Case Report

Unanticipated change in access site and anesthetic considerations for transcarotid transcatheter aortic valve implantation procedure: A case report

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ABSTRACT

A 76-year-old man was admitted to our hospital due to his symptomatic severe aortic stenosis. With the high risk of open surgery due to comorbidities, transcatheter aortic valve implantation (TAVI) was selected after an in-depth discussion between the heart team and the patient. Since the traditional transfemoral access route was not appropriate due to severe calcifications out of proportion to computed tomography imaging, the access was changed to the left carotid route intraoperatively. A 24.5 mm Myval OCTOCAR valve was successfully implanted without any complications. The patient significantly improved postoperatively without any major cerebral and cardiovascular adverse events. TAVI through the carotid artery is thus feasible, safe, and effective in such unanticipated conditions.

Key words: Anesthetic implications, Carotid access, Transcarotid, Transcatheter aortic valve implantation, Transcatheter aortic valve replacement

Aortic valve (AV) stenosis is one of the most common valvular heart diseases in patients with end-stage chronic kidney disease (CKD) [1]. Although surgical AV replacement (SAVR) is considered the standard therapy for aortic stenosis (AS), the mortality rate is quite high for patients with AS and CKD and advanced age who are undergoing open surgery due to sternotomy, cardiopulmonary bypass, and aorta cross-clamping. In recent decades, TAVI has emerged as a potential alternative to surgical AVR for the treatment of such patients [2,3]. The majority of transcatheter AV implantations (TAVI) are being performed through the transfemoral approach. The transcarotid approach for TAVI is one of the alternatives when transfemoral route is contraindicated [4].

In this report, we describe a case of severe AS and CKD who had been planned for transfemoral TAVI but underwent transcarotid TAVI due to bad femoral vessels found intraoperatively. This case report highlights the crucial role of anesthesiologists in managing unplanned surgical approaches. It underscores the importance of their preparedness, in-depth knowledge, and understanding of the anesthetic implications associated with various surgical techniques.

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CASE REPORT

A 76 year old male with Type 2 diabetes mellitus for 40 years, CKD for 4 years, and coronary artery disease (CAD) for 1 year presented to our institution with complaints of retrosternal burning sensation with mild sweating for 10 days. He initially went to outside hospital 9 days back and diagnosed to have acute coronary syndrome-anterior wall myocardial infarction and was thrombolysed with Inj. Tenecteplase and came to our institution for further management. He had a history of CAD for which coronary angiography and percutaneous coronary intervention (PCI) was done to obtuse marginal and left anterior descending (LAD) arteries 1 year back. He had CKD for 4 years, non-oliguric type, and not on dialysis previously. His medications include Tab. ticagrelor, Tab. ecosprin, Tab. atorvastatin, Tab. ivabradine, Tab. dihydralazine, insulin, Tab. cilnidipinde, Tab. prazosin, and Tab. sodium bicarbonate.

On examination, he was conscious, oriented, afebrile, and moderately built with the weight of 61 kg and a body mass index of 24. General examination showed pallor and bilateral pedal edema, systemic examination showed bibasal crepitations, ejection systolic murmur in the left parasternal region, and hepatomegaly. His vitals were Pulse rate 90 beats/min, Respiratory rate 24/min, oxygen saturation (S_pO_2) 98% in Room Air, and Blood pressure

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130/60 mmHg.

His laboratory parameters were Hemoglobin (Hb) 8 g/dL, creatinine 3.4 mg/dL, NT ProBNP 18,720 pg/mL, and capillary blood glucose 280 mg/dL. Echocardiography showed mid-distal interventricular septum (IVS), left ventricular (LV) apex akinesia, ejection fraction of 30%, severe AS with valve area 1 cm^2 and gradient of 20/33 mmHg (Mean Pressure Gradient/Peak Pressure Gradient), moderate pulmonary artery hypertension with right ventricular (RV) systolic pressure of 50 mmHg. High-resolution computed tomography (CT) showed early interstitial lung disease features with bilateral moderate pleural effusion. Coronary angiogram (CAG) showed 40% in-stent restenosis in proximal LAD and 90% diffuse disease in distal LAD. He was started with Heparin and Furosemide infusion.

In view of his age and comorbidities with severe LV dysfunction, he was planned for TAVI combined with CAG and PCI, by our heart team. Pre-operative cardiac CT was taken and an aortic annulus area of 457.8 mm^2, effective diameter of 24.1 mm, distance to the right coronary artery of 11.5 mm, and distance to the left main coronary artery of 11 mm were noted. CT aortogram showed severe calcification in the abdominal aorta, moderate calcification at both common iliac arteries (measurement 7.8 mm in the right and 6.8 mm in the left), and both femoral arteries (measurement 6.3 mm in the right and 6 mm in the left). Coronary perfusion scintigraphy showed a moderate-sized area of absent perfusion in the apex, apicoanterior, apicoseptum, and mid anteroseptum in LAD with rest of LAD, entire left circumflex, and right coronary territories showing preserved perfusion. Since his volume overload status was optimized and creatinine showed a decreasing trend, Hb improved after the blood transfusion, and sugars were controlled, he was planned for the procedure after 13 days of admission.

A pre-operative airway examination was done and he was suspected to have a difficult airway with Mallampati Grade of III and moderate neck restriction. Immediate pre-operative investigations showed creatinine of 3.5 with urine output of more than 1.5 L/day, serum sodium 133 mEq/L, potassium 4.4 mEq/L, HbA1C 9.2%, Hb 9.5 g/dL, platelets 260,000 cells/microlit. Ticagrelor was stopped 1 week before the procedure and bridged with heparin. Tab. ivabradine, Tab. sodium bicarbonate, and Tab. furosemide were continued on the day of the procedure and 2 packed red blood cells (PRBC) and 2 fresh frozen plasma were reserved. High-risk consent was obtained and the need for post-procedure intensive care unit (ICU) care was explained to the patient and attenders.

Anesthetic management

The patient had a 20 gauge IV cannula in the right dorsum of the hand. In the cardiac operation theatre, the patient's right radial artery was secured with 20 gauge switch cannula and the left internal jugular vein (IJV) was cannulated with an 8.5Fr 4lumen catheter under local anesthesia. His pre-induction vitals were pulse rate 74/min, blood pressure 140/60 mmHg, and S_PO_2 100% with 4L O_2 in the facemask. After preoxygenation for 3 min, he was induced with titrated doses of Propofol, Fentanyl 100 mcg, and Rocuronium 50 mg. After mask ventilation for 2 min, he was intubated with 8.5 size Portex endotracheal tube with the help of video laryngoscopy and bougie. Maintenance of anesthesia with Sevoflurane, oxygen, and medical air with fresh gas flow of 1 L/min. Intermittent positive pressure ventilation was maintained in a volume-controlled ventilation mode with a Tidal volume of 400 mL, respiratory rate 14/min, peak airway pressure 20 cm H_2O, and positive end-expiratory pressure 5 cm H_2O. Antibiotics according to institution guidelines were given and noradrenaline and dobutamine infusions were initiated and titrated accordingly.

The left femoral 7Fr sheath was inserted for PCI and the right IJV permcath was inserted in view of anticipated long-term dialysis for the patient. The surgical team made a cut down in the right groin to take control of the right femoral artery to accommodate the access sheath required for TAVI. The artery was severely calcified circumferentially out of proportion to the CT finding. A left groin cut down was made to plan for valve delivery through the left femoral artery. However, it was also severely calcified, so it was decided to take the left carotid artery as the access vessel. On-table ultrasound examination revealed normal bilateral carotid arteries without any calcifications, with the left carotid artery measuring 7 mm in diameter. Since the central venous catheter was placed through a high approach, there was enough space for a left carotid cut down. Hence, the left carotid was exposed and taken control, a 9fr sheath was inserted under vision into the artery and the patient was shifted to the cardiology cath laboratory.

To have better space utilization, the patient was put on an ICU ventilator in the cath laboratory. Anesthesia was maintained with propofol infusion titrated based on clinical judgment. Trans-esophageal echo (TEE) probe was inserted. External defibrillator paddles were applied. Since the approach had been changed, the position of the monitor, infusion pumps, and ventilator had to be changed. For femoral access, all these things would be placed on the left side of the head end of the patient. Now for the left carotid access, we moved our monitor, pumps, and ventilator to the right side of the head end of the patient. Before beginning the procedure, the C-Arm was positioned at the working angle and ensured that Intravenous lines, pressure lines, and ventilator tubings were free from entanglement. A balloon-tipped TPI was placed in the RV apex through right femoral venous access. A pigtail was positioned in the aortic root through the left femoral artery sheath. Then, the stenotic valve was crossed with a guidewire through the left carotid access. This was then exchanged for a pigtail catheter through which the preformed TAVI wire was positioned in the LV apex. The patient was heparinized with 100 U/kg of unfractionated heparin intravenously. 9fr sheath was exchanged with 14fr python sheath for valve delivery. Then balloon aortic valvuloplasty was carried out by dilating the native valve and deployed with a 24.5 mm Myval OCTOCAR valve.

Rapid ventricular pacing is instituted through the pacing wire to reduce the LV ejection and cardiac motion, therefore stabilizing both the valvuloplasty balloon during inflation and the valve during deployment. TEE and arterial waveform observation were used to verify the lack of ventricular contraction and peripheral arterial pulse waves during the testing of rapid ventricular pacing. After each episode, there was a considerable delay before optimum cardiac function resumed, accompanied by systemic hypotension. This period of hemodynamic instability was treated with vasopressors and fluid boluses. Optimal positioning of the device across the AV was ensured with fluoroscopy, aortography, and TEE with Doppler. After valve implantation, TEE was performed and paravalvular regurgitation, hemopericardium, and aortic dissection were ruled out. Post-procedure there was no residual gradient with nil aortic regurgitation. Complex PCI with drug-eluting stent was done to distal LAD through the right femoral arterial (RFA) access. The RFA access site was closed surgically. Restrictive fluid strategy was followed during the intraoperative period and about 600 mL of fluid was administered, blood loss was around 100 mL, and urine output was 300 mL. Then the patient was shifted to the cardiac ICU in stable condition for monitoring.

Postoperatively, 1 unit of PRBC was transfused. Inotropes weaned off over 2 h and stopped. Since his Glasgow Coma Scale was normal, able to move all limbs with no evidence of stroke, he was extubated the same day in the ICU after 3 h. Since urine output was in decreasing trend with a normal intravascular volume status, furosemide infusion was started and tapered slowly over 24 h. The pacing sheath and left femoral arterial sheath were removed 6 h post-procedure. T. ecosprin and T. clopidogrel 75 mg each were started on the same night. Post-operative Echo showed AV MPG/PPG-2/4 mmHg, ischemic heart disease with Distal IVS, LV apex akinesia with severe LV dysfunction, EF 30–35%, Mild tricuspid regurgitation with right ventricular systolic pressure of 30 mmHg. Since he was hemodynamically stable, he was shifted to ward on Post operative day 1 and discharged after 6 days of post-operative period.

DISCUSSION

Aortic valvular stenosis remains the most common debilitating valvular heart lesion. Despite the benefit of SAVR, many high-risk patients cannot tolerate surgery due to multiple comorbidities [5]. Over the last decade, transcatheter AV replacement has evolved from a procedure reserved for high-to-prohibitive surgical risk patients, to an established therapeutic alternative to SAVR in the low-to-intermediate risk population [6,7]. This transcatheter procedure is performed traditionally through transfemoral approach. In recent years, transcarotid access is gradually becoming a promising alternative approach when the femoral artery is unsuitable. The first transcatheter AVR (TAVR) using transcarotid artery was reported in 2010 by Modine *et al*. [8], after which the number of cases has been increasing. This technique allows a direct path for AV implantation as well as provides a shorter distance from the entry access to the aortic root, which gives a better device control for valve implantation [9]. To perform TAVI through transcarotid route, the diameter of the common carotid artery (CCA) should be ≥6 mm [10], and the left carotid access is preferred to the right one because of its superior coaxial alignment of the transcatheter AV with the aortic annulus [11] provided no contralateral significant (≥70%) internal or CCA stenosis, or occlusion of the contralateral CCA or internal carotid artery [10,11].

Although there is no established consensus on the choice of anesthetic approach, a recent meta-analysis and systematic review suggest that TAVR performed under local anesthesia is associated with significantly lower risks of adverse clinical outcomes. These include reduced 30-day mortality, stroke, major and life-threatening bleeding, major vascular complications, long-term mortality, and shorter hospital and ICU stays [12]. Some case reports have been reported under epidural anesthesia [13] for transapical access for TAVI but transapical approach is less common nowadays [14]. The advantages of sedation are less risk of stroke and hemodynamic instability but TEE probe placement can be difficult. Airway obstruction and respiratory depression risk may warrant conversion to G.A anytime during the procedure. Respiratory depression, hypercarbia and acidosis during moderate to deep sedation may increase pulmonary vascular resistance and may lead to RV failure. Hence, general anesthesia may be favorable when compared to sedation in patients with pre-existing pulmonary hypertension. Ideally, sedative drugs should facilitate rapid and clear awakening to enable early detection of cerebral infarction. Agents with a short half-life, rapid metabolism, and fast onset/offset such as remimazolam, remifentanil, dexmedetomidine, and propofol are preferred [15,16].

General anesthesia allows open surgical access, TEE probe placement, and it is possible to minimize respiratory movement through cessation of mechanical ventilation under GA. Pre-existing hypovolemia in combination with the vasodilatory effect of anesthetic agents may lead to hypotension in patient undergoing G.A and thus explain the increased requirement for vasopressor therapy in this patient undergoing G.A. In our case, we opted for G.A. due to the routine use of TEE probe placement for TAVI in our center.

The main concern in transcarotid TAVI is periprocedural stroke. The 30-day neurological complication rate for transcarotid TAVI was found to be 3.8% [4]. The main cause is embolism due to atherosclerotic debris from the carotid artery or valvular calcification. G.A impairs real-time assessment of neurologic status, which potentially leads to extended cerebral hypoperfusion in high-risk patients. There are some methods to help reduce stroke in transcarotid TAVI similar to the technique followed during carotid endarterectomy such as a thorough radiological assessment of the bilateral carotid arteries, the circle of Willis by CT or magnetic resonance angiography, closely monitoring the cerebral SpO_2 with Near-infrared spectroscopy during the procedure [17,18], clamping the distal carotid artery during valve deployment. In our case, we opted for G.A. and we did not use cerebral oximetry since transcarotid approach is not pre-planned. However, we maintained high systolic blood pressure (>140 mmHg) for maintaining cerebral perfusion [19].

Postoperatively, tracheal extubation can usually be performed at the end of the procedure or in a high dependency after a complete neurological assessment. Early critical care discharge is likely if the procedure was uncomplicated, and hospital discharge may be possible significantly earlier than after conventional AVR. After wound infiltration with local anesthesia, analgesia requirements are minimal, and regular oral paracetamol is usually sufficient. Regular aspirin and clopidogrel, starting soon after the end of the procedure, are recommended by the manufacturers unless contraindicated. These are normally continued for 3–6 months.

CONCLUSION

This case demonstrates that transcarotid TAVI is feasible, safe, and effective for patients with AS and chronic kidney disease. More studies are needed to better evaluate the outcomes of TAVI in such patients.

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