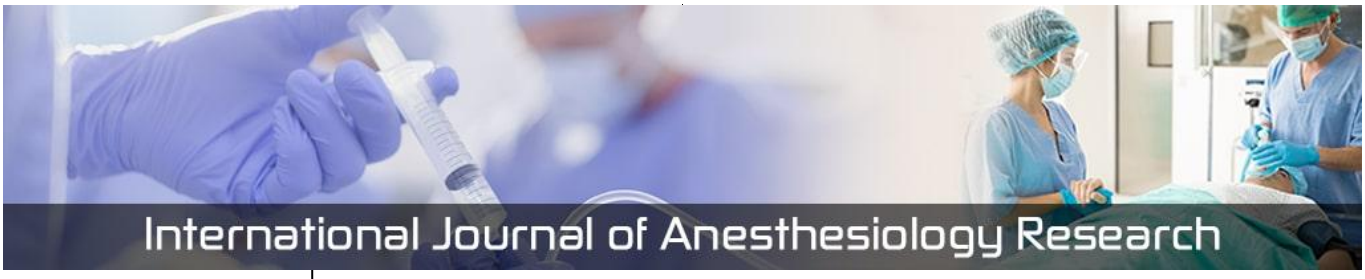

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Anesthetic challenges in perioperative hemodynamic management for combined radical nephrectomy and hepatic segmentectomy in an HBsAg-positive patient with renal cell carcinoma and segment 4B Metastasis

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Abstract
Background: Renal Cell Carcinoma (RCC) frequently metastasizes to the lungs, bones, and liver. In carefully selected patients, radical nephrectomy with metastasectomy offers potential curative benefit. Combined renal and hepatic resections, however, pose significant anesthetic and surgical challenges due to prolonged duration, major blood loss, and the requirement for advanced hemodynamic management.
Case presentation: We report the perioperative management of a 55-year-old male with left RCC, solitary segment 4B liver metastasis, and associated incisional hernia. He underwent radical nephrectomy, hepatic metastatectomy, and incisional hernia repair under general anesthesia with advanced hemodynamic monitoring. Invasive arterial pressure, central venous pressure, and Stroke Volume Variation (SVV)-guided goal-directed fluid therapy (GDFT) were employed. Hemodynamic instability during surgery, particularly during hepatic resection and prolonged Pringle's maneuver, was managed with vasopressor support, blood product transfusion, and individualized fluid therapy. This case underscores the critical role of multimodal monitoring and GDFT in guiding perioperative fluid and vasopressor therapy during combined renal and hepatic resections. The unique balance between renal perfusion post-nephrectomy and hepatic outflow during resection requires meticulous anesthetic planning.
Conclusion: Combined nephrectomy and hepatic metastasectomy can be performed safely in selected patients with RCC. Perioperative optimization with advanced hemodynamic monitoring, GDFT, and tailored anesthetic strategies are vital for improving surgical outcomes.

Keywords: Renal cell carcinoma, liver metastasis, nephrectomy, hepatic segmentectomy, anesthesia, hemodynamic monitoring

Introduction
Renal Cell Carcinoma (RCC) accounts for approximately 3% of adult malignancies and is the most common primary renal neoplasm [1]. It frequently spreads hematogenous, with the lungs, bones, and liver representing the most common metastatic sites [2, 3]. At diagnosis, up to one-third of patients present with synchronous metastases [3, 4].
In a subset of patients with isolated or oligometastatic disease, surgical resection of both the primary tumour and metastatic deposits offers survival benefit and, in some cases, long- term remission [5, 6]. Among metastatic sites, liver involvement is seen in approximately 20% of patients [5]. While systemic therapy with targeted agents and immunotherapy forms the cornerstone of treatment for disseminated disease, resection of solitary hepatic metastases may be justified in selected cases with good performance status [6, 12].
The anaesthetic management of combined radical nephrectomy and hepatic resection is challenging due to prolonged operative duration, risk of major blood loss, fluid shifts, and the competing demands of renal and hepatic perfusion. Advanced perioperative hemodynamic monitoring including arterial waveform analysis and dynamic preload indices such as stroke volume variation (SVV) provides real-time insights into fluid responsiveness and guides goal-directed fluid therapy (GDFT). This approach has been shown to improve outcomes in major abdominal surgery [7-9, 13]. We report the case of a patient with RCC and

an isolated segment 4 liver metastasis who underwent simultaneous radical nephrectomy and hepatic segmentectomy, emphasizing the role of advanced perioperative hemodynamic monitoring

Case Presentation

A 55-year-old male, ASA class III, weight ~70 kg, presented with left flank pain, intermittent haematuria, anorexia, and 6 kg weight loss over three months. He had no major comorbidities, non-smoker, and occasional alcohol intake. Laboratory investigations: Hb 11.2 g/dL; platelets 230,000/mm³; creatinine 1.1 mg/dL; normal liver enzymes. Imaging (contrast CT) revealed a ~12 × 10 cm left renal mass, a solitary 3 × 2.5 cm lesion in liver segment 4B, and incisional hernia. Echocardiography: ejection fraction 60%, no major valvular issues.

Fig 1: Postoperative clinical photograph of the abdomen showing a well-healed incision with multiple interrupted sutured sites. No evidence of wound infection or dehiscence is noted

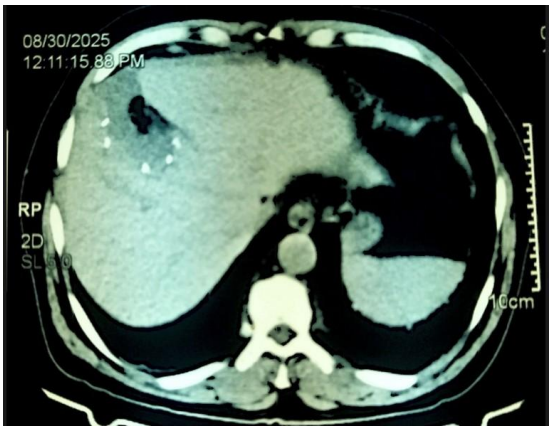

Fig 2: Contrast-enhanced CT abdomen (axial section, postoperative) demonstrating postoperative changes in the liver following segment 4B segmentectomy. The resection cavity is seen with surrounding postoperative changes, without evidence of residual lesion or intra-abdominal collection

Multidisciplinary decision made for radical left nephrectomy, hepatic metastatectomy (segment 4B), and incisional hernia repair in a single combined surgery. Post-Operative images are attached (Fig 1 and Fig 2).

Anaesthetic and Perioperative Management

Access & Monitoring: Under ultrasound guidance, central venous catheter placed in right internal jugular vein, arterial line in right radial artery. Standard ASA monitors plus invasive arterial pressure, central venous pressure (CVP), stroke volume variation (SVV) via advanced hemodynamic monitoring.

- **Fluid & Blood Products:** Estimated blood loss ~800 mL. Inputs: 6 L crystalloids, 250 mL colloid, 4 units fresh frozen plasma (FFP), 2 units packed red blood cells (PRBC). Output: urine ~1400 mL.
- **Glucose & Metabolic Management:** Intra-operative capillary blood glucose (CBG) elevated ~218 mg/dL. Arterial blood gas at ~1900 h (7:00 PM): pH 7.2, pCO_2 34 mmHg, pO_2 180 mmHg, Na^+ 145 mEq/L, K^+ 5.5 mEq/L, CBG ~209 mg/dL. To correct acidosis and hyperkalaemia, sodium bicarbonate 44 mL in 50 mL NS was infused over 30 minutes.
- **Hemodynamic Support:** Noradrenaline single-strength infusion at 4 mL/hour started at 7 PM to maintain MAP.
- **Surgical Duration & Stages:** Prolonged surgery combining nephrectomy, metastatectomy and hernia repair; multiple phases including mobilization, resections, possibly Pringle's manoeuvre during hepatic transection.

Postoperative ICU Management

- **Ventilation:** Elective mechanical ventilation in Surgical ICU (SICU) due to prolonged procedure. Volume-controlled continuous mandatory ventilation (VC-CMV) mode with tidal volume 500 mL, PEEP 5 cm H_2O, FiO_2 80%, I:E ratio 1:2.
- **Sedation & Analgesia:** Vecuronium infusion at 2 mL/hour. Midazolam 1 mg IV as needed (SOS). Morphine 4 mg IV. Plan to initiate dexmedetomidine infusion for further sedation and to aid in analgesia/sedation balance with less respiratory depression.
- **Hemodynamic and Metabolic Stability:** Vitals monitored; heart rate ~71/min; blood pressure 160/90 to 140/80 mmHg. Close monitoring of renal function, electrolytes, liver function tests planned.

Postoperatively, the infusion of dexmedetomidine and vecuronium was discontinued at 8:30 am, and the patient was transitioned from SIMV mode to T- piece ventilation. Following achievement of adequate spontaneous respiratory efforts, the patient was extubated uneventfully. Post-extubation, the patient maintained stable vitals with HR 92 bpm, BP 110/70 mmHg, and SpO_2 99% on 6 L/min oxygen via face mask. Systemic examination revealed bilateral normal vesicular breath sounds without added sounds on respiratory examination and normal S1S2 heart sounds on cardiovascular examination. The patient was observed in the postoperative recovery area with stable hemodynamics and adequate respiratory efforts.

Discussion

Simultaneous radical nephrectomy and hepatic resection for RCC with isolated metastasis is uncommon but may provide curative potential [4, 12]. Anaesthetic challenges include prolonged operative duration, large blood loss, hemodynamic swings during vascular occlusion, and the need to preserve renal and hepatic perfusion.

Advanced hemodynamic monitoring provides critical guidance for intraoperative management. Static indices such as CVP are unreliable predictors of fluid responsiveness, whereas dynamic parameters like SVV and pulse pressure variation correlate better with preload dependence [7]. In our

patient, SVV-guided GDFT allowed individualized administration of fluids, reducing the risk of both hypoperfusion and fluid overload [8, 9, 13].

Balanced crystalloids were used, as chloride-liberal solutions are associated with increased risk of kidney injury [10]. Vasopressor support with noradrenaline was employed to maintain perfusion pressure while minimizing excessive fluid administration [11].

The management of patients with RCC and isolated hepatic metastasis is supported by data showing improved survival when metastatectomy is combined with nephrectomy, especially in solitary metastasis and when radical resection is possible. For example, in a Dutch nationwide study of RCC liver metastases, 5-year overall survival was about 43% after surgical resection or local ablation, with no operative mortality among selected patients [3]. Another study showed that liver resection for metastatic RCC yielded a 5-year overall survival of ~62% vs ~29% in non-surgical controls, particularly in those with solitary and metachronous metastases [1]. Extended hepatic metastasectomy series report 5-year survival rates in the 38-45% range [2].

From an anaesthetic perspective, key considerations include:

1. **Preoperative Optimization:** Ensuring good baseline organ function, cross-matched blood, patient counselling. Especially in cases with hernia, nutritional status and pulmonary function (incisional hernia may reduce respiratory excursion) should be optimized.
2. **Advanced Monitoring:** Use of arterial line, central venous line, and dynamic preload indices (SVV/PPV) provides better guidance than static measures (CVP alone). This allows titration of fluids, avoidance of both under-resuscitation (leading to hypoperfusion of kidney and liver) and over-resuscitation (leading to oedema, hepatic congestion).
3. **Fluid Strategy and Transfusions:** Balanced crystalloids over excessive saline to avoid metabolic disturbances. Early replacement of blood loss with PRBC and FFP helps maintain oxygen carrying capacity and coagulation. Colloids may help but must be used cautiously.
4. **Correction of Metabolic Derangements:** Surgical stress, blood loss, and tissue hypoperfusion can lead to metabolic acidosis and hyperkalaemia, as in this case. Timely ABG monitoring and correction (e.g., sodium bicarbonate) are essential.
5. **Vasopressors:** Use of noradrenaline (or other suitable agents) when hypotension cannot be corrected with fluids alone, to maintain perfusion pressure, especially after nephrectomy when renal perfusion is critical.
6. **Postoperative Care:** Because of duration, metabolic load, risk of lung injury, and anaesthetic agents, elective postoperative ventilation aids in safe recovery. Sedation-analgesia protocols (including neuromuscular blockade if needed, balanced opioids, sedatives, and where possible adjunctive agents like dexmedetomidine) help reduce ventilator dyssynchrony, pain, and stress responses.
7. **Outcomes and prognosis indicators:** Solitary liver metastasis, radical resection, absence of extrahepatic disease, good performance status, prolonged disease-free interval are favourable prognosticators [3, 7]. Also, the histological grade, margin status, and tumour burden impact long-term outcomes.

The perioperative management of patients who are positive for hepatitis B surface antigen (HBsAg) requires a dual focus: ensuring patient safety while preventing transmission to health care workers and other patients. From the anaesthesiologists' perspective, this entails careful planning encompassing preoperative, intraoperative, and postoperative phases.

- Preoperative considerations include thorough evaluation of the patient's hepatic functional reserve, coagulation status, and comorbidities such as portal hypertension, ascites, or renal impairment, which may alter anaesthetic pharmacokinetics and pharmacodynamics [14, 15]. Liver function tests, coagulation profile, viral load (HBV DNA), and imaging should guide anaesthetic planning. Drug dosing must be individualized, as hepatocellular dysfunction can prolong the metabolism and clearance of commonly used anaesthetic agents such as benzodiazepines, opioids, and muscle relaxants [16].
- Infection control precautions are paramount. HBsAg-positive status demands strict adherence to universal precautions to minimize occupational exposure to blood and body fluids. Use of double gloves, protective eyewear, impermeable gowns, and safe handling/disposal of sharps are critical [17]. Breaches in aseptic technique may result in nosocomial transmission to health care workers or contamination of anaesthesia work surfaces. The anaesthesia team should avoid recapping needles, use closed suction systems, and ensure appropriate disinfection of anaesthesia equipment between cases [18].
- Intraoperative management requires vigilance regarding hepatotoxic agents. Volatile anaesthetics such as halothane should be avoided due to their association with immune- mediated hepatitis, while safer alternatives like sevoflurane or isoflurane are preferred [19]. Intravenous agents such as propofol are generally well tolerated, but dose adjustments may be necessary for prolonged infusions. Muscle relaxants dependent on hepatic metabolism (e.g., vecuronium, rocuronium) should be used cautiously, with atracurium and cisatracurium being preferable due to organ-independent metabolism [20, 21]. Maintenance of hemodynamic stability is critical to preserve hepatic blood flow, and avoidance of hypoxia, hypercarbia, and hypotension is essential [22].
- Postoperative care focuses on minimizing hepatotoxic insults and preventing infection transmission in recovery areas. Adequate pain management should be provided, avoiding excessive paracetamol or NSAIDs due to hepatotoxicity and coagulation risks, respectively [23]. Regional anaesthesia can be considered but must be weighed against deranged coagulation profiles to prevent neuraxial hematomas [24]. Patients should be monitored closely for signs of hepatic decompensation, encephalopathy, or worsening coagulopathy.

From an institutional perspective, vaccination of health care workers against HBV remains the most effective protective measure [25]. Anaesthesiologists must ensure that they are immunized and aware of post-exposure prophylaxis protocols. Furthermore, meticulous documentation, communication with surgical colleagues, and adherence to infection control guidelines help reduce perioperative risks.

In summary, the anaesthetic management of HBsAg-positive patients involves a multidisciplinary approach

balancing the challenges of altered pharmacology due to liver dysfunction and the imperative of infection prevention. By adhering to evidence-based infection control measures and tailoring anaesthetic techniques, anaesthesiologists can optimize patient outcomes while ensuring the safety of the perioperative team.

This case demonstrates that combined radical nephrectomy and hepatic resection is feasible in selected patients, provided perioperative care incorporates advanced monitoring, GDFT, and tailored anaesthetic strategies. In this case, the combination of all the above - advanced monitoring, prompt correction of metabolic disturbance, balanced fluids/transfusion, use of vasopressors, careful ventilatory and sedation strategy - likely contributed to the patient's stable postoperative course. Literature supports that in selected patients, with similar extensive surgeries, morbidity can be acceptable and survival significantly better than non-surgical management.

Limitations

Single case report; follow-up for long-term survival not yet available; no formal measurement of dynamic parameters like SVV recorded in detail in the postoperative period or long-term renal/hepatic function beyond early postoperative days.

Conclusion

Combined radical nephrectomy, hepatic metastasectomy, and hernia repair were successfully performed in this patient with RCC and solitary liver metastasis. The case demonstrates that advanced hemodynamic monitoring, SVV-guided fluid therapy, and proactive ICU care are indispensable in ensuring perioperative safety. With careful patient selection and tailored anesthetic management, such complex combined surgeries can yield favorable outcomes.

Conflict of Interest

Not available

Financial Support

Not available

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