CASE REPORT

Robot-Assisted Laparoscopic Surgery for Pheochromocytoma in a Dilated Cardiomyopathy Patient

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ABSTRACT

Pheochromocytomas are rare endocrine tumors which secrete catecholamines leading to severe cardiovascular complications. Dilated cardiomyopathy (DCM) is known to exist in patients with pheochromocytomas. The presence of these two conditions makes the anesthetic management of such cases even more complex. In this article, we present the case of a young male who had both pheochromocytoma and DCM, and who underwent robot-assisted laparoscopic surgery. The challenges in managing this case are discussed.

Keywords: Adrenal pheochromocytoma, retroperitoneal mass, catecholamines, catecholamine-induced cardiomyopathy

Dilated cardiomyopathy (DCM) is an idiopathic clinical condition characterized by left ventricular or biventricular dilation and impaired contractions. DCM is a potentially lethal disease and its 5-year mortality rate is above 50%[1]. The anesthetic management of patients with DCM is challenging for anesthesiologists because of poor left systolic function, risk of arrhythmias, chamber enlargement and risk of sudden cardiac death[2]. Pheochromocytomas are rare tumors of the adrenal medulla. The catecholamines secreted by the tumor can lead to serious cardiovascular complications including paroxysmal hypertension and cardiac failure. In individuals with pheochromocytomas, activities such as movement, endotracheal intubation, pneumoperitoneum, and compression of the tumor during surgery can trigger the release of significant amounts of catecholamines[3]. The substantial fluctuations in blood pressure that occur during surgery are the primary reason why pheochromocytoma resection is deemed a high-risk procedure. A rapid decline in catecholamine levels following tumor removal may result in difficult-to-manage hypotension, particularly during the induction of anesthesia or the surgical excision of pheochromocytomas. However, if the pheochromocytoma is removed swiftly, the prognosis is generally very favorable[4].

Additionally, patients with these tumors may experience severe complications, such as DCM, which poses considerable challenges and requires more extensive preoperative evaluation and anesthesia management[5]. In this report, we discuss a rare case of DCM in an adult patient who underwent a highly risky pheochromocytoma resection.

CASE REPORT

A 23-year-old male was admitted due to a left retroperitoneal mass identified via computed tomography (CT) scan while investigating left-sided abdominal pain (Fig. 1). The lesion measured 5.6 cm in diameter, and the patient exhibited no additional symptoms such as palpitations, fatigue, central obesity, or purple striae. Laboratory tests indicated elevated catecholamine levels and their metabolites, suggesting a diagnosis of pheochromocytoma. The patient had a history of DCM for 2 years and reported recent shortness of breath during stair climbing. There was no other significant medical history.

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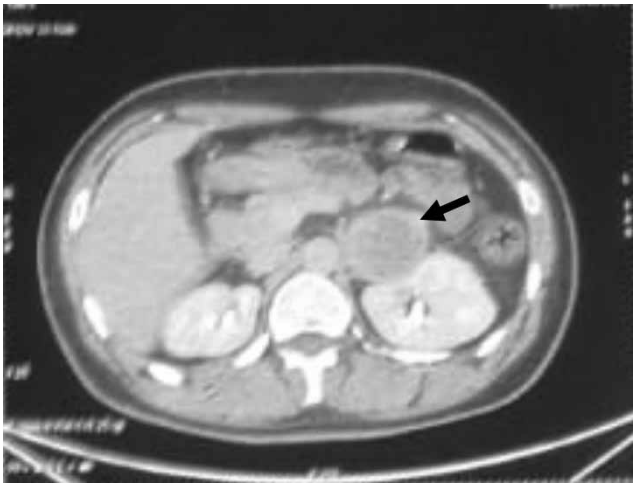

Figure 1. Noncontrast CT scan of abdomen showing left adrenal mass (*solid arrow*).

Upon admission, the physical examination revealed the following: height 172 cm, weight 89 kg, pulse rate 78 bpm, and blood pressure 112/78 mmHg. The patient was alert with a regular heart rhythm, clear lung sounds, and no lower limb edema. Other medical tests showed no significant abnormalities. Blood analysis indicated normal platelet counts, white and red blood cell counts, coagulation parameters, and liver and kidney functions. Urinary tests showed a 24-hour normetanephrine level of 1,005 μg/g creatinine (normal range: 70.00- 335.00 μg/g), and metanephrine level of 178 μg/g creatinine (normal range: 20.0-150.0 μg/g). Plasma normetanephrine was at 526 ng/L (normal range: 20.1-135.40 ng/L), while plasma metanephrine was significantly elevated at 3,910 ng/L (normal range: 7.90-88.7 ng/L). A DOTANOC-PET/CT scan indicated increased uptake in the left adrenal mass with no abnormal uptake elsewhere in the body (Fig. 2). A two-dimensional echocardiogram revealed an ejection fraction of 20%, along with dilation of the left atrium and ventricle and global hypokinesia.

The preoperative diagnosis was established as left pheochromocytoma with DCM. The patient underwent a Da Vinci robot-assisted laparoscopic resection of the left adrenal pheochromocytoma (Fig. 3). General anesthesia induction was planned during endotracheal intubation, along with invasive arterial pressure monitoring, central venous pressure monitoring, intraoperative transesophageal echocardiography (TEE), and bispectral index monitoring. Preoperative multidisciplinary consultation included administering prazosin (20 mg/day for 2 weeks) and metoprolol (25 mg/day for 1 week), along with echocardiography and N-terminal pro-B-type natriuretic peptide (NT-proBNP) assessments every 2 days to manage blood pressure and provide volume

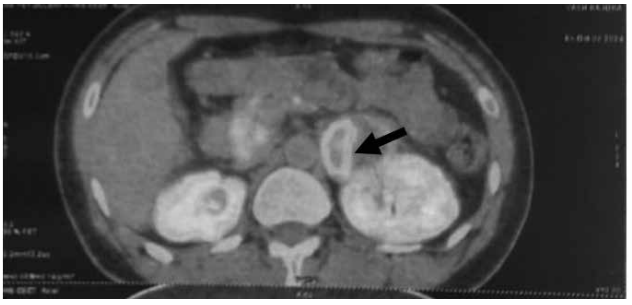

Figure 2. DOTANOC PET-CT image showing uptake in left adrenal mass (*solid arrow*).

Figure 3. Da Vinci robot-assisted laparoscopic resection of pheochromocytoma in progress.

expansion therapy for 1 week, while continuously monitoring cardiac function.

Anesthesia induction involved intravenous administration of midazolam (1 mg), etomidate (20 mg), cisatracurium (16 mg), dexmedetomidine (0.5 μg/kg/h for 30 minutes), and fentanyl (100 μg). Maintenance included propofol (3-5 mg/kg/h), fentanyl (0.5μg/kg/h), cisatracurium (6 mg/h), and sevoflurane (1%) inhalation. Throughout the procedure, intraoperative cardiac function and left heart volume status were monitored using TEE following general anesthesia induction with endotracheal intubation. Invasive arterial blood pressure, central venous pressure, depth of anesthesia, and temperature were also monitored during surgery.

To prevent stress ulcers and potential esophageal damage from the TEE probe, intravenous omeprazole was administered, along with methylprednisolone to enhance stress response capability during the operation; human serum albumin was also given. Intraoperative TEE showed a left ventricular ejection fraction ranging from 27% to 31% and a normal inferior vena cava diameter (16-18 mm). The total operative time was 2 hours and 15 minutes, with uneventful procedures performed throughout.

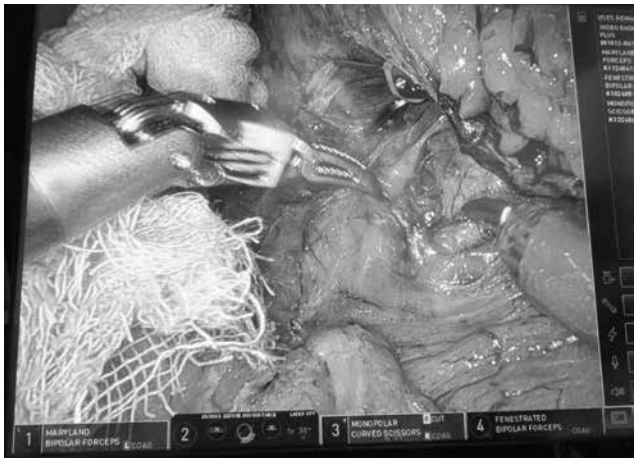

Figure 4. Intraoperative image of pheochromocytoma resection.

Intraoperative anesthesia remained stable with parameters including invasive arterial blood pressure between 110 to 130 mmHg/66 to 78 mmHg; central venous pressure between 6 to 10 cmH_2O; intraoperative blood loss at 250 mL; urine output at 400 mL and infusion volume at 1,500 mL. The adrenal mass was successfully excised, with postoperative histopathology confirming pheochromocytoma (Fig. 4). Postoperative analgesia was initiated under close observation, leading to the patient's transfer to the intensive care unit for further monitoring before returning to the general ward 3 days post-operation. He was discharged 4 days later in good condition and expressed satisfaction with his treatment and recovery.

DISCUSSION

This report outlines the successful execution of a rare, high-risk surgical procedure assisted by robotic technology, along with the optimization of anesthesia management through comprehensive preoperative evaluation and preparation. Intraoperative monitoring of cardiac function and hemodynamics was crucial for accurately guiding fluid therapy and the administration of vasoactive medications. An effective multidisciplinary team, comprising hospital physicians, anesthetists, urologists, and cardiovascular specialists, is essential in managing patients with DCM and pheochromocytoma[6]. Optimal anesthetic management for patients with DCM necessitates comprehensive preoperative assessment, vigilant perioperative monitoring, appropriate anesthesia techniques, refined fluid management, and maintenance of stable hemodynamic conditions.

Pheochromocytoma releases catecholamines that can lead to catecholamine-induced cardiomyopathy, including DCM; however, this complication is rarely reported[7]. Chronic use of adrenaline inhalers may also contribute to DCM development[8]. The mechanisms behind cardiomyopathy in pheochromocytoma patients include catecholamine-induced vasoconstriction of small arterioles, direct toxic effects from catecholamines and their metabolites, as well as receptor-mediated pathways[9]. Pheochromocytoma may result in myocardial fibrosis along with both systolic and diastolic dysfunction. While impaired myocardial function can often be improved through medical treatment or surgery, complete restoration may not be achievable in all patients[10].

Early surgical intervention is critical for managing catecholamine-induced cardiomyopathy associated with pheochromocytoma, with laparoscopic tumor removal being the preferred approach. Robot-assisted laparoscopy can significantly enhance perioperative conditions by reducing stress and energy expenditure while minimizing complications[11]. This precision surgical technique lessens stimulation from pheochromocytomas, thereby improving safety during the procedure. Consequently, we successfully performed a Da Vinci robot-assisted laparoscopic resection of the adrenal pheochromocytoma. There are documented cases indicating that surgical treatment can reverse myocardial dysfunction[12].

Preoperative preparation for pheochromocytoma resection must meet stringent standards, including maintaining blood pressure below 120/80 mmHg, a heart rate of 60 to 80 bpm, and ensuring electrocardiographic recovery from ventricular premature contractions. Additionally, there should be a decrease in hematocrit of more than 5% following volume expansion therapy, alongside improvements in hypermetabolic syndrome and correction of impaired glucose metabolism[13]. Elevated catecholamine levels can cause sustained vasoconstriction and reduced effective circulating blood volume, leading to hypertension, tachycardia, hypovolemia, and hemoconcentration in patients. In this case, the patient had DCM with a low ejection fraction of 20%, necessitating careful monitoring and gradual volume expansion therapy to avoid exacerbating heart failure. Preoperative blockade with alpha-blockers is recommended for all patients with hormonally active paragangliomas, and combining these with calcium antagonists may further stabilize intraoperative blood pressure. Proper preoperative anesthesia preparation is essential for maintaining stable circulation during the surgical procedure[14].

The perioperative mortality rate for pheochromocytomas is notably high, with risks including hypertensive crises and heart failure. However, hypotension and

hypoglycemic shock can occur following tumor resection. Additionally, the patient presented with DCM. To optimize anesthesia induction and management, we closely monitored the depth of anesthesia, cardiac function, and hemodynamics, maintaining systolic blood pressure between 90 and 140 mmHg and diastolic blood pressure between 60 and 90 mmHg. The patient was susceptible to hypotension and tachycardia after anesthesia induction, prompting the administration of norepinephrine via a micropump to stabilize his condition. These measures ensured that the surgery proceeded safely and smoothly.

Anesthesia induction was conducted smoothly, ensuring adequate sedation, analgesia, and muscle relaxation. We utilized intravenous anesthesia while continuously monitoring the depth of anesthesia to maintain stability throughout the procedure.

Perioperative hemodynamic instability is a significant challenge during pheochromocytoma surgery, especially in patients with compromised cardiac function[15]. To manage this, an intraoperative TEE probe was used for real-time monitoring of left heart function and volume, which is crucial for guiding fluid management. TEE revealed a stable left ventricular ejection fraction of 28% to 32%, and careful monitoring of invasive arterial and central venous pressures allowed for timely adjustments in vasoactive drug administration. Goal-directed fluid therapy was implemented to replenish intravascular volume while avoiding fluid overload, which could lead to complications such as heart failure. Continuous monitoring of blood glucose levels post-surgery was also essential to prevent hypoglycemia, particularly in patients with epinephrine-predominant tumors[16].

CONCLUSION

Anesthetic management for adrenal pheochromocytoma resection in adult patients with DCM presents significant risks but is achievable with careful planning. Our multidisciplinary team conducted thorough preoperative assessments and maintained vigilant perioperative monitoring; anesthesia and fluid management were optimized to achieve stable hemodynamics throughout the procedure. The use of robot-assisted laparoscopy further enhanced surgical safety. The challenges inherent in perioperative anesthetic management can be mitigated through invasive monitoring techniques and minimally invasive surgical approaches. This case underscores the importance of personalized management strategies and multidisciplinary collaboration for achieving successful outcomes.

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