



BMH Med. J. 2026;13(2):60-64. **Case Report**

Anaesthetic management of a patient undergoing robotic partial nephrectomy in a solitary kidney

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Abstract

Patients with a solitary kidney undergoing nephrectomy represent a uniquely high-risk group in whom anaesthetic management directly influences renal and overall perioperative outcomes. With the increasing use of robotic-assisted techniques such as the da Vinci Surgical System, anaesthesiologists must address procedure-specific physiological challenges of pneumoperitoneum and lateral positioning, restricted access after docking, and potential warm ischemia - all of which may compromise renal perfusion. Preoperative assessment must focus on renal reserve, optimization of volume status and risk stratification for acute kidney injury. Intraoperative management included balanced general anesthesia with endotracheal intubation, invasive arterial pressure monitoring and strict haemodynamic control to maintain adequate mean arterial pressure. Ventilatory adjustments were made to counteract the physiological effects of carbon dioxide pneumoperitoneum.

Keywords: Solitary kidney, Partial nephrectomy, da Vinci surgical system, Robotic nephrectomy

Introduction

A solitary kidney may be congenital (renal agenesis), acquired (post-nephrectomy), or functionally solitary due to pronounced contralateral renal impairment. In such patients, the preservation of residual renal function assumes critical importance, as any perioperative insult may precipitate acute kidney injury (AKI) and long-term chronic kidney disease (CKD) [1]. The surgical management of renal masses in this demographic thus represents a distinctive clinical challenge, necessitating a delicate equilibrium between optimal surgical dissection and nephron preservation [1,2].

Robotic-assisted nephrectomy performed using platforms such as the da Vinci Surgical System has increasingly become an established approach for both partial and radical nephrectomy [3,4]. Compared with open surgery, robotic techniques provide enhanced visualization, improved dexterity, reduced blood loss, and shorter hospital stay [3,4]. Partial nephrectomy is generally recommended in patients with a solitary kidney to preserve nephron mass and reduce the risk of long-term renal dysfunction, consistent with guidance from the American Urological Association and the European Association of Urology [1,2]. However, complex tumors, unfavorable anatomy, or intraoperative findings may necessitate radical nephrectomy despite the increased risk to renal reserve [1,2].

From an anaesthetic perspective, robotic nephrectomy introduces significant physiological challenges related to carbon dioxide pneumoperitoneum and lateral positioning [5]. Pneumoperitoneum increases intra-abdominal pressure, reduces venous return, alters renal blood flow, and may impair glomerular filtration rate [5]. Lateral decubitus positioning and prolonged operative duration further influence cardiopulmonary dynamics and tissue perfusion [5]. During partial nephrectomy, temporary renal hilar clamping and warm ischemia may contribute to postoperative renal dysfunction, making maintenance of adequate mean arterial pressure and oxygen delivery critical [4]. Restricted access to the patient after robotic docking necessitates meticulous preparation, secure airway management, and reliable vascular access to ensure patient safety [3,5].

In patients with a solitary kidney, anaesthesia therefore plays a central role in perioperative renal protection [4]. Strategies including preoperative optimization, avoidance of nephrotoxic agents, goal-directed fluid therapy, and strict haemodynamic control are essential to minimize perioperative renal injury [4]. Thus, anaesthetic management is not merely supportive but integral to preserving renal function and improving outcomes in this high-risk surgical population [4].

Case report

An elderly gentleman known a case of COPD - emphysema since childhood, hypertension for the past 1 year presented with complaints of abdominal pain which was associated with backpain radiating to his leg. General and Systemic examination were within normal limits. On assessment of airway, mouth opening was normal, with adequate neck movements and the Mallampatti grade was 2.

Lab values showed Hb - 13.4gm%, platelet count -2.65 lakhs/mm³, aPTT was 10.3/10.4 with an INR value of 0.99. Other blood investigations showed S.Creatinine 1.3 and serum electrolytes were within normal limits. The electrocardiogram taken showed normal sinus rhythm with T inversion in lead aVL. Echocardiogram showed no regional wall motion abnormality, normal left ventricular systolic function, left ventricular diastolic dysfunction, and LV ejection fraction of 64%. Chest X-ray was taken which showed tubular shaped heart, Bilateral hyper inflated lung fields with increased bronchovascular markings. CT Thorax taken showed mild to moderate cylindrical bronchiectasis involving apical, anterior and posterior segments of right upper lobe and basal segments of right lower lobe. Mild cylindrical bronchiectasis noted in medial segment of right middle lobe.

After preoperative optimization including incentive spirometry, nebulization with Levosalbutamol and Fluticasone, one sachet of Carboload in 250ml of water orally on the previous night and morning two hours before surgery. He was taken up for procedure under General anaesthesia. A high risk informed consent was taken informing postoperative ventilation, postoperative dialysis.

He was premedicated with injection Metoclopramide 10 mg IV and injection Pantoprazole 40 mg IV, Midazolam 1mg and Dexamethasone 8mg IV. In the operation theatre, all standard ASA monitors including pulse oximeter, 5 lead ECG and noninvasive blood pressure was attached. Room air saturation was 98% under room air. Oxygen was initiated via Hudson's face mask at 5L/min.

He was induced with injection Propofol 150 mg, injection Fentanyl 100mcg, Vecuronium 8mg and intubated with 8 mm internal diameter flexometallic cuffed endotracheal tube under Sellicks maneuver using McCoy Laryngoscope, CL grading 4 was noted. Cuff was inflated to a pressure of 22 cm of H₂O and fixed it at 21cm at the anterior incisor level. A suction catheter of size 14G was inserted to deflate the stomach. Patient was mechanically ventilated with (pressure controlled-volume guaranteed (PC-VG) mode using closed circuit and end tidal carbon dioxide was monitored. The ventilatory settings were adjusted as tidal volume-400ml, RR - 14/minute, PEEP - 5 cm H₂O, FiO₂ - 55%. Maintenance was carried out using sevoflurane,oxygen, air, Paracetamol one gram IV at induction and fentanyl infusion at 50microgram/hr, ensured adequate depth.

Left radial artery cannulation was performed for invasive blood pressure (IBP) monitoring, and a right internal jugular vein catheter (Certofix protect 7 French triple lumen) was secured. A transdermal Fentanyl patch releasing 25mcg/hour was placed on the chest at the end of procedure. A Bair Hugger and a hotline fluid warmer and an oral temperature probe were also kept in place. Deep Vein Thrombosis (DVT) prophylaxis during intra op period was by intermittent pneumatic compression devices which was continued in the post op period also.

Arterial blood gas analysis (ABG) done following induction which showed normal values. Fluid requirements were met with warm balanced crystalloid solutions such as Sterofundin.

The surgical procedure was uneventful, with an approximate blood loss of 250ml. Intraoperatively, the patient had a pulse rate of 70-76/min and a systolic BP fluctuating which was managed with Noradrenaline and NTG infusion which was titrated accordingly. During the surgery antibiotics were repeated after 4hrs, mannitol 20 gm IV, methyl prednisolone 125 mg IV, Furosemide 20 mg IV was given. N acetyl cysteine infusion (10 gram in 50 ml) at 2 ml/hr IV was started. Specimen was removed through a 4-6 cm surgical incision. A USG guided unilateral lateral transverse abdominal plane (TAP) block with ropivacaine 0.2%, 20 ml was given to cover the somatic pain from the surgical incision. After the surgical procedure, patient was reversed with Suggamadex 200mg IV. Postextubation he was haemodynamically stable and was shifted to Postoperative ICU.

Discussion

Patients with a solitary kidney undergoing robotic partial nephrectomy require careful perioperative management because preservation of renal function is critical and the risk of postoperative acute kidney injury (AKI) remains significantly higher compared with patients with bilateral kidneys. Recent studies have shown that although robot-assisted partial nephrectomy provides favorable long-term renal functional outcomes, solitary kidney patients remain more vulnerable to postoperative AKI, particularly when warm ischemia time exceeds 25 minutes or when baseline renal function is reduced [6].

Furthermore, contemporary studies indicate that robotic partial nephrectomy is both a safe and effective surgical intervention, effective approach for tumors in solitary kidneys, offering advantages such as improved operative precision, reduced complications, and preservation of renal function when compared with traditional laparoscopic techniques. [7]

Robotic nephrectomy utilizing advanced systems such as the da Vinci Surgical System confers numerous surgical advantages, including enhanced visualization, superior precision, and diminished intraoperative blood loss. Nevertheless, the establishment of carbon dioxide pneumoperitoneum and the necessity for lateral decubitus positioning engender significant physiological alterations. Elevated intra-abdominal pressure may attenuate venous return and cardiac output while concurrently augmenting systemic vascular resistance, potentially jeopardizing renal blood flow and glomerular filtration rate. These physiological ramifications are particularly consequential in patients with a solitary kidney, wherein the preservation of renal perfusion is paramount.

Invasive hemodynamic monitoring plays a critical role in the anaesthetic management of these cases. Placement of an arterial line allows continuous blood pressure monitoring and facilitates frequent arterial blood gas analysis during prolonged procedures. Continuous monitoring enables early detection of hypotension or haemodynamic fluctuations that may adversely affect renal perfusion. Maintaining adequate mean arterial pressure is essential to ensure sufficient renal blood flow, particularly during pneumoperitoneum or periods of surgical manipulation [4]. In addition, central venous catheterization may be useful for administration of vasoactive medications, fluid management, and assessment of volume status during major laparoscopic or robotic procedures with

potential hemodynamic instability [8].

Patient positioning is another key consideration in robotic nephrectomy. The lateral decubitus position combined with robotic docking restricts access to the patient once the surgical system is engaged. Therefore, careful positioning and padding before docking are essential. Adequate padding of pressure points such as the head, dependent shoulder, elbows, iliac crest, knees, and ankles helps prevent nerve injuries and pressure-related complications during prolonged surgery. Particular attention should be paid to protecting the brachial plexus, peroneal nerve, and ulnar nerve, which are vulnerable in the lateral position [9]. Proper alignment of the spine and use of gel pads or foam supports can further reduce the risk of pressure injuries.

Prolonged operative duration and reduced patient mobility during robotic surgery also increase the risk of venous thromboembolism (VTE). The use of intermittent pneumatic compression devices, such as calf pumps, is therefore recommended intraoperatively to promote venous return and reduce venous stasis in the lower limbs [10]. These devices are particularly useful during lengthy procedures in the lateral position, where venous pooling in dependent limbs may occur.

Fluid management remains another critical component of renal protection. Both hypovolemia and excessive fluid administration can adversely affect renal perfusion and postoperative outcomes. Goal-directed fluid therapy guided by invasive monitoring or dynamic parameters can optimize intravascular volume and maintain adequate organ perfusion. Avoidance of nephrotoxic medications and maintenance of normothermia also contribute to minimizing perioperative renal injury [4].

Finally, limited access to the patient after robotic docking necessitates thorough preparation before the start of surgery. Securing the airway, ensuring reliable intravenous access, confirming appropriate monitoring, and checking all pressure points are essential steps prior to docking of the robotic system. Such meticulous preparation helps ensure patient safety throughout the procedure.

Overall, anaesthetic management plays a pivotal role in optimizing perioperative outcomes in patients with a solitary kidney undergoing robotic nephrectomy. Careful haemodynamic monitoring, meticulous positioning and padding, thromboprophylaxis with mechanical devices, and renal-protective anesthetic strategies are crucial to minimizing complications and preserving postoperative renal function.

Conclusion

Robotic nephrectomy in a patient with a solitary kidney presents significant anaesthetic challenges in which renal preservation is paramount. The physiological effects of pneumoperitoneum, lateral positioning, potential hemodynamic instability, and restricted access after docking of the da Vinci Surgical System demand meticulous preparation and vigilant intraoperative management.

A proactive, renal-protective anaesthetic strategy - emphasizing optimization of volume status, strict maintenance of mean arterial pressure, goal-directed fluid therapy, avoidance of nephrotoxic agents, and close postoperative monitoring - is essential to minimize the risk of acute kidney injury. In such high-risk cases, anaesthesia extends beyond supportive care and becomes central to preserving renal function and ensuring favorable perioperative outcomes.

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