves of 23 and 29 sizes were deployed inside the prosthetic annulus of the aortic and mitral valves, respectively, aortic being the first to be deployed. Rapid ventricular pacing at 180 beats/min was delivered for 14 and 11 s during the balloon inflation for the deployment of the aortic and mitral valves, respectively. Baseline fetal heart rate (FHR) was between 120 and 130 beats/min (BPM) with a variability of 5–10 of accelerations/min which was never more than 15 BPM and showed no deceleration. FHR pattern remained unchanged during the period of rapid ventricular pacing. Maternal hemodynamics remained stable throughout the procedure except during the rapid ventricular pacing, where the mean arterial pressure (MAP) dropped to 35–40 mmHg. Maternal cardiac rhythm, rate, and MAP were restored to sinus pattern and normal values within 10 s of stopping the rapid pacing. TEE assessment of the new valves showed laminar flows across both of them with no flow acceleration and peak/mean gradients of 68/24 and 18/5 mmHg across the aortic and mitral valves, respectively. Both prosthetic valves had normal leaflet motion and there were no abnormal intra- or para-valvular leaks [Videos 2 and 3]. LV function appeared normal with an ejection fraction of 60% and no new RWMA. RV function showed marginal improvement with a calculated PASP of 52 mmHg. An abnormal flail structure was identified on the prosthetic valve annulus close to the atrial appendage [Video 4] which could be a dehisced portion of the old prosthetic valve leaflet. Heparin was neutralized with 100 mg of protamine. She did not require any inotropes perioperatively. During thoracotomy wound closure, two ON-Q continuous infiltrative analgesic catheters (Halyard Health, 5405 Windward Parkway, Alpharetta, Georgia, USA) were placed in the wound, and 0.25% levobupivacaine was used through this for continuous infiltrative analgesia. The patient was extubated 2 h later in the ICU and was monitored there during the first 24 h. Postoperatively, the maternal and fetal parameters remained stable and uterine activity corresponded to the gestational age. A TTE at the time of discharge from hospital, on the 5th postoperative day, showed a peak/mean gradient of 52/20 and 15/5 mmHg across aortic and mitral valves, respectively, normal leaflet motion and no abnormal leaks. The flail structure appeared to remain stable. The patient was put on once daily dose of oral aspirin 81 mg and 80 mg of enoxaparin injection subcutaneously from the first postoperative day until the time of admission for delivery. The patient was followed up by the multidisciplinary team, and at term, she gave

birth to a healthy baby through normal vaginal delivery with epidural labor analgesia.

Discussion

CPB-assisted cardiac surgery during pregnancy carries a higher risk for the fetus than the mother. The fetal mortality rate remains high at 16%–33% while the maternal mortality rate has decreased from an earlier report of 3%–15% to 1.47%, which is comparable with that of nonpregnant women undergoing cardiac surgery on CPB.[5-7] This prompted the team to look for an alternative to open surgical valve replacement, and transcatheter approach seemed to be a feasible option. Paradis *et al.* had reported a case of concomitant, transcatheter, aortic and mitral, valve-in-valve replacement through the transapical approach in an elderly male patient.[8] There were case reports of transcatheter aortic valve implantation during pregnancy, but all were done through the femoral route.[9,10] Transfemoral, transatrial septal, and antegrade mitral valve implantation has been successfully tested in human trials using the CardiAQ transcatheter mitral valve (Edwards Lifesciences, Irvine, CA, USA), but it was not commercially available.[11] Decision to deploy both Edwards Sapien XT valves through the LV apical approach was taken because this valve can be deployed in mitral position only through this approach and this is a standardized alternative route for its deployment in the aortic position. The Medtronic CoreValve does not support a transapical approach for aortic valve implantation and is not approved for deployment in the mitral position.

Radiation exposure of the fetus is of prime concern during fluoroscopy procedures. Physical growth retardation, impairment of neurocognitive development and IQ, and even loss of fetus has been reported following fetal radiation exposure in excess of 500 mGy but is unusual if it is <50 mGy.[12] Strategies to minimize radiation exposure are avoidance of unnecessary radiological investigations, use of appropriate radiation shields, avoid/restrict cineradiography, and minimize the total duration and amount of radiation by depending more on fluorography and fluoro-grab at a lower frame rate and "LOW" power setting.[10] A computed tomographic (CT) angiogram could be avoided in this patient because the *in situ* prosthetic valve sizes were known and the planned approach was through the LV apex. A transfemoral approach requires a CT angiographic scan to assess the size and nature of femoral arteries, iliac arteries, and aorta and mandates fluoroscopic guidance while advancing guidewires, catheters, and valve assembly through these vessels during the procedure. TEE guidance is more reliable than fluoroscopy in LV apical approach to maneuver guidewires and valve assembly within the LV cavity to avoid entanglement with chordae tendineae.

Rapid ventricular pacing is mandatory during balloon-assisted deployment of Sapien XT valves, and maternal hypotension during this time is unavoidable. Severity and duration of hypotension can be minimized by ensuring adequate intravascular volume and shortening the duration of pacing. FHR monitoring helps to detect significant reduction of uteroplacental blood flow. This patient had no changes in FHR during the two short bursts of rapid pacing.

Functional integrity of the valve can be assessed with TEE immediately after the deployment. Position and stability of the new prosthetic valve, the range of leaflet movement, type of flow across the valve and presence of flow acceleration, abnormal para- or intravalvular leaks, velocity of blood flow across the valve and measurement of peak and mean gradients, visualizing the flow in coronary arteries, chamber functions, and any new RWMA are some of the important parameters to be assessed using echocardiography. As mentioned above, the abnormal flail structure that was identified on the mitral annulus of this patient, immediately after the deployment of the new valve, could be a dehisced portion of the old prosthetic valve leaflet. Serial echocardiography would help to assess its stability. Documentation of such echocardiographic findings in the patient's charts will help to avoid spurious diagnosis of endocarditis in follow-up examinations.

Basic principles of anesthetic care for a pregnant patient undergoing surgery under general anesthesia were followed in this case. Lung isolation was not required to provide an ideal operating condition through the minithoracotomy. Controlled ventilation through the normal endotracheal tube with a tidal volume of 5–6 ml/kg and a rate set to achieve normocarbia did not interfere with the procedure. Hypocarbia and alkalosis should be avoided as it may compromise placental circulation. Continuous monitoring with a cardiotocograph would help in early detection of compromise in uteroplacental circulation. Extubation was electively delayed by a couple of hours in this patient to watch for any acute complications.

In conclusion, a precious pregnancy complicated by prosthetic double-valve stenosis was salvaged by transcatheter double valve-in-valve implantation thus avoiding the fetal complications of surgical valve replacement on cardiopulmonary bypass. LV apical approach helped in minimizing radiation exposure of the fetus with TEE playing an invaluable role. A well-planned and coordinated teamwork resulted in a successful outcome of this case.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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