



Anesthetic Management of Emergency Transcatheter Arterial Embolization under General Anesthesia for Postoperative Intra-Abdominal Hemorrhage Following Laparoscopic Extended Pancreaticoduodenectomy: A Case Report

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Abstract

Laparoscopic extended pancreaticoduodenectomy is a radical surgical procedure for malignant tumors of the pancreatic head and periampullary region, characterized by extensive surgical trauma and complex anatomical dissection. Postoperative intra-abdominal hemorrhage is a life-threatening complication with rapid progression and can quickly lead to hemorrhagic shock. As a minimally invasive and precise hemostatic approach with less secondary trauma, transcatheter arterial embolization (TAE) has become the first-choice emergency treatment for postoperative arterial intra-abdominal hemorrhage.

However, these patients have usually just undergone major surgery and may present with severe hemorrhagic shock, coagulation dysfunction, and multiple organ impairment, posing enormous challenges to anesthetic management. This paper reports the anesthetic management process of a patient with intra-abdominal arterial hemorrhage after laparoscopic extended pancreaticoduodenectomy who underwent emergency digital subtraction angiography (DSA) and TAE under general anesthesia. The key points of perioperative circulatory management, airway management, coagulation regulation, and organ protection are summarized, providing references for anesthetic treatment of similar critical cases in clinical practice.

Keywords

Laparoscopic Extended Pancreaticoduodenectomy, Postoperative Intra-Abdominal Hemorrhage, Transcatheter Arterial Embolization, General Anesthesia, Anesthetic Management

Introduction

Laparoscopic extended pancreaticoduodenectomy (LEPD) is widely performed for radical resection of pancreatic periampullary and head malignancies. Despite advances in laparoscopic technology, it is still

associated with perioperative complications due to its technical complexity and extensive tissue dissection [1]. Postoperative intra-abdominal hemorrhage, especially arterial hemorrhage, is one of the most catastrophic acute complications, with an incidence of 3%-9%,

which can rapidly induce irreversible hemorrhagic shock and multi-organ dysfunction if not treated promptly [2]. Compared with emergency exploratory laparotomy, emergency DSA-guided transcatheter arterial embolization (TAE) achieves rapid and accurate hemostasis with less trauma, making it preferable for critically ill patients who cannot tolerate secondary open surgery. Nevertheless, patients with postoperative hemorrhagic shock are in an unstable physiological state, requiring rigorous and individualized anesthetic management to maintain hemodynamic stability. Herein, we present a case of emergency TAE for postoperative intra-abdominal hemorrhage after LEPD and elaborate on the critical strategies of anesthetic management.

Case Presentation

General Information:

A 55-year-old female patient, weighing 56 kg and with a height of 160 cm, was admitted to our hospital with a diagnosis of periampullary carcinoma. Preoperative examinations excluded surgical contraindications, and she underwent elective laparoscopic extended pancreaticoduodenectomy under general anesthesia. The operation lasted 5.9 hours, with intraoperative blood loss of approximately 400 mL and stable hemodynamics. The patient was transferred to the post-anesthesia care unit (PACU). After 40 minutes of observation following extubation, the patient reported no obvious abnormalities and was transferred back to the general ward.

Nine hours after returning to the ward, the patient developed sudden hypotension and progressive tachycardia, with approximately 800 mL of bright red bloody fluid drained from the abdominal drainage tube within a short period. Physical examination showed apathetic consciousness, blood pressure (BP) 72/45 mmHg, heart rate (HR) 142 beats/min, pulse oxygen saturation (SpO₂) 90% (face mask oxygen inhalation at 5 L/min), cold and clammy extremities, prolonged capillary refill time, and abdominal distension. Emergency laboratory tests revealed hemoglobin (Hb) 53 g/L, platelet count $96 \times 10^9/L$, prothrombin time 18.2 s, activated partial thromboplastin time 46.3 s, and fibrinogen 0.97 g/L. Bedside abdominal ultrasound confirmed massive intra-abdominal effusion, and the

patient was diagnosed with postoperative intra-abdominal arterial hemorrhage and hemorrhagic shock.

After multidisciplinary consultation involving the departments of pancreatic surgery, interventional radiology, and anesthesiology, it was determined that the patient could not tolerate exploratory laparotomy in the short term. Therefore, emergency DSA-guided transcatheter arterial embolization was performed. The anesthesiology department conducted an urgent preoperative evaluation and initiated the emergency anesthesia protocol for critically ill patients.

Preoperative Comorbidities and Physical Status:

The patient had suffered from chronic hypertension for 10 years, well controlled with oral antihypertensive drugs, with preoperative BP maintained at 130-140/80-90 mmHg. She also had a more than 30-year history of chronic hepatitis B and was receiving entecavir treatment. She had no history of diabetes, coronary heart disease, coagulation disorders, or drug allergies. Her preoperative renal function, electrocardiogram, and echocardiography were unremarkable, with ASA physical status III.

Anesthetic Management

Preoperative Emergency Resuscitation and Preparation:

Rapid Volume Resuscitation:

Upon admission to the interventional radiology suite, two 18G peripheral venous accesses and a right internal jugular venous central catheter were established immediately for central venous pressure (CVP) monitoring. Crystalloid solution (compound sodium chloride), colloid solution (hydroxyethyl starch and 5% albumin), suspended red blood cells, and fresh frozen plasma were infused rapidly following the principles of limited fluid resuscitation and goal-directed therapy, aiming to maintain mean arterial pressure (MAP) ≥ 65 mmHg and CVP at 6-8 cmH₂O while avoiding excessive fluid infusion that could aggravate intra-abdominal pressure and tissue edema.

Multi-Parameter Monitoring:

Routine monitoring included electrocardiography, invasive arterial BP continuous monitoring, SpO₂, end-tidal carbon dioxide partial pressure (PetCO₂), and body

temperature. Blood gas analysis, electrolytes, Hb, and coagulation function were tested synchronously and re-examined every 15 minutes to adjust resuscitation strategies in real time.

Anesthetic and Emergency Equipment Preparation:

General anesthetic induction and maintenance drugs were prepared, along with vasoactive agents (norepinephrine, epinephrine, dopamine), hemostatic drugs (tranexamic acid and hemocoagulase snake venom), and anti-shock medications. Blood products were prewarmed, and preparations for cardiopulmonary resuscitation and emergency tracheotomy were completed.

Anesthetic Induction and Airway Management

Given the patient's hemorrhagic shock and impaired consciousness, rapid-sequence induction was performed using intravenous etomidate 0.3 mg/kg (to maintain circulatory stability), sufentanil 0.3 µg/kg, and rocuronium 0.6 mg/kg. After 30 seconds of mask ventilation (without positive pressure ventilation) for preoxygenation, endotracheal intubation was successfully completed.

Mechanical ventilation parameters were set at a tidal volume of 6-8 mL/kg, respiratory rate of 14 breaths/min, and inspiratory-to-expiratory ratio of 1:2, maintaining PetCO₂ at 35-40 mmHg to avoid cerebral ischemia and hypoxia caused by hyperventilation or hypoventilation.

Blood gas analysis revealed significant hyperkalemia, metabolic acidosis, and stress hyperglycemia (pH 7.100; K⁺ 5.16 mmol/L; Glu 30 mmol/L; Lac 15 mmol/L; Hb 58 g/L; BE -18.3). Corrective treatment for acidosis was initiated immediately, fluid resuscitation was continued, and calcium agents were administered appropriately to protect myocardial function. During induction, BP remained below 60 mmHg, and norepinephrine 5-20 µg was injected intermittently through the central vein, followed by continuous infusion at 0.08 µg/(kg•min) to stabilize circulation and prevent worsening shock.

The endotracheal tube was firmly fixed and connected to the anesthesia machine. Active warming

measures, including heated humidified ventilation and a body-surface warming blanket, were applied to maintain body temperature ≥36°C and prevent hypothermia-induced coagulation dysfunction.

Anesthetic Maintenance and Intraoperative Management

Combined intravenous-inhalation general anesthesia was adopted, with continuous inhalation of sevoflurane at 2 L/min and remifentanil at 0.1-0.2 µg/(kg•min), supplemented with intermittent rocuronium injection for muscle relaxation. The dosages of anesthetics were adjusted in real time according to hemodynamic status, vital signs, and surgical stimulation.

Norepinephrine was continuously infused at 0.05-0.2 µg/(kg•min) to maintain MAP at 65-75 mmHg and HR at 100-120 beats/min. Fluid infusion rate and vasoactive drug dosage were adjusted precisely according to CVP and blood gas analysis results to prevent drastic BP fluctuations that could aggravate bleeding.

DSA confirmed massive contrast extravasation in the dorsal pancreatic artery, and super-selective arterial embolization with coils was performed by interventional radiologists. BP was monitored closely during embolization to prevent vasospasm and sudden hypertension. Tranexamic acid 1 g was infused continuously intraoperatively for hemostasis. Fibrinogen and platelets were supplemented according to repeated coagulation and blood routine examinations to correct coagulation dysfunction.

Blood gas analysis was dynamically monitored to correct metabolic acidosis and electrolyte disorders (hypokalemia and hypocalcemia) promptly, maintaining internal environmental stability. SpO₂ ≥98% was maintained to ensure tissue oxygenation. Nephrotoxic drugs were avoided, and renal perfusion pressure was maintained appropriately to prevent acute kidney injury. Body temperature was monitored continuously to prevent coagulation disorders and arrhythmias induced by hypothermia.

The interventional hemostasis procedure lasted 50 minutes, and repeated DSA confirmed complete occlusion of the bleeding vessel with cessation of intra-

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abdominal hemorrhage. A total of 4 U suspended red blood cells, 400 mL fresh frozen plasma, and 1 g fibrinogen were infused, with a total fluid infusion volume of 1500 mL.

At the end of the operation, the patient's BP was 105/68 mmHg, HR 92 beats/min, and SpO₂ 99%, while blood gas analysis and coagulation function were significantly improved compared with preoperative values. Considering that the patient's condition was not yet fully stable, she was transferred to the surgical intensive care unit (SICU) with the endotracheal tube retained for further observation and treatment. Before transfer, vital signs were reassessed, and emergency drugs and portable monitoring devices were prepared. The patient was escorted back to the SICU by anesthesiologists and interventional radiologists, with detailed handover regarding intraoperative anesthetic management, hemodynamic status, fluid balance, and postoperative precautions.

After returning to the SICU, the patient received continuous monitoring, anti-infection treatment, liver protection, acid suppression, and nutritional support therapy. Abdominal drainage fluid gradually decreased without rebleeding. On postoperative day 2, repeated blood routine examination showed Hb 92 g/L with normal coagulation function, and the endotracheal tube was removed. The patient was transferred to the general ward on postoperative day 3 with stable vital signs and was discharged 14 days after the interventional procedure. No complications such as recurrent intra-abdominal hemorrhage, pancreatic fistula, or biliary fistula occurred during the 1-month follow-up, and liver and kidney function remained normal.

Discussion

Laparoscopic extended pancreaticoduodenectomy is associated with a high risk of postoperative intra-abdominal hemorrhage, mostly caused by insecure vascular ligation, vascular stump slippage, or vascular erosion by pancreatic/biliary fistula [3]. Arterial hemorrhage is particularly dangerous because it can rapidly progress to severe hemorrhagic shock with high mortality. Emergency TAE avoids relaparotomy and achieves rapid and accurate hemostasis, making it the

optimal treatment for these critically ill patients, although perioperative anesthetic management remains highly challenging. Most of these patients present with severe hemorrhagic shock, and excessive preoperative examinations are unnecessary. Effective venous access should be established immediately to initiate fluid resuscitation while prioritizing tissue perfusion. Limited fluid resuscitation is recommended to avoid aggravating bleeding due to excessive BP elevation while ensuring adequate perfusion of vital organs, thereby creating favorable conditions for anesthetic induction and surgery.

Anesthetic induction in patients with hemorrhagic shock is highly prone to circulatory collapse. The core principle of drug selection is minimal circulatory suppression. Etomidate is suitable for induction in shock patients because of its limited cardiovascular effects, whereas high-dose propofol induction should be avoided to prevent sudden hypotension. Low-dose and precisely adjusted combined intravenous-inhalation anesthesia is recommended for maintenance to balance anesthetic depth and circulatory stability while minimizing the requirement for vasoactive drugs. Combined monitoring of invasive arterial BP and CVP enables precise circulatory regulation. Norepinephrine is the preferred vasoactive agent because it increases BP while simultaneously improving tissue perfusion. As is well known, hypothermia, acidosis, and shock constitute the "lethal triad"; therefore, active warming, acidosis correction, and timely blood product supplementation are essential to reverse coagulation dysfunction. Low tidal volume and appropriate respiratory rate should be applied during mechanical ventilation to ensure oxygenation while avoiding impaired venous return caused by excessive intrathoracic pressure. Extubation should only be performed after the patient's vital signs are completely stable and spontaneous respiration has fully recovered, with continuous oxygen monitoring after extubation. Critically ill patients require comprehensive monitoring during transfer, with adequate emergency preparation to prevent intraoperative accidents.

Conclusion

For patients undergoing emergency TAE for intra-abdominal arterial hemorrhage after laparoscopic

extended pancreaticoduodenectomy, the core principles of anesthetic management are rapid correction of hemorrhagic shock, maintenance of circulatory stability, regulation of coagulation function, and protection of vital organ function. Anesthesiologists should participate in multidisciplinary collaboration early, formulate individualized anesthetic plans, and implement precise real-time monitoring with dynamic adjustment of treatment strategies, thereby improving the success rate of treatment and promoting favorable postoperative outcomes.

Conflict of Interest

The author has read and approved the final version of the manuscript. The author has no conflicts of interest to declare.

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