Application of ultrasound-guided femoral nerve block in a patient with severely impaired left ventricular function undergoing femoro-popliteal bypass reconstructive surgery

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Introduction

Elderly patients with advanced cardiovascular disease undergoing major vascular surgery represent one of the highest-risk populations in anesthetic practice. Surgical treatment is associated with significantly increased perioperative cardiovascular complications and mortality compared to patients without cardiac disease [1]. Patients with coexistence of severe left ventricular systolic dysfunction, impaired diastolic filling and extensive atherosclerotic disease have significantly increased risk for perioperative morbidity and mortality. Therefore, all these well-known facts require carefully tailored anaesthetic management focused on maintaining hemodynamic stability, preservation of myocardial function while avoiding exacerbation of pre-existing organ dysfunction. The goals of anaesthetic management in these patients undergoing major surgery include optimization of preload, maximization of forward flow, maintenance of stable hemodynamics, and prevention of potentially dangerous complications such as arrhythmias and acute on chronic heart failure [2]. Achieving these goals requires careful titration of anesthetic agents and continuous hemodynamic monitoring. In such patients, even minor alterations in preload, afterload, heart rate, or myocardial contractility may lead to profound and significant hemodynamic instability leading to clinically relevant end-organ hypoperfusion. General anesthesia in patients with severe heart failure is frequently associated with adverse hemodynamic effects, including myocardial depression, vasodilatation and impaired autonomic regulation. Excessive use of systemic anesthetic agents and opioids may further compromise cardiac output and tissue perfusion. Regarding the risk of occurrence of all these well-known side effects with significant hazardous potential, multimodal and opioid-sparing anaesthetic techniques have gained increasing importance in guiding high-risk patients with cardiovascular comorbidities [3]. Therefore, strategies aimed at minimizing the use of myocardial depressant drugs while ensuring adequate analgesia and optimal surgical conditions have become modalities of particular interest and importance. Such a technique is the combination of general anesthesia with regional anesthetic techniques which provides effective analgesia with reduced opioid requirements and improves perioperative hemodynamic stability in high-risk patients. The anesthetic management of patients with severe left ventricular dysfunction undergoing major vascular surgery represents a significant clinical challenge. In the present case, carefully titrated general anesthesia was combined with ultrasound-guided femoral nerve block and continuous low-dose inotropic support in order to maintain hemodynamic stability, reduce myocardial depression, and limit opioid use. This case highlights the importance

of an individualized hemodynamic approach in the anesthetic management of high-risk vascular patients.

Case report

This case report describes the anaesthetic management of an 84-year-old ASA IV patient with severe left ventricular dysfunction undergoing femoropopliteal bypass surgery. The aim of this case report is to highlight the benefits of a carefully titrated general anaesthesia combined with an ultrasound-guided femoral nerve block and a low-dose intraoperative inotropic support, emphasizing an individualized, opioid-sparing approach in a patient with complex cardiovascular and renal comorbidities. We present an 84-year-old female patient, 70 kg in weight and 160 cm in height, scheduled for elective lower limb revascularization surgery where femoropopliteal bypass was a technique of choice due to critical peripheral arterial disease. According to the American Society of Anesthesiologists physical status classification, our patient was classified as an ASA IV due to the presence of severe cardiovascular disease and multiple comorbidities. The patient's medical history was significant for advanced ischemic heart disease. She underwent coronary artery bypass grafting 22 years prior and had suffered an anterolateral myocardial infarction 10 years prior to the current admission. Her echocardiography findings have revealed dilated left ventricular chambers with segmental wall motion abnormalities, combined systolic and diastolic dysfunction, and a severely reduced left ventricular ejection fraction of approximately 35%. Additional comorbidities included chronic renal impairment with unilateral renal agenesia with preoperatively elevated urea levels (17.5 mmol/L) and creatinine concentration of 122 μmol/L. Coagulation profile was within normal limits. Given the patient's advanced age, severe left ventricular dysfunction, renal impairment, and extensive cardiovascular history, a combined anaesthetic approach was planned. The strategy consisted of carefully titrated general anaesthesia combined with peripheral regional anaesthesia in order to minimize myocardial depression, reduce opioid requirements, and preserve hemodynamic stability throughout the procedure. Prior to induction of general anaesthesia, invasive arterial blood pressure monitoring was established via radial arterial cannulation to allow continuous real-time assessment of hemodynamic parameters. Standard monitoring included electrocardiography, pulse oximetry, capnography. Low-dose dobutamine infusion was initiated before induction and was titrated gradually depending on the patient's needs. Dobutamine infusion of 2 μg/kg/min was initiated prior to induction and maintained at doses ranging from approximately 2 to 2.5 μg/kg/min providing inotropic support to maintain myocardial contractility. Induction of general anaesthesia was performed slowly and cautiously. The patient received midazolam 1 mg, fentanyl 50 μg, ketamine 50 mg, propofol 30 mg, and cisatracurium 7 mg. Drug doses used for induction and intraoperative management were calculated according to the patient's actual body weight. Cisatracurium was chosen due to its organ-independent metabolism, particularly suitable in the presence of renal impairment. Tracheal intubation was achieved smoothly without significant fluctuations in arterial blood pressure or heart rate. Following induction and stabilization, a central venous catheter was inserted to enable central venous pressure monitoring and facilitate fluid and vasoactive drug administration. General anaesthesia was maintained with sevoflurane at low concentrations, targeting a minimum alveolar concentration (MAC) of approximately 0.3, in combination with controlled ventilation. An ultrasound-guided femoral nerve block was performed on the operative side using a total volume of 15 mL, consisting of 7.5 mL of 0.5% bupivacaine and 7.5 mL of 2% lidocaine. The

block was performed using a high-frequency linear ultrasound probe with an in-plane needle approach, allowing continuous visualization of the needle tip and accurate deposition of local anesthetic adjacent to the femoral nerve. The block was administered to enhance intraoperative analgesia and reduce the requirement for systemic anesthetic agents as part of an opioid-sparing strategy. During the surgical procedure, which lasted approximately 2 hours and 30 minutes, the patient received multimodal non-opioid analgesia, including metamizole and paracetamol. Additional medications administered as part of routine perioperative care included dexamethasone 8 mg, metoclopramide 10 mg, pantoprazole 40 mg, unfractionated heparin 5000 IU according to surgical requirements, sodium bicarbonate 20 mL guided by arterial blood gas analysis, and furosemide 20 mg. Approximately 2500 mL of balanced crystalloid solution were administered intraoperatively in order to maintain adequate preload while avoiding fluid overload in a patient with reduced left ventricular function. Throughout the entire procedure, the patient remained hemodynamically stable, without clinically significant episodes of hypotension, hypertension, arrhythmia or tachycardia. Intraoperative mean arterial pressure ranged between approximately 80 and 100 mmHg, while heart rate ranged between 55 and 75 beats per minute. Arterial blood gas analysis demonstrated pH 7.32, pCO_2 35 mmHg, and pO_2 85.9 mmHg with lactate 2.62 mmol/L, without evidence of clinically significant tissue hypoperfusion. Intraoperatively, no additional opioids, nor muscle relaxants were required after induction of anaesthesia. At the end of surgery, neuromuscular blockade was reversed and the patient was successfully extubated in the operating theatre. She was awake, hemodynamically stable, and pain-free, with no evidence of residual motor blockade. The patient was transferred to the surgical ward for postoperative monitoring. Hemodynamic parameters remained stable and no signs of myocardial ischemia, arrhythmia, or cardiac decompensation were observed. The patient did not require admission to the intensive care unit. Postoperative analgesia remained adequate during the first postoperative day without the need for opioid administration. The postoperative course was uneventful and the patient was discharged from the hospital in stable condition.

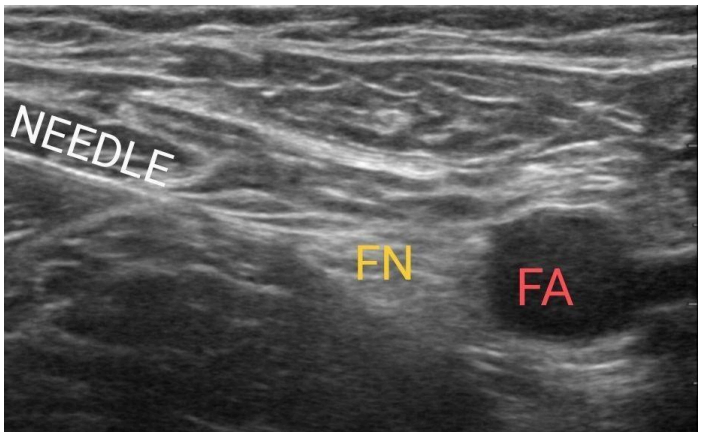

Figure 1. Ultrasound image demonstrating the femoral nerve (FN) adjacent to the femoral artery (FA) with in-plane needle visualization during ultrasound-guided femoral nerve block.

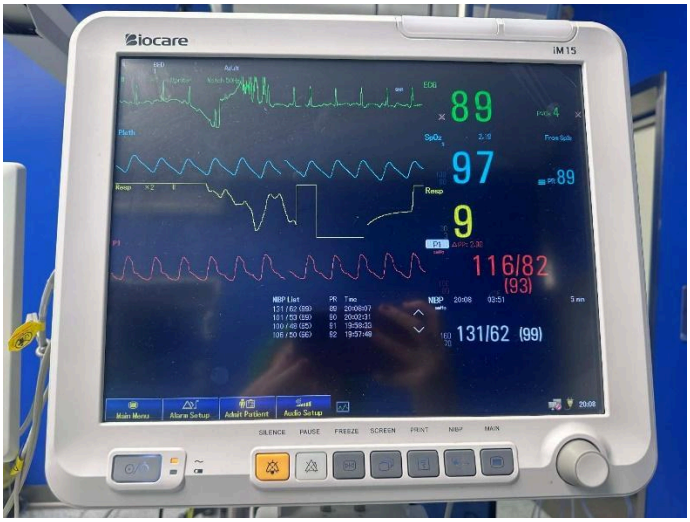

Figure 2. Representative intraoperative monitor display demonstrating stable hemodynamic parameters, including invasive arterial blood pressure and heart rate, during surgery under combined general and regional anaesthesia.

Discussion

Vascular surgical techniques that involve open revascularization generally have a high risk of perioperative complications. Recent publications in the Macedonian Journal of Anaesthesia have emphasized the importance of individualized perioperative management strategies in cardiac patients undergoing high-risk non-cardiac procedures, particularly in those with reduced left ventricular function [4]. In this regard, Garcia et al. identified the occurrence of perioperative complications in as many as 15.6% of patients with a 3.2% mortality rate [5]. In another retrospective study, the occurrence of perioperative ischemic complications in patients undergoing vascular surgery was 11.4%, while the same authors detected not only increased morbidity in patients with cardiovascular disease, but also increased perioperative mortality of 6.4%, emphasizing the presence of cardiovascular disease as a significant risk factor for the development of serious perioperative complications and mortality [6]. Hence, the two previous studies emphasize the severity of cardiovascular comorbidity as a significant risk factor for an unfavorable outcome of vascular surgical procedures even when all precautions are taken. The above case completely fits into the category of patients analyzed in the studies of Garcia and Thomas, which indicate that anesthetic management can play a significant role in the occurrence or prevention of perioperative cardiovascular complications and mortality. Namely, in the study of Thomas and colleagues, it was determined that epidural analgesia as a regional technique complementary to general anesthesia does not have a favorable effect on the incidence of cardiovascular complications and mortality [6], which was not applied in the presented case, but a safer regional anesthetic technique such as the peripheral femoral nerve block was used as an alternative to neuraxial anesthesia. The safety of peripheral nerve blocks and their impact on perioperative morbidity and mortality was not analyzed in the above studies, but they may represent a safer alternative to neuraxial anesthesia, as peripheral nerve blocks are not associated with significant reductions in peripheral vascular resistance or systemic vasodilation. According

to Huttler et al., as many as 37% of patients undergoing major vascular surgery for peripheral arterial disease develop serious perioperative complications, while this percentage is significantly lower, at 19%, in patients with peripheral arterial disease undergoing minor vascular procedures [7]. According to the aforementioned study, the surgical procedure performed on the patient presented in this paper is categorized as a major vascular surgery for peripheral arterial disease with an exceptionally high risk of intra- and postoperative complications and mortality due to the presence of cardiovascular comorbidity. This fact justifies all the activities undertaken to reduce perioperative risk, including the use of invasive monitoring, continuous inotropic support from the very beginning of the procedure, and the use of peripheral nerve block as a regional technique with the aim and idea of reducing intraoperative consumption of opioids, hypnotics, and relaxants and thus ensuring hemodynamic stability. Echocardiographic findings that suggest the presence of elements of left ventricular failure as detected in the presented patient have been recognized and identified as a significant risk factor for postoperative complications in patients undergoing open vascular surgery [8].

The positive effects of regional anesthesia and peripheral nerve blocks have been recognized previously, with a reduced incidence of cardiovascular complications identified when peripheral nerve blocks are used versus neuraxial anesthesia [9]. Hence, their use before neuraxial anesthesia is clearly defined and included in European recommendations when guiding patients with cardiovascular comorbidities for non-cardiac surgery. In this regard, this paper presents the effect of the use of peripheral femoral nerve block and its analgesic properties in cardiac compromised patients, which is seen through the creation of ideal working conditions for the surgeon with reduced systemic use of drugs. The hemodynamic stability of the patients and the reduced incidence of cardiovascular events in the perioperative period are most likely due to the lower stress response and the reduced or completely extinguished activation of the sympathetic nervous system during the application of peripheral nerve blocks in patients with cardiovascular comorbidities [9], which supports the use of ultrasound-guided femoral nerve blocks in routine clinical practice when performing vascular procedures on the peripheral arteries of the lower limb. The usefulness of peripheral nerve blocks in patients with existing cardiac pathology has also been seen in the meta-analysis of Memtsoudis and colleagues, where after analyzing 122 studies, a significantly lower incidence of cardiac complications in the perioperative period was determined compared to patients where only general anesthesia was applied [10].

Knowledge regarding the effects of peripheral nerve blocks on the sympathetic nervous system compared to neuraxial anesthesia suggests that they may represent a safer option in patients with cardiovascular comorbidities, considering that peripheral nerve blocks do not show a decrease in peripheral vascular resistance and systemic vasodilation. Peripheral nerve blocks may offer important advantages over neuraxial anesthesia in patients with significant cardiovascular comorbidities, as they are not associated with pronounced sympathetic blockade and sudden decreases in peripheral vascular resistance. This characteristic may be particularly beneficial in patients with severe left ventricular dysfunction, where maintaining stable hemodynamic conditions is essential. In such patients, even minor reductions in systemic vascular resistance or myocardial contractility may lead to significant hemodynamic instability

and impaired end-organ perfusion, which highlights the importance of carefully titrated anesthetic techniques. Furthermore, the use of regional anesthesia contributed to an opioid-sparing anesthetic strategy, which may further support hemodynamic stability and reduce perioperative stress response in high-risk vascular patients. Hence, the choice of this technique where general anesthesia is supplemented with regional anesthesia was not only a personal choice of the attending anesthesiologists, but an approach supported by evidence-based medicine and recommendations from modern guidelines for the treatment of patients with cardiac pathology in non-cardiac surgery.

Conclusion

The use of peripheral nerve blocks in combination with general anesthesia can provide excellent conditions for performing complex vascular procedures in patients with cardiac comorbidities. Namely, the absence of significant hemodynamic destabilization in an already cardiovascularly compromised patient indicates the safety of the peripheral femoral nerve block, which can serve as a tool for reducing the systemic use of anesthetics. Ultrasound-guided femoral nerve block can and should be used in everyday anesthetic practice as a regional anesthetic technique complementary to general anesthesia when performing reconstructive techniques of the peripheral arteries of the lower limb. This case highlights the potential benefits of combining ultrasound-guided peripheral nerve blocks with carefully titrated general anesthesia in high-risk vascular patients with severe left ventricular dysfunction.

Ethics approval

This case report contains fully anonymized patient data and does not include any identifiable patient information. Ethical approval was not required for publication of a single case report according to institutional regulations.

Author contributions
All authors contributed to the conception of the work, data collection, manuscript preparation, and approved the final version of the manuscript.

Conflict of interest
The authors declare that they have no conflict of interest.

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