(CASE REPORT)

Anesthetic management of a high-risk patient with complex medical conditions: A case report of multimodal analgesia and regional nerve blocks in urgent transfemoral amputation

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Abstract

This case article presents the anesthetic management of a patient with complex medical conditions and surgical requirements. The patient had secondary hyperparathyroidism due to chronic renal failure, resulting in hypocalcemia. The patient required a transfemoral amputation due to progressive bacterial infection and global foot gangrene. The urgency of the operation prevented preoperative preparation and necessitated careful consideration of the patient's cardiovascular and respiratory challenges. Due to the patient's facial deformity and limited neck mobility, general anesthesia was not feasible. Instead, a multimodal analgesia approach was adopted, utilizing regional nerve blocks targeting various nerves involved in lower limb innervation. This approach, combined with sedation, provided effective surgical anesthesia.

Keywords: High-Risk; Anesthetic Management; Regional Nerve Blocks; Amputation; Hyperparathyroidism.

1. Introduction

Hyperparathyroidism, a pathological condition characterized by the excessive production of parathyroid hormone (PTH) from the parathyroid glands, disrupts calcium homeostasis[1]. These small endocrine glands, located in the neck region posterior to the thyroid gland, play a crucial role in maintaining physiological calcium and phosphate levels, which are vital for bone integrity and the optimal functioning of multiple organ systems[2].

The etiology of hyperparathyroidism involves various factors, with primary hyperparathyroidism primarily associated with parathyroid adenomas or hyperplasia. Secondary hyperparathyroidism, on the other hand, occurs as a compensatory response to chronic diseases or conditions such as renal failure or vitamin D deficiency. Excessive release of PTH in hyperparathyroidism leads to skeletal resorption, causing an increased calcium release into the bloodstream and decreased phosphate levels. This disruption upsets the delicate balance necessary for cellular processes and exerts systemic effects [2].

Clinical presentations of hyperparathyroidism vary widely, ranging from asymptomatic cases incidentally identified during routine laboratory evaluations to individuals experiencing symptoms such as fatigue, muscular weakness, bone pain, gastrointestinal disturbances, renal calculi, and cognitive impairment. Some patients may exhibit symptoms and signs associated with acute or gradual-onset hypocalcemia, along with persistently elevated levels of parathyroid hormone[2] (Frazer, 2009). The diagnosis of hyperparathyroidism involves obtaining a relevant clinical history, conducting a thorough examination, and evaluating plasma levels of albumin-adjusted calcium, phosphate, PTH, 25-

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hydroxyvitamin D2 or D3, and total alkaline phosphatase. These tests are crucial for recognizing and confirming the diagnosis in specific disease scenarios [2].

Timely diagnosis and intervention are essential to prevent complications such as osteoporosis, nephrolithiasis, and cardiovascular pathologies. Management strategies for hyperparathyroidism include surgical excision of the affected parathyroid gland or pharmacological interventions targeting calcium regulation, depending on the underlying cause and disease severity.

Table 1 Biochemical Measurements in Chronic Kidney Disease Responsible for Secondary Hyperparathyroidism [2](Frazer, 2009)

Parameters	Normal Range	Patient's Values
Serum Calcium (mg/dL)	8.5-10.5	7.2
Serum Phosphate (mg/dL)	2.5-4.5	6.1
Parathyroid Hormone (pg/mL)	10-65	320
25-Hydroxyvitamin D2 or D3 (ng/mL)	30-80	12
Total Alkaline Phosphatase (IU/L)	38-126	180

Note: The patient's values indicate abnormal levels associated with secondary hyperparathyroidism in chronic kidney disease; Abbreviation: IU/L = International Units per liter.

Brown tumors, characterized by rapid osteoclastic resorption and peritrabecular fibrosis, are osseous lesions that result in local destruction and subsequent granuloma formation rich in giant cells[3]. The reported incidence of brown tumors is approximately 1.5% to 1.7% in secondary hyperparathyroidism and 3% in primary hyperparathyroidism [4].

Clinically, brown tumors can manifest as either asymptomatic or symptomatic, with symptoms including bone pain and pathological fractures. Although rare, spinal involvement may necessitate urgent surgical intervention to preserve neurological function and achieve spinal stability. Notably, only a limited number of cases (nine) involving symptomatic brown tumors in the spine among patients with secondary hyperparathyroidism have been reported in the literature.

Imaging modalities such as ultrasound, computed tomography (CT), magnetic resonance imaging (MRI), and parathyroid scintigraphy play crucial roles in the diagnosis and assessment of brown tumors. These techniques facilitate the identification of parathyroid adenomas and provide valuable information regarding the extent of the lesions [5].

Parathyroid scintigraphy utilizing 99mTc-sestamibi exhibits high sensitivity in detecting parathyroid adenomas. CT imaging reveals osteolytic lesions characterized by a dense border surrounding a soft tissue density, which may extend into the adjacent soft tissues, presenting a pseudo-tumoral appearance.

This case report highlights the successful implementation of multimodal analgesia techniques in the management of pain in a complex surgical case involving a patient with secondary hyperparathyroidism resulting from chronic renal failure-induced hypocalcemia.

2. Case presentation

This case report was conducted with explicit informed consent from the patient for dissemination in an educational publication. The patient, a 55-year-old male with a weight of 51 kg and an American Society of Anesthesiologists physical status of III, was scheduled for transfemoral amputation due to complications arising from a complicated diabetic foot with global foot gangrene [6]. The patient had a medical history of global cardiac insufficiency resulting from ischemic cardiomyopathy with impaired ejection fraction, requiring curative anticoagulation with vitamin K antagonists. Additionally, the patient presented with end-stage anuric chronic renal failure undergoing hemodialysis with a creatinine level of 11 ml/min. The patient also had a scoliotic spine and uncontrolled type 1 diabetes.

During the airway evaluation, the patient exhibited a Mallampati class II, an inter-incisor distance of 50 mm, and restricted neck mobility. Radiographic imaging revealed abnormal findings in the cervical and thoracic vertebrae and pelvis, including the absence of the normal curvature of the vertebral column, kyphosis, vertebrae resembling bamboo joints, reduced intervertebral spaces, and fusion of both sacroiliac joints (Figure 1). Furthermore, the patient had a sacral pressure ulcer.

Objective cardiovascular assessment showed the patient to be dyspneic in New York Heart Association (NYHA) stage VI. Electrocardiogram findings indicated a regular sinus rhythm with a heart rate of 92 bpm, anterior abrasion of the R wave, complete left bundle branch block, and negative T waves in the inferolateral and basal regions (Figure 2). Echocardiography confirmed a dilated left ventricle with impaired systolic function (ejection fraction of 30%) and global hypokinesis, as well as a dilated left atrium and elevated filling pressures, including significant pulmonary hypertension.

On the day of the surgical intervention, the patient underwent a hemodialysis session and received a transfusion of a phenotyped packed red blood cell unit. Following informed consent, the patient was transported to the surgical suite and positioned supine with appropriate head support using pillows. Standard monitoring devices were applied to capture initial vital signs, including an oxygen saturation level of 90%, arterial blood pressure measuring 149/85 mm Hg, and a heart rate of 90 beats per minute. Oxygen administration at a rate of 5 L/min through a face mask resulted in an improvement in oxygen saturation to 100%. Assessment and preparation of intubation equipment, including a NIHON KEHDEN life scope, were completed and placed on standby.

An ultrasound-guided fascia iliaca block and femoral nerve block were performed using a high-frequency linear ultrasound probe (L12-3, 10-12 Hz; General Electric Logiq 7) [7]. Incremental doses of a local anesthetic solution containing 0.25% bupivacaine and 2% lidocaine, totaling 15 milliliters, were administered using a 21-gauge, 100-mm Stimuplex needle (UniPlex NanoLine; Pajunk, Geisingen, Germany) with constant negative aspiration. After successful completion of the fascia iliaca block and femoral nerve block, the patient achieved analgesia and was subsequently positioned in the right lateral decubitus position for the sciatic nerve block.

The right sciatic nerve block was performed using the subgluteal space approach, as described by Karmakar [8] .guided by ultrasound imaging and aided by a nerve stimulator (Stimuplex®, HNS12; B. Braun, Melsungen, Germany), along with a 21-gauge, 100-mm needle. Foot eversion was elicited at a current of 0.5 mA or higher. Incremental doses of 15 milliliters of a local anesthetic solution composed of a combination of 0.25% bupivacaine and 2% lidocaine were administered.

The Lateral Femoral Cutaneous Nerve block was performed under ultrasound guidance, following the technique previously described by Nielsen [9], using an insulated 21-gauge, 100-mm Stimuplex needle. A 5 ml injection of the aforementioned local anesthetic solution was administered.

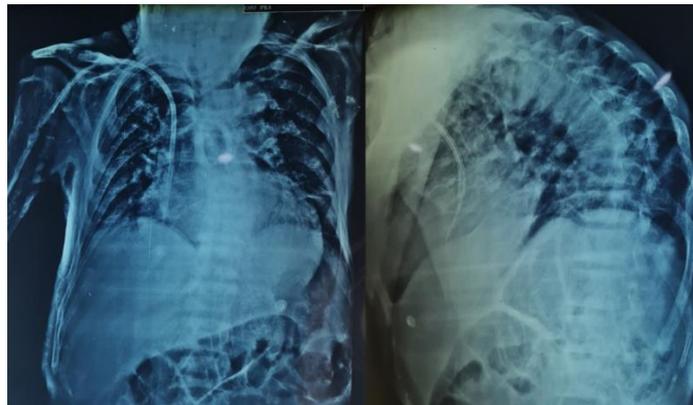The Obturator nerve block was then performed under ultrasound guidance, utilizing a nerve stimulator (Stimuplex®,

Figure 1 Radiographic imaging revealed abnormal findings in the cervical and thoracic vertebrae and pelvis, including the absence of the normal curvature of the vertebral column.

HNS12; B. Braun, Melsungen, Germany) and an insulated 21-gauge, 100-mm Stimuplex needle. The distal approach for obturator nerve block, as described by Sinha [10], was employed. This technique involves the separate blocking of the anterior and posterior branches of the obturator nerve by administering two injections of local anesthetic directed towards the interfacial planes where each branch is located. A total of 10 milliliters of bupivacaine 0.125% was administered.

Throughout the procedure, the patient's vital signs remained stable, and no complaints were reported. Subsequently, the patient was positioned supine on the operating table in preparation for the surgical procedure. Sedation was

administered to the patient, consisting of 50 mg of ketamine and 30 mg of propofol. The surgery lasted for 35 minutes, during which the patient maintained stable hemodynamics and did not require additional analgesics.

On the first postoperative day, the patient reported varying levels of pain, with visual analog scale scores of 4 during exercise, 0 during rest, and 2 for the majority of the day. No pain was reported on the subsequent two days, and the patient was discharged without any complications after 8 days.
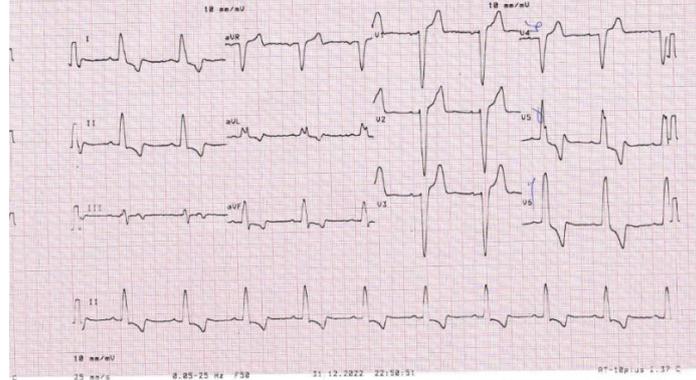

Figure 2 Electrocardiogram findings indicated a regular sinus rhythm, anterior abrasion of the R wave, complete left bundle branch block, and negative T waves in the inferolateral and basal regions.

3. Discussion

The anesthetic management of a patient with coronary artery disease necessitates the stratification of anesthetic risk based on patient characteristics and the surgical procedure. In this particular case, the patient achieved a score of 4 points on the Revised Cardiac Risk Index for Pre-Operative Risk, indicating a 15% mortality risk within the 30 days following the operation. The patient was admitted for a transfemoral amputation with a high estimated cardiac risk of 5% according to the 2014 ACC/AHA guideline on perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery [11].

The urgent nature of the operation was predicated upon a highly progressive invasive bacterial infection, suggestive of global foot gangrene. The emergent nature precluded any preoperative preparation [12]. While general anesthesia is typically the most suitable anesthetic technique [13], it was deemed unfeasible in this case due to facial deformity, restricted inter-incisor distance (50 mm), limited neck mobility, and secondary restrictive ventilatory disorders stemming from thoracic and thoracolumbar spinal anomalies. These factors present challenges to respiratory weaning and airway management. The anesthesiologist is confronted with difficulties in managing the airway due to limited range of motion and a fixed cervical spine.

Upon admission, the patient's vitamin K antagonist was discontinued two days prior to the intervention. Additionally, considering the described spinal anomalies, fragile cardiac status, severe dehydration [14], and infection at the surgical site rendering vulnerability to blood pressure fluctuations and hypovolemia, these factors may contraindicate the performance of neuraxial anesthesia [15]. As a general guideline, warfarin should be discontinued at least 5 days before the surgical procedure, and normalization of the international normalized ratio (INR) should be ensured prior to any neuraxial intervention [16].

Emergency regional anesthesia (RA) is justified as an approach to avoid the risks associated with general anesthesia (GA). Factors such as the level of urgency, patient status, location and type of lesions, as well as the expertise of the anesthesiologists, should also be taken into consideration. These factors allow for the determination of whether RA represents the preferred option for providing effective and safe anesthesia while minimizing the risks associated with GA. However, the ultimate decision to employ RA in an emergency situation should be made by the medical team based on individual case assessment [12].

A retrospective study encompassing nearly 400,000 patients undergoing orthopedic surgery demonstrated a lower rate of morbidity and mortality with the utilization of regional anesthesia. Therefore, it is worth considering the use of these techniques in coronary patients while ensuring the maintenance of hemodynamic stability [17].

The clinical application of a combined lumbar plexus (psoas compartment) and sciatic nerve block has proven successful in practice [18], as reported by H. Koçoğlu in 2020. In a retrospective analysis conducted[19], by Karaca et al in 2012, mortality rates of 257 patients with hip fractures were examined. The study revealed that a nerve block, specifically the combination of lumbar plexus block with sciatic nerve block and lateral femoral cutaneous nerve block, yielded reduced mortality rates, minimized hemodynamic disturbances, and improved cardiovascular stability compared to general anesthesia and central neuraxial blockade.

However, it is important to acknowledge the limitations associated with performing a lumbar plexus block in patients with ankylosing spondylitis. Notably, the considerable deformity of the vertebral column in these patients poses challenges for lumbar plexus block placement. Furthermore, there are inherent risks, such as the potential for epidural spread of local anesthetic, associated with lumbar plexus block [20], as reported by J.C. Gadsden in 2008. Therefore, considering the specific case of our patient, a lumbar plexus block was deemed unsuitable.

Instead, we opted for a regional anesthesia technique that targeted the various nerves responsible for innervating the lower limb. This approach involved blocking the fascia iliaca, femoral nerve, obturator nerve, sciatic nerve, as well as the lateral femoral cutaneous nerve. By combining nerve block techniques with sedation, we achieved successful outcomes in our patient, ensuring adequate surgical anesthesia.

4. Conclusion

The anesthetic management of high-risk patients with complex medical conditions and urgent surgical needs requires careful risk stratification and individualized approaches. In this case, the patient's cardiac and respiratory limitations necessitated the use of regional nerve blocks instead of general anesthesia. The combination of lumbar plexus, sciatic, and other peripheral nerve blocks, along with appropriate sedation, proved successful in achieving optimal surgical anesthesia. These findings emphasize the importance of a multidisciplinary approach, including close collaboration between anesthesiologists, surgeons, and other healthcare professionals, to ensure patient safety and favorable outcomes in challenging cases. Further studies and clinical experience are needed to evaluate the efficacy and safety of regional nerve blocks in similar high-risk patient populations.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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