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The Challenges of Anesthetic Management in Patients with Heart Failure Undergoing Resection of a Gi-ant Catecholamine-Secreting Pheochromocytoma: A Case Report

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Abstract

The anesthetic management of patients with heart failure undergoing resection of giant catecholamine-secreting pheochromocytomas presents significant challenges due to the complex hemodynamic changes induced by excessive catecholamine release. This case report details the perioperative management of a 35-year-old female with cardiogenic shock, acute pulmonary edema, and left ventricular dysfunction secondary to a giant pheochromocytoma. Advanced preoperative preparation with adrenergic blockers and intraoperative monitoring, including pulmonary artery catheterization, were employed to optimize hemodynamic stability. During surgery, hypertensive episodes triggered by tumor manipulation required nitroprusside infusion, while vasopressors and inotropes were carefully titrated to address hypotension and maintain ventricular-arterial coupling. The six-hour procedure, involving tumor resection and distal pancreatectomy, was complicated by significant hemodynamic fluctuations but ultimately successful. This report highlights the critical role of multidisciplinary planning and advanced hemodynamic monitoring in managing perioperative risks associated with pheochromocytoma resection. Strategies such as goal-directed fluid therapy, volume resuscitation, and targeted pharmacologic interventions are essential in addressing the unique challenges posed by these tumors, particularly in patients with preexisting cardiac dysfunction.

Keywords: Giant pheochromocytoma, anesthetic management, heart failure, hemodynamic instability, pulmonary artery catheterization

Introduction

Pheochromocytomas are rare neuroendocrine tumors originating in the adrenal gland, capable of producing catecholamines such as adrenaline, noradrenaline and dopamine. Excess release of these substances can lead to striking symptoms, including hypertension, headaches, and sweating, along with severe cardiovascular complications such as myocardial infarction, arrhythmias and heart failure. Giant pheochromocytomas are rarely linked to excessively high levels of catecholamines. Most of these cases do not exhibit the classical symptoms typically associated with pheochromocytoma. Despite being a rare condition, these tumors present significant challenges, particularly in anesthetic management during surgical resection.[1-2]

Surgery is currently the only curative treatment available. Still, it is associated with potentially fatal complications, such as hypertensive or hypotensive crises triggered by uncontrolled catecholamine release due to nociceptive stimuli or tumor manipulation.[3]

Preoperative management, particularly adrenergic blockers, reduces intraoperative complicated outcomes. Current recommendations suggest initiating alpha-adrenergic blockade 7 to 14 days before surgery, focusing on blood pressure control. However, debates persist about the necessity of complete blood pressure normalization in all cases, as some studies indicate that only patients with target organ damage benefit from stricter control.[4]

This report examines the latest evidence on anesthetic management for patients undergoing resection of giant pheochromocytomas and paragangliomas. It focuses on the critical role of advanced hemodynamic monitoring in maintaining intraoperative stability. Special attention is given to patients with severe heart failure, where precise monitoring significantly enhances safety and efficacy. The review highlights the value of advanced tools, such as pulmonary artery catheters (PAC), in optimizing hemodynamic control during treating this complex condition.

Case Report

A 35-year-old female patient with a body mass index (BMI) of 18 presented with dyspnea, hypotension, palpitations, confusion, hemiplegia, and left-sided facial paralysis. She had no reported history of comorbidities. Upon admission, she was transferred to the intensive care unit (ICU), where hemodynamic and ventilatory stabilization were promptly initiated.

The patient presented with cardiogenic shock, sinus tachycardia, acute pulmonary edema, and diffuse left ventricular hypokinesia, with a left ventricular ejection fraction (LVEF) of 28% on bedside echocardiography. Inotropic support, vasodilators, and mechanical ventilation were initiated. Computed tomography (CT) revealed a probable ischemic stroke, for which prompt thrombolysis was performed, resulting in a complete resolution of neurological deficits.

After stabilization and additional tests, an abdominal CT scan revealed a heterogeneous retroperitoneal mass in the left adrenal region invading the pancreas' body and tail, along with para-aortic lymphadenopathy. Doppler ultrasound showed lobulated contours with evident internal flow, estimating the tumor volume at 293 cm^3. Elevated urinary metanephrine levels confirmed the likely diagnosis of pheochromocytoma. Preoperative preparation was initiated with doxazosin, followed by carvedilol.

The patient was admitted to the operating room and sedated with midazolam. She was positioned in the sitting position, and epidural anesthesia (T9-T10) was administered using an 18G Tuohy needle with an injection of 10 mL of 0.1% ropivacaine and 2 mg of morphine, followed by the insertion of an epidural catheter. An invasive arterial line was placed in the left radial artery. Anesthetic induction was achieved with etomidate, lidocaine, rocuronium, and sufentanil. Maintenance anesthesia was achieved with 1.6% sevoflurane, guided by bispectral index (BIS) monitoring. A PAC was inserted via the right internal jugular vein.

In the initial surgical phase, the patient experienced significant hypertension, with systolic blood pressure ranging from 160 to 240 mmHg. Blood pressure spikes occurred during laryngoscopy and tumor manipulation, requiring nitroprusside infusion (3 mcg/kg/min). Dobutamine infusion (5 mcg/kg/min) was initiated, guided by PAC parameters, to increase cardiac output and optimize ventricular-arterial coupling. After venous drainage exclusion, the patient developed hypotension, prompting the discontinuation of nitroprusside and initiation of vasopressin (0.04 U/min) and norepinephrine (0.5 mcg/kg/min).

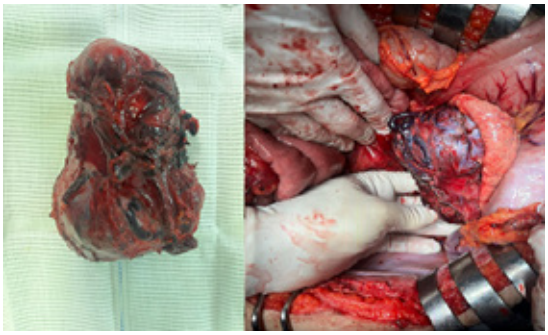

Figure 1: pheochromocytoma excised and tumor resection

Postoperatively, the patient was transferred to the intensive care unit (ICU) hemodynamically unstable, requiring high-dose vasopressor support but showing improvement in tissue perfusion markers and clinical signals. The invasive pressures and blood glucose were closely monitored, the use of vasopressors and inotropes were gradually reduced, and she made a good recovery.

Discussion

Giant pheochromocytomas are defined as tumors exceeding 7 cm in diameter and are associated with significant challenges for both anesthetists and surgeons.[2] Perioperative management in pheochromocytoma resection is notoriously challenging due to excessive catecholamine production and significant hemodynamic instability. During surgery, patients often experience episodes of hypertension, tachycardia, and arrhythmias, particularly before tumor removal. This situation necessitates a multidisciplinary approach and careful planning to minimize perioperative risks.[3]

Several surgical approaches are available for the treatment of pheochromocytomas. Laparoscopic-assisted resection is the preferred technique for tumors smaller than 6 cm, offering benefits such as more stable perioperative hemodynamics, faster postoperative recovery, and fewer complications. However, open surgery is generally recommended for larger pheochromocytomas. Moreover, the patient in this case developed heart failure secondary to tumor activity, which could further complicate the procedure by exacerbating the challenges of pneumoperitoneum, as it would contribute to an additional increase in afterload.[5]

Patients with pheochromocytoma may present with preexisting cardiac conditions such as heart failure, which further increases perioperative risk. In this case, the patient exhibited left ventricular systolic and diastolic dysfunction associated with diffuse hypokinesia. These structural and functional cardiac alterations require strict hemodynamic monitoring to ensure effective and safe perioperative management.[6] The pathogenesis of catecholamine-induced cardiomyopathy leading to cardiogenic shock in advanced pheochromocytoma is complex and multifactorial. The most common mechanism involves myocardial dysfunction due to catecholamine-induced damage to myocardial fibers. Moreover, excessive adrenergic stimulation can lead to coronary vasoconstriction and vasospasm, which in turn causes myocardial ischemia and the development of cardiomyopathy.[7]

Continuous monitoring, including invasive blood pressure measurement and pulmonary artery catheterization, is crucial in anticipating and managing hemodynamic changes during surgery. These methods allow for a more accurate estimation of cardiovascular status through cardiac output and systemic vascular resistance assessments, reducing risks and improving surgical outcomes.[8]

The cardiovascular system's main goal is to ensure adequate cardiac output and maintain proper blood pressure for organ perfusion. In stressful situations, optimal cardiac and vascular function occurs when the ventricle and arterial system are matched. In conditions like systolic heart failure or cardiogenic shock, reduced heart function makes the heart sensitive to changes in arterial elastance (Ea). As well, increased systemic vascular resistance disrupts ventricular-arterial (VA) coupling, while therapies like vasodilators that reduce Ea can improve VA coupling and heart efficiency. This scenario delineates the hemodynamic management during the tumor resection phase, which was refined and optimized through the utilization of pulmonary artery catheterization (PAC), a crucial tool in volume replacement, as well as in the titration of vasopressor amines and inotropic agents.[8]

Excessive catecholamine release and consequent hypertension during surgery can lead to severe cardiovascular complications. Due to its favorable pharmacodynamic profile, sodium nitroprusside is frequently used to mitigate these effects. This agent promotes a gradual reduction in vascular resistance, essential to avoid abrupt fluctuations that could compromise hemodynamic stability and tissue perfusion.[3]

After tumor removal, hypotension frequently occurs due to abrupt increases in venous capacity, blood loss and downregulation of alpha and beta-adrenergic receptors. Exposed to prolonged elevated circulating catecholamine levels, these receptors become less responsive, exacerbating hypotension. Also, prolonged peripheral vasoconstriction induced by high catecholamine levels contributes to intravascular volume depletion.[9]

Volume resuscitation is critical in these cases, particularly before tumor resection, to stabilize circulatory volume. Considering the patient's compromised cardiac function fluid therapy requires greater care to prevent the onset of pulmonary edema. Among vasopressors, vasopressin stands out in managing persistent distributive shock. Vasopressin acts on vascular smooth muscle independently of adrenergic receptor availability, which is particularly advantageous in patients with receptor downregulation.[10]

Conclusion

In conclusion, this review emphasizes the importance of a comprehensive approach to managing this severe condition, particularly in patients with preexisting cardiac disease or significant hemodynamic instability. Pulmonary artery catheterization for monitoring cardiac output and systemic vascular resistance facilitates an integrated strategy combining invasive monitoring, precise hemodynamic optimization, and targeted pharmacologic interventions, ultimately minimizing risks and promoting cardiovascular stability.

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