Case Report

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Monitored anesthesia care with dexmedetomidine in transfemoral percutaneous trans-catheter aortic valve implantation
-two cases report-

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Percutaneous trans-catheter aortic valve implantation (TAVI) is recommended for inoperable patients with severe aortic stenosis at high risk for conventional aortic valve replacement. Originally, TAVI was mostly performed under general anesthesia. Here we describe two cases of transfemoral TAVI performed under monitored anesthesia care (MAC) with dexmedetomidine. Dexmedetomidine provides sedation, analgesia with minimal respiratory depression. Although MAC during transfemoral TAVI has limitations, such as unexpected patient movement and difficulty in intra-procedural use of transesophageal echocardiography, MAC with dexmedetomidine is feasible with close monitoring, fluoroscopic guidance and the participation of experienced anesthesiologists. (Korean J Anesthesiol 2014; 66: 317-321)

Key Words: Anesthesia, Dexmedetomidine, Heart valve prosthesis implantation, Hypnotics and Sedatives.

Since its introduction in 2002, percutaneous trans-catheter aortic valve implantation (TAVI) has been recommended for inoperable patients with severe aortic stenosis (AS) at high risk for surgical aortic valve replacement [1,2]. The number of TAVIs performed has since increased each year. Initially, TAVI was carried out under general anesthesia (GA) due to the large size of the sheath and the surgical access to femoral artery. GA has many advantages, which includes facilitation of sheath placement, removal, and eventual surgical repair of the arterial access site, immobility during valve deployment, peri-procedural transesophageal echocardiography (TEE), airway management, prevention of breathing artifacts, and rapid cardiopulmonary bypass when necessary [2,3].

GA in severe AS patients, however, can have complications, including cardiac and pulmonary morbidity with renal dysfunction and the need for intraoperative and/or postoperative hemodynamic support [4]. With the decrease in sheath sizes, improvements in procedural techniques, and increased cardiologists experience, TAVI via a transfemoral route is possible under monitored anesthesia care (MAC). Several studies have

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compared TAVI under MAC and under GA [4-8]. In this case report, we describe two cases of transfemoral TAVI performed under MAC with dexmedetomidine in our institute.

Case Reports

Case 1

An 83-year-old woman was diagnosed with severe AS. She had experienced dizziness and dyspnea on exertion (NYHA class III) for 1 year prior to presentation at our institute, occurring once to twice per month. Her medical history included hypertension, which had been treated with aspirin 100 mg/day, isosorbide dinitrate 40 mg/day, and furosemide 20 mg/day. Before the procedure, she was premedicated with clopidogrel 300 mg/day. Transthoracic echocardiography (TTE) showed severe calcification and thickening of the aortic valve, with an aortic valve area of approximately 0.6 cm^2, a maximum transaortic valvular velocity of 6.2 m/sec, a peak/mean pressure gradient of the aortic valve of 152/92 mmHg, and a left ventricular ejection fraction of 52%. Her aortic annulus diameter was 21 mm by TEE. Computed tomography (CT) revealed mild atherosclerosis in the aorta and in both common iliac arteries. A coronary angiogram showed a normal coronary artery, and her EuroSCORE II was 3.58%. Evaluation of her airway showed adequate head extension, mouth opening, and jaw protrusion, and a Mallampatti score of 1 to 2. Room-air arterial blood gas analysis results were normal. (pH: 7.36, $PaCO_2$: 49 mmHg, PaO_2: 144 mmHg, HCO_3: 28.0 mmHg, Saturation: 99%)

Anesthetic monitoring consisted of a 5-lead electrocardiogram (ECG), bispectral index (BIS), pulse oximetry, cerebral oximetry, and capnography. Oxygen was supplied by a simple facemask at 4 L/min. A CO_2 analyser probe was placed close to a nostril to increase accuracy of end-tidal carbon dioxide tension ($ETCO_2$) measurement. Sedation was induced with midazolam 1 mg, fentanyl 50 μg and dexmedetomidine (Precedex®, Hospira, Lake Forest, IL, USA) loading of 50 μg (1 μg/kg). Arterial cannulation was inserted into the left radial artery for continuous pressure monitoring and a central venous catheter was inserted into the right internal jugular vein. Two external defibrillator pads were attached to the patient for the early treatment of atrial fibrillation or ventricular fibrillation. After loading of dexmedetomidine, the patient was sedated with continuous intravenous infusion of dexmedetomidine 0.5 μg/kg/hr. BIS was monitored from 60 to 90 [9], and the patient's consciousness status was carefully assessed by the anesthesiologist. Following dexmedetomiine infusion, her blood pressure (BP) and heart rate (HR) showed minimal changes within the normal ranges. Respiratory function showed consistent saturation of 98–100% and $ETCO_2$ of 20–40 mmHg with a respiratory rate (RR) of > 10. A TEE probe was not inserted to a patient, and only fluoroscopy and aortography guidance was used for the procedure.

Because the cardiologists of our institution inserted the femoral sheath without a local anesthetic block, the patient received fentanyl 50 μg prior to femoral vessel manipulation. A pacing wire was inserted into the right ventricular apex via the left femoral vein, and a pigtail catheter was inserted into the aortic root via the left femoral artery. Right femoral artery cannulation was performed to insert an introducer catheter.

Before balloon valvuloplasty, the patient received intravenous heparin 1 mg/kg to achieve an activated coagulation time of > 250 sec. Valvuloplasty was successfully performed under rapid ventricular pacing (RVP) of 200 bpm. A 23 mm Edwards SAPIEN Valve® (Edwards Life sciences Inc., Irvine, CA, USA) was placed at the aortic annulus under RVP, and the optimal prosthetic valve position was confirmed by fluoroscopic angiogram. When RVP was performed, the patient's systolic BP dropped below 45–55 mmHg, and ventricular fibrillation occurred with the patient's HR reaching 200 bpm. BP and HR restored to the previous levels of 110/55 mmHg and 50–60 bpm, respectively, after termination of pacing. Cardiac rhythm also recovered to normal sinus rhythm. The duration of cardiac standstill during RVP was less than 10 seconds. After confirming successful prosthesis implantation, dexmedetomidine infusion was discontinued. The TAVI procedure was terminated 5–10 minutes later, immediately after withdrawal of the catheter from femoral vessels.

The total length of the intervention time was 80 min and the total anesthesia time was 110 min. After the procedures, patient's BIS value was 80–90, and she was transferred to the intensive care unit (ICU) for close hemodynamic monitoring. On arrival at the ICU, the patient's level of consciousness was assessed according to the Glasgow Coma Scale and Richmond Agitation Sedation Scale; she showed scores of 15 and -2, respectively, which suggests a "light sedation" (patients awakens with eye opening and eye contact, but not sustained). In addition, she showed spontaneous respiration, and saturation was maintained 98–100%. Two hours after arrival in the ICU, the patient showed an alert mental status.

The patient was transferred to the general ward on postoperative day 3, after her vital signs were stable and she showed normal sinus rhythm without atrioventricular (AV) blockage. TTE showed that the prosthetic aortic valve was functioning well, with no paravalvular and transvalvular leakage. On postoperative day 4, she developed a fever. She was found to be positive for Scrub typhus antibody on postoperative day 16 and was administered empirical therapy with doxycycline 100 mg. On postoperative day 21, she was discharged without complications.

Case 2

An 82-year-old woman presented with progressive degenerative AS. She had been diagnosed with AS 11 years earlier. She had developed dyspnea 1 year earlier and complained of recently developed resting dyspnea with orthopnea. She had hypertension, diabetes mellitus, and osteoporosis and was being treated with an angiotensin-converting enzyme inhibitor 4 mg/day, furosemide 40 mg/day, statin 10 mg/day, and glimepiride 2 mg/day. The patient received aspirin 100 mg/day and clopidogrel 300 mg/day the day before the TAVI.

A TTE showed severe degenerative AS with concentric left ventricular hypertrophy. The aortic valve area was 0.48 cm^2, a peak/mean pressure gradient was 111/67 mmHg, and the maximum transaortic valvular velocity was 5.3 m/sec. Her left ventricular ejection fraction was 62%, and her aortic root annulus diameter was 19 mm. CT showed mild atherosclerosis in the descending thoracic aorta and in both common and internal iliac arteries. A coronary angiogram showed mild coronary artery disease. Her EuroSCORE II was 2.94%.

The patient was given oxygen via a simple facemask at 4 L/min. A CO_2 analyser probe was placed close to a nostril to measure $ETCO_2$. Fentanyl (50 μg) was administered via injection, and dexmedetomidine was loaded at a dose of 60 μg (1 μg/kg). Her left radial artery was cannulated, and a central venous catheter was inserted into her right internal jugular vein. She was given 1mg midazolam and a 25 μg bolus of fentanyl and was continuously infused with dexmedetomidine 0.5 μg/kg/hr. Her BP decreased to 120/55 mmHg from a baseline BP of 160/80 mmHg, and her HR reduced from 80 bpm to 60 bpm after injection of dexmedetomidine, midazolam and fentanyl. The patient had a BIS level of 60–90, saturation of 98–100%, and $ETCO_2$ of 25–40 mmHg.

The TAVI procedure was aided by fluoroscopy and aortography. The patient was given heparin 1 mg/kg to achieve an activated coagulation time of > 250 seconds. Without using RVP, a 29 mm Core Valve® (Medtronic, Minneapolis, Minnesota, USA) was advanced over a guide-wire and deployed within the annulus under fluoroscopic guidance and serial aortography to validate the position of the valve.

Once valve competence was assessed, dexmedetomidine infusion was discontinued. Sheaths from the femoral vessels were then carefully removed. The intervention took 60 min, and the total anesthesia time was 100 min. The patient became alert immediately after completion of the procedure and was transferred to the ICU with a BP of 112/54 mmHg, saturation of 99–100%, and no complaints of dizziness of dyspnea. On postoperative day 3, the patient underwent TEE and a coronary valve CT, which revealed non-specific findings. An ECG, however, showed that a left bundle branch block (LBBB) rhythm alternated with a first degree AV block rhythm and was accompanied by an increase in HR to 115–220 bpm. The patient had no symptoms corresponding to these arrhythmias, and she was transferred to the general ward on the next day postoperative day 4. Continuous ECG monitoring was maintained and AV block rhythm was constantly checked using a 12-lead ECG. ECG continuously showed LBBB and the first degree AV block. On the 7th day after TAVI, she underwent an electrophysiologic examination to assess whether she needed a permanent pacemaker. EP study showed a normal HR and LBBB, without an AV block. Her prosthetic valve motion was well preserved with mild perivalvular aortic regurgitation (AR). The patient was discharged on postoperative day 12.

Discussion

Several previous studies have compared MAC and GA use during TAVI and described the advantages and limitations of MAC. In those studies, anesthesiologists used the sedative agents such as propofol, remifentanil, fentanyl, ketamine, and midazolam [4-7]. Recently a report described the use of dexmedetomidine as an alternative to sedative agents during TAVI under MAC [8]. Dexmedetomidine is a highly selective alpha-2 agonist with sedative, analgesic properties, making it an anesthetic adjuvant. It is associated with minimal respiratory depression, reduced opioid requirements, and decreased hemodynamic changes. Furthermore, it can be used for cooperative sedation in which well-sedated patients can be awakened by stimulation for clinical assessment or cooperation [10]. For these reasons, dexmedetomidine is increasingly used for sedation procedures.

However, rapid injections of dexmedetomidine have been found to induce transient hypertension, bradycardia, and tachycardia [11,12]. To avoid these effects, in the present cases, we slowly infused a loading dose of 1 μg/kg over 10 minutes, followed by a continuous dose 0.5 μg/kg/hr, and this regimen showed no hemodynamic instability.

In the present cases, the cardiologist did not inject local anesthetics into the groin. Therefore, we gave an additional bolus of midazolam 1 mg and/or fentanyl 25–50 μg before sheath dilatation and RVP to prevent unexpected movements and to ensure patient comfort. Patient immobility and an adequate level of sedation are crucial in achieving successful valve implantations with or without RVP. It is possible to minimize respiratory movement through cessation of mechanical ventilation under GA. However, our patients maintained spontaneous respiration throughout the procedures under MAC. Nevertheless, the cardiologists could implant the prosthetic valve in the proper position.

Furthermore, RVP can result in ventricular fibrillation and decrease in systolic arterial pressure. Pre-emptive therapy with

vasopressor such as norepinephrine, epinephrine, and phenylephrine, is important to treat hypotension and facilitate recovery after RVP [13]. In our patients, BP, HR and cardiac rhythm were restored to baseline levels within 10−15 seconds after termination of RVP. The use of inotropes, vasopressor, and defibrillation were therefore not necessary.

Airway obstruction or respiratory depression may develop under MAC, which cause adverse effects, especially in older AS patients who have significant comorbidities, such as cardiac dysfunction and pulmonary disease. In the two present cases, we assessed the patients' airways before the procedures to determine whether they were suitable for MAC. The patients' respiratory functions were maintained at rates of > 10, and SpO_2 was 98−100%. $ETCO_2$ was 20−40 mmHg, and the difference between $ETCO_2$ and $PaCO_2$ was 15−20 mmHg. Complications, such as apnea, hypoventilation, and hypoxemia, did not occur. In addition, the procedures were performed by experienced cardiac anesthesiologists in a hybrid room, and all appropriate equipment was prepared in case of emergency procedures.

TEE can be used during TAVI procedures to assess cardiac function and prosthetic valve size and position [13]. However, intra-procedural TEE may be limited under MAC. In the present patients, TEE was used as a pre-procedural evaluation, while only fluoroscopy, and not intra-procedural TEE, was performed during the procedure. Appropriate valve positioning guided by fluoroscopy was achieved without valve migration or malposition. Post-procedural valve function and complications were adequately assessed using TTE.

The patient in the second case developed an AV block and LBBB on post-procedural ECG, which seem to be complications associated with CoreValve® implantation rather than with dexmedetomidine administration on the basis of following consideration [14,15]. Firstly, the conduction abnormality appeared on post-procedure day 3, Secondly, there were no ECG abnormalities during the TAVI. TAVI with the CoreValve® prosthesis results in a high incidence of total AV block requiring permanent pacemaker insertion and new-onset LBBB [15]. Hence, cardiologists should monitor post-procedural ECG and, if necessary, insert a temporary or permanent pacemaker.

In conclusion, GA and MAC can both be used in transfemoral TAVI, depending on the individual patient and procedural details. Successful TAVI performed under MAC with dexmedetomidine is feasible with close monitoring, appropriate drug titration, and fluoroscopic guidance without intra-procedural TEE monitoring. Adequate airway evaluation and experienced anesthesiologists are also needed.

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