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CASE REPORT

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Titrated segmental epidural anesthesia for bilateral total knee replacement in a patient with severe aortic stenosis and severe bilateral carotid artery stenosis: a case report

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Abstract

Background Total knee replacement is a major orthopedic procedure for severe, painful, and mobility-limiting knee arthritis. Aortic valve stenosis is the most frequent valvular heart disease and the most commonly performed valvular procedure. Stenosis of the valve may lead to left ventricular hypertrophy, ventricular dysfunction, myocardial ischemia, and a state of fixed cardiac output. Changes in hemodynamic parameters such as hypotension and bradycardia in patients with carotid artery stenosis may lead to cerebrovascular accidents, especially during anesthesia.

Case presentation A 76-year-old woman with a 6-year history of bilateral knee pain. The pain was dull, aching, and severe in intensity, and it prevented her from sleeping despite optimal analgesics. A general physical examination revealed an elderly, frail woman in mild respiratory distress. She had bilateral small-volume radial pulses, positive hepatojugular reflux, and heart sounds of S1, S2, and S4 with an ejection systolic murmur, and carotid bruits were heard bilaterally. Epidural anesthesia was done by injection of 2.5 mL of 0.5% plain bupivacaine in aliquots every 5 min until the level of the block reached the suprapubic region (titrated segmental epidural anesthesia). The patient was not preloaded with intravenous fluid prior to the establishment of epidural anesthesia, and the epidural anesthesia-induced hypotension that may ensue was managed with intraoperative dopamine infusion at 5 µg/kg/min.

Conclusions Titrated segmental epidural anesthesia with intraoperative infusion of low-dose dopamine reduces the perioperative risk of myocardial infarction, cerebrovascular accident, and neurocognitive deficit in a patient with severe aortic stenosis and severe bilateral carotid stenosis.

Keywords Aortic, Carotid, Stenosis, Titrated, Segmental, Epidural, Anesthesia

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Background

Total knee replacement is a major orthopedic procedure for severe, painful, and mobility-limiting knee arthritis. The presence of comorbid medical conditions can increase morbidity and/or mortality during the procedure or in the immediate postoperative period. Cardiovascular diseases are one of the most common conditions encountered by surgical patients. Aortic valve stenosis is the most frequent valvular heart disease and the most commonly performed valvular procedure (Clavel et al. 2016). With the stenosis of the valve, there is a reduction in pressure proximally but an increase in pressure distal to the valve. This leads to left ventricular dysfunction, myocardial ischemia, and a state of fixed cardiac output (Brighouse 1998). Stable hemodynamic status is very important for a good perioperative outcome because an increase in heart rates reduces coronary filling time, and a sudden reduction in afterload can also compromise coronary perfusion significantly (Brighouse 1998).

The current recommendation of the American College of Cardiology for patients with aortic stenosis scheduled for noncardiac surgery is corrective valvular surgery, but this may not always be possible due to high surgical risk or patient refusal of valvular surgery (Goel et al. 2018; Chacko and Weinberg 2012).

Atherosclerosis of the carotid vessels causes stenosis, which can lead to a transient ischemic attack or stroke. The prevalence of internal carotid artery stenosis increases with age, from 0.5% among people between the ages of 50 and 59 years to 10% in those over 80 years (Escalona et al. 2016). Carotid artery stenoses are one of the major causes of ischemic stroke (Oledzki et al. 2015). Embolism of the stenotic artery from atherosclerotic or thrombotic waste materials proximally can cause occlusion of the distal cerebral vessel. Similarly, changes in hemodynamic parameters such as hypotension and bradycardia in patients with carotid artery stenosis may lead to cerebrovascular accidents, especially during anesthesia (Sani et al. 2018). The best way to ensure surveillance for cerebral ischemia in a patient under anesthesia is through continuous monitoring of the neurocognitive function of the conscious patient (Johansson and Lind 2017). This can only be achieved when the surgical procedure is done under regional anesthesia.

Anesthetic management of patients with stenoses of aortic valves and carotid arteries requires adequate preparations, special precautions, and vigilance during the intraoperative period, with the main goal of limiting sympathetic block, which might probably avoid hypotension and subsequently avert a disastrous outcome. This case report describes the successful anesthetic management of an elderly woman with morbid severe aortic stenosis and severe bilateral carotid artery stenosis who had bilateral total knee replacement on account of severe bilateral knee arthritis under epidural anesthesia.

Case presentation

A 76-year-old woman, AA, presented to our orthopedic clinic with a 6-year history of bilateral knee pain. The pain was dull, aching, and severe in intensity (the numerical rating scale was 8/10), and it prevented her from sleeping despite optimal analgesics. Though there was no associated hip pain, she could only move within her room with the aid of a walking frame and support from relatives. She also complained of poor appetite, weight loss, and easy fatiguability from minimal exercise.

She developed a peptic ulcer due to chronic use of NSAIDs; she was diagnosed as hypertensive 2 years prior to presentation, but she is neither diabetic nor asthmatic. She was on analgesics (tenoxicam 20 mg daily, dihydrocodeine 40 mg twice daily, and paracetamol 1 g thrice daily) and nifedipine 20 mg daily. There was a history of drowsiness due to the use of tramadol and chlorpheniramine, and she experienced a fixed drug eruption from consumption of chloramphenicol. She had two previous cesarean sections under general anesthesia; the last one was 40 years ago, during which she had blood transfusions.

A general physical examination revealed an elderly frail woman in mild respiratory distress (RR of 28 cycles per min), pale but not dehydrated, anicteric, and with nil pedal swelling. She had bilateral small-volume radial pulses, her blood pressure was 105/68 mmHg, she had positive hepatojugular reflux, and her heart sounds were S1, S2, and S4, with an ejection systolic murmur heard loudest at the 2nd intercostal space and radiated to the neck. Carotid bruits were heard bilaterally, though louder on the left side. There was bilateral symmetrical chest movement, breath sound was vesicular, and peripheral oxygen saturation (SpO_2) ranged between 92 and 95% in room air.

The patient had an antalgic gait with severe wasting of the quadriceps, hamstrings, and calf muscles. There was a restricted range of motion in both knee joints with patellofemoral crepitus, but a fair range of motion was observed at both hip joints with increased tone globally. However, ankle clonus was absent.

Doppler ultrasound scan of the carotid arteries revealed severe stenosis of both carotid arteries (88% stenosis at the bulb of the internal carotid artery and 86% stenosis at the common carotid artery on the left side and 82% stenosis at the distal common carotid artery bulb on the right side). The electrocardiogram showed left ventricular hypertrophy and cardiac ischemia with anterolateral infarct. Echocardiography showed severe aortic stenosis (0.8 cm^2) with a markedly reduced ejection

fraction of 30%. An X-ray of both knee joints revealed severe osteoarthritis; packed cell volume was 31%, but results of other laboratory investigations were within the normal range. She was initially counseled for aortic valve replacement before total knee replacement, but the patient and her relatives refused the valvular procedure and opted for only the limb surgery.

Pre-anesthetic evaluation revealed a known hypertensive with aortic stenosis and bilateral carotid artery stenosis, diagnosed with bilateral severe osteoarthritis with the American Society of Anesthesiologists category IV, Mallampati (MP) score II, and Goldman cardiac risk index class IV (29 points). She was counseled for bilateral total knee replacement under segmental titrated epidural anesthesia.

In the operating room, a quick anesthetic check was done, and the patient was connected to a multiparameter patient monitor, and baseline blood pressure (BP), pulse rate (PR), and peripheral oxygen saturation (SpO_2) measured were 105/68 mmHg, 70 bpm, and 98%, respectively. Venous access was secured on the volar surface of the forearm with a 16-G canula for fluid maintenance, replacement of ongoing losses, and probably for resuscitation. Appropriate resuscitation drugs and airway equipment were made available.

In a sitting position with the patient's feet on a stool and under strict aseptic technique, the L4–L5 intervertebral space was located, and an epidural catheter was inserted with 4 cm left in the epidural space. Three milliliters of 1% lidocaine in 200,000 adrenalines were first administered as a test dose to eliminate the possibility of intrathecal or intravascular injection. Thereafter, epidural anesthesia was achieved by injection of 2.5 mL of 0.5% plain bupivacaine in aliquots every 5 min until the level of the block reached the suprapubic region after 20 min. This level of the block corresponded to the T12 and L1 dermatomal segments achieved by the administration of plain bupivacaine, in aliquot, into epidural space (titrated segmental epidural anesthesia). Two-point-five milliliters of 0.5% plain bupivacaine as the only supplemental dose of the epidural anesthesia was administered 90 min after the activation dose.

Monitoring of blood pressure (BP) was done non-invasively every 3 min, while heart rate (HR), peripheral oxygen saturation (SpO2), and electrocardiogram (ECG) were monitored continuously. The patient was not preloaded with intravenous fluid prior to the establishment of epidural anesthesia, and the epidural anesthesia that may probably induce hypotension was managed with intraoperative dopamine infusion at 5 μg/kg/min throughout the surgery that lasted for 2 h and 25 min.

Fluid maintenance and replacement of ongoing losses were achieved with 0.9% normal saline. Intraoperative systolic and diastolic blood pressure ranged from 104 to 110 mmHg to 66 to 72 mmHg, respectively, throughout the surgery that lasted for 145 min. Verbal contact was maintained with the patient throughout the surgery, and the cognitive function of the patient was monitored by assessing her memory and orientation in time, place, and person every 20 min until the end of surgery. A tourniquet was applied on both thighs (for 70 and 65 min on the right and left, respectively) to reduce significant intraoperative bleeding, and the estimated blood loss was 100 mL.

The patient was transferred to the intensive-care unit (ICU), and multimodal postoperative analgesia was provided with intravenous morphine (2 mg every hour), infusion acupan (20 g every 8 h), and paracetamol (1 g every 8 h) in addition to epidural analgesia by intermittent administration of 5 mL of 0.125% plain bupivacaine every 2 h for 24 h after the surgery. On the second day in the ICU, epidural analgesia was discontinued, and oral analgesics were commenced (tab tramadol 50 mg every 8 h and tab paracetamol 1 g every 8 h), and she was subsequently discharged to a surgical ward on the third postoperative day and discharged home after a 7-day stay in the hospital. She began physiotherapy on her second postoperative day, which continued throughout her stay in the hospital and for 2 weeks after discharge. On her first follow-up visit in 4 weeks after surgery, she was able to walk by herself with the aid of crutches.

Discussion

Rheumatic heart disease is the most frequent cause of valvular heart disease and one of the commonest causes of heart failure in sub-Saharan Africa (Sani et al. 2018). Normally, the aortic valve is 2.5–3.5 cm^2, and critical stenosis is when the orifice is less than 1.0 cm^2 combined with a mean aortic valve gradient less than 40 mmHg (Johansson and Lind 2017). In aortic stenosis, the left ventricle is hypertrophied and poorly compliant, resulting in diastolic dysfunction. Left ventricular hypertrophy increases myocardial oxygen demand while decreasing supply as a result of high ventricular wall pressures compressing intramyocardial coronary vessels. The poorly functioning left ventricle also causes elevated left ventricular end-diastolic pressure, which impairs ventricular filling.

Given the altered physiological parameters, general anesthesia poses a significant risk in patients with aortic stenosis due to the absence of a compensatory response to the depressant effects of anesthetics on the cardiovascular system. Epidural anesthesia is believed to be contraindicated in patients with fixed cardiac output like severe aortic stenosis because of its sympatholytic effect,

which can lead to loss of vascular tone and subsequent low cardiac output (Johansson and Lind 2017).

As suggested by Brighouse (Brighouse 1998), bilateral total knee replacement was successfully done using titrated segmental epidural anesthesia. He showed that incremental induction of epidural anesthesia is a better choice over conventional epidural anesthesia or general anesthesia in patients with aortic stenosis. In our patient with severe aortic stenosis and coronary artery disease, the technique involved the injection of 2.5 mL of 0.5% plain bupivacaine in aliquots at intervals of 5 min, while the level of blood and hemodynamic changes were monitored. It ensures that an optimal volume of the local anesthetic agent is injected into the epidural space to achieve adequate anesthesia, less motor block, and little or no sympatholytic effect.

This technique also interferes less with heart rates and aortic diastolic pressure, which maintain adequate coronary blood flow. Other studies have also confirmed the safety of titrated segmental epidural anesthesia in patients with fixed cardiac output (Goel et al. 2018; Naz et al. 2015; Ige et al. 2017; Bundgaard-Nielsen et al. 2005). Instead of preloading with fluid, which can result in fluid overload and poor perioperative outcomes, low-dose vasopressors should be used to maintain hypotension induced by the sympatholytic effect of local anesthetic agents (Ige et al. 2017). Low doses of dopamine at 5 μg/kg/min were infused during surgery to maintain normotension and prevent sudden drops in blood pressure that can cause coronary and cerebral vascular insufficiency. Dopamine infusion will also avoid a sudden increase in the afterload that can further compromise ventricular filling.

Titrated segmental epidural anesthesia allowed for continuous monitoring of neurocognitive function in patients with coronary and cerebral arterial insufficiency during anesthesia. Monitoring the neurocognitive function every 20 min throughout the surgery enabled us to look out for signs of a cerebrovascular accident early and to deploy prompt treatment.

Conclusions

We report a successful and uncomplicated use of titrated segmental epidural anesthesia with intraoperative infusion of low-dose dopamine for total knee replacement in a patient with severe aortic stenosis and severe bilateral carotid stenosis. The case showed perioperative hemodynamic stability in the absence of neurocognitive impairment.

Abbreviations

NSAIDs	Non-steroidal anti-inflammatory drugs
SpO_2	Peripheral oxygen saturation
MP	Mallampati
BP	Blood pressure
PR	Pulse rate
HR	Heart rate
ECG	Electrocardiogram
ICU	Intensive care unit

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Authors' contributions

OA, lead anesthetist and jointly writing up the first draft and final (third) draft. AA, lead orthopedic surgeon and jointly write up the first draft. SZA, writing up the second draft and final review. ALA, he recruited and follow up the patient in the clinic. FSB, he assisted lead orthopedic surgeon and also prepared the patient for surgery. OAA, he assisted the lead anesthetist in conduction of the anesthesia. All authors have read and approved the manuscript and ensure that it is the case that will be reported.

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Availability of data and materials

Information on data supporting the results that is reported in this article can be collected from the corresponding author, through the e-mail address (talktorhymes@yahoo.com).

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

The authors certify that written informed consent was obtained from the patient, and her clinical information will be reported in a journal without revealing her identity.

Competing interests

The authors declare that they have no competing interests.

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