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MANAJEMEN ANESTESI PADA BAYI DENGAN DUKTUS ARTERIOSUS PATENT YANG MENJALANI LAPAROSKOPI DUODENOSTOMI: LAPORAN KASUS

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Abstrak

Manajemen anestesi pada bayi dengan kelainan kongenital seperti patent ductus arteriosus (PDA) dan atresia duodenum memerlukan perhatian khusus, terutama pada prosedur bedah laparoskopi yang menambah kompleksitas akibat efek hemodinamik insuflasi karbon dioksida. Laporan kasus ini bertujuan mengulas pengelolaan anestesi pada seorang bayi perempuan berusia 5 hari dengan PDA dan atresia duodenum yang menjalani duodenostomi laparoskopik. Pasien menunjukkan distensi abdomen sejak lahir dan diagnosis prenatal PDA dengan shunt kiri-kanan. Anestesi dilakukan dengan menggunakan Sevofluran untuk induksi, Fentanil dan Ketamin untuk analgesi, serta Atrakurium untuk intubasi. Analgesi pascaoperasi dilakukan dengan anestesi caudal menggunakan Bupivakain 0,25%. Hemodinamik pasien terjaga stabil sepanjang prosedur, dengan saturasi oksigen 98-100% dan denyut jantung 124-137 bpm. Prosedur bedah berhasil tanpa komplikasi, dan tidak ada kebocoran pada anastomosis. Pasien dipindahkan ke ruang perawatan intensif untuk pemantauan lebih lanjut. Kesimpulannya, manajemen anestesi yang hati-hati dan individual sangat penting pada bayi dengan PDA yang menjalani pembedahan laparoskopik, dengan pendekatan anestetik multimodal yang mengoptimalkan stabilitas hemodinamik dan kontrol nyeri.

Kata kunci: Anestesi kaudal, Atresia duodenum, Neonatus, Duodenostomi laparoskopik, Patent ductus arteriosus

Abstract

Anesthetic management in infants with congenital anomalies such as patent ductus arteriosus (PDA) and duodenal atresia presents unique challenges, particularly during laparoscopic surgery due to the hemodynamic effects of carbon dioxide insufflation. This case report discusses the anesthetic approach for a 5-day-old female infant with PDA and duodenal atresia undergoing laparoscopic duodenostomy. The patient presented with abdominal distention since birth and was diagnosed prenatally with a left-to-right shunt of PDA. Anesthesia was induced with Sevoflurane, with Fentanyl and Ketamine for analgesia, and Atracurium for intubation. Postoperative analgesia was managed with caudal block using 0.25% Bupivacaine. Hemodynamic stability was maintained throughout the procedure, with oxygen saturation between 98-100% and heart rate between 124-137 bpm. The surgery was successful with no leakage at the anastomosis, and the patient was transferred to the ICU for further monitoring. In conclusion, careful, individualized anesthetic management is critical for infants with PDA undergoing laparoscopic surgery, with a multimodal anesthetic approach ensuring hemodynamic stability and effective pain control.

Keywords: *Caudal Anesthesia, Duodenal Atresia, Laparoscopy Duodenostomy, Neonate, Patent Ductus Arteriosus*

Introduction

Infants undergoing surgical procedures present unique challenges in anesthetic management, particularly when associated with congenital anomalies such as patent ductus arteriosus (PDA) and duodenal atresia (Al-Obaidi et al., 2023; Backes et al., 2022; Parkerson et al., 2021). The delicate physiology of neonates, coupled with the complexity of congenital heart defects, requires meticulous planning and execution of anesthesia to minimize risks and optimize outcomes (Grundy, 2006; Saikia & Mahanta, 2019; Sepúlveda Oviedo et al., 2022). Laparoscopic surgeries in infants, while minimally invasive, add an additional layer of complexity due to the potential hemodynamic effects of carbon dioxide insufflation and pneumoperitoneum, which can exacerbate existing cardiac conditions such as PDA (Gutt et al., 2004; Nasr et al., 2023).

This case report discusses the anesthetic management of a 5-day-old infant diagnosed with duodenal atresia and PDA undergoing laparoscopic duodenostomy. Special attention is given to the selection of anesthetic agents, the use of caudal analgesia for pain control, and the considerations necessary for managing an infant with a significant cardiac condition. The case highlights the benefits and limitations of various anesthetic techniques and provides insights into optimizing care in neonatal patients with complex congenital conditions.

Research Methods

A 5-days baby girl, born via cesarean section at Prof. Dr. I.G.N.G. Ngoerah General Hospital, was admitted for surgical management of suspected duodenal atresia (Fig. 1). Patient presented with abdominal distention since birth, with no reported episodes of fever, difficulty breathing, or cyanosis. Throughout her stay in the NICU, a nasogastric tube (NGT) was placed, with greenish output of 15 ml in the past 24 hours. She had regular bowel movements and urination through diapers. The patient was alert and responsive, with strong spontaneous crying and no signs of respiratory distress. A prenatal diagnosis of patent ductus arteriosus (PDA) with a left-to-right shunt was made, for which she was treated with intravenous Ibuprofen (35 mg every 24 hours). She is the third child of the family, born at 38 weeks of gestation with a birth weight of 3300 grams and a length of 50 cm, with no cyanosis reported at birth.

On physical examination, the patient exhibited features consistent with Down syndrome, including facial dysmorphisms and hypotonia. The respiratory rate was at 43 breaths per minute, but oxygen saturation remained at 97% on room air, with no signs of wheezing or rhonchi in the lung fields. Cardiovascular examination revealed a regular heart rate of 141 beats per minute with no detectable murmurs. Abdominal examination showed a soft abdomen with normal bowel sounds, and spontaneous urination was noted.

Significant findings from laboratory investigations included a white blood cell count of 11.12 x $10^3/\mu L$, slightly elevated for neonates, and hemoglobin at 11.3 g/dL, lower than normal for this age. A coagulation profile showed a mildly prolonged APTT at 37.6 seconds, but the prothrombin time (PPT) and INR were within normal limits.

Chemistry results indicated mild hypoalbuminemia with an albumin level of 2.5 g/dL, and hyponatremia at 129 mmol/L.

Imaging studies were notable for cardiomegaly with a cardiothoracic ratio (CTR) of 62%, right atrial enlargement, and left ventricular hypertrophy, as observed on a babygram (Fig. 1). The echocardiogram revealed a moderate PDA with left-to-right shunt and a small secundum ASD, consistent with the patient's congenital heart condition. Additionally, the babygram showed dilatation of the stomach and duodenal bulb, supporting the diagnosis of duodenal atresia.

Figure 1. Preoperative X Ray Evaluation

The patient was premedicated with 0.1 mg of Atropine Sulfate intravenously to reduce secretions and prevent bradycardia during the induction of anesthesia. In the operating room, standard monitoring was initiated, including noninvasive blood pressure (BP), pulse oximetry, and electrocardiogram (ECG). Baseline readings were obtained, and the patient was placed in the supine position for surgery.

For induction, the patient was preoxygenated with 100% oxygen, and anesthesia was induced using Sevoflurane inhalation. Analgesia was provided with Fentanyl 7,5 mcg IV and Ketamine 5 mg IV to ensure adequate pain control while maintaining cardiovascular stability. Atracurium 1.5 mg IV was administered to facilitate endotracheal intubation. The endotracheal tube (ETT) was inserted, and its position was confirmed by bilateral auscultation of the chest, ensuring that no air entered the stomach. The ETT was then secured.

Following intubation, caudal analgesia was performed with Bupivacaine 0.25%, administered via a caudal catheter in the sacral hiatus with a total volume of 3 ml (1.5 ml Bupivacaine + 1.5 ml normal saline). The maximum dose was calculated at 7.5-9 mg to provide analgesia up to the thoracolumbar level. The patient was placed in the Sims position during the procedure, and measures were taken to prevent hypothermia using a plastic wrap.

5 mcg Fentanyl was given 15 minutes after the caudal analgesia right before the first incision. Anesthesia was maintained with 0.8 MAC Sevoflurane, along with Oxygen

and Compressed air. Atracurium 0.1 mg/kg IV was administered intermittently every 30-45 minutes to maintain muscle relaxation, and no more opioid was added throughout the whole surgery

During the surgery, hemodynamic stability was maintained with heart rates ranging from 124-137 beats per minute and respiratory rates between 32-38 breaths per minute. The patient remained stable with oxygen saturation maintained at 98-100%, body temperature between 36.2-36.4°C, and end-tidal CO2 levels within 35-38 mmHg (Fig. 2). The patient received 100 ml of Ringer's lactate as intravenous fluid. Blood loss was minimal at 5 ml, and urine output was 20 ml.

The surgery involved laparoscopic duodenostomy, with findings of duodenal atresia type III. After completing the 3-hour procedure, no leakage was observed at the anastomosis, and patency to the colon was confirmed.

Postoperatively, analgesia was continued with an infusion of 15 mcg in 10 ml normal saline at a rate of 0.4 ml/hour, and Paracetamol 40 mg was administered intravenously every 8 hours for additional pain relief. The patient was transferred to the NICU for further monitoring and was extubed one day after the surgery and discharged after 3-weeks of multidiscipline care, especially in the management of the nutrition and hydration ensuring digestive system healed properly while avoiding complications.

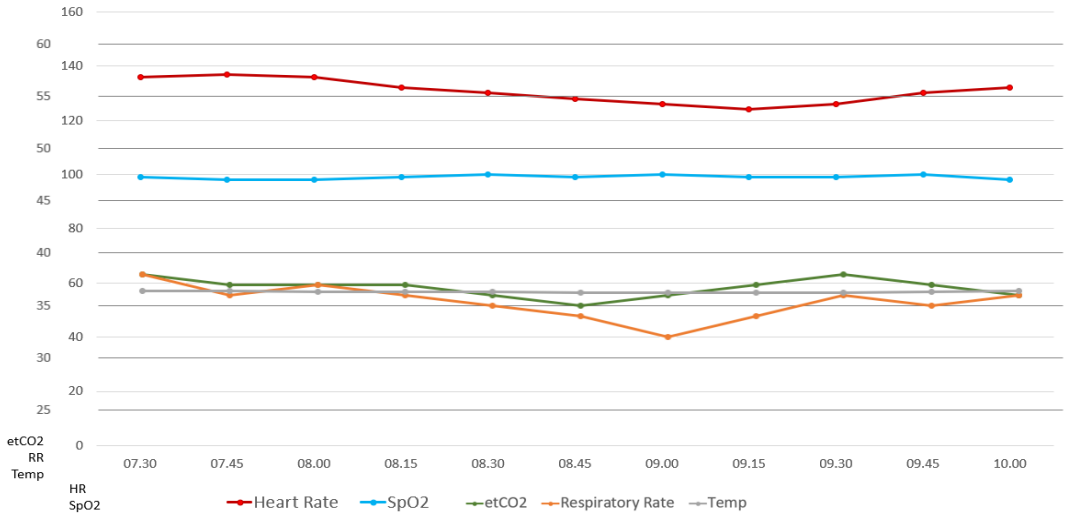

Figure 2. Intraoperative Hemodynamic

Results and Discussion

The anesthetic management of infants undergoing surgery, especially those with congenital conditions like patent ductus arteriosus (PDA) and duodenal atresia, requires careful consideration of drug selection and anesthetic techniques (Antony et al., 2022; Frydman et al., 1997). In this case, the primary focus was on ensuring cardiovascular stability, minimizing hemodynamic fluctuations, and providing effective pain control (Nasr et al., 2023; Kritzmire et al., 2022).

Selection of anesthetic drugs was critical in this case, given the patient's PDA and the potential for hemodynamic instability during surgery. Sevoflurane was chosen as the

primary anesthetic agent due to its favorable profile in neonates. It provides rapid induction and recovery while minimizing the risk of cardiovascular depression, which is especially important in patients with PDA. In combination with Fentanyl and Ketamine, the anesthetic approach ensured adequate analgesia and stable cardiovascular function. Fentanyl was chosen for its potent analgesic effects, while Ketamine was included for its dual anesthetic and analgesic properties, as well as its ability to maintain cardiac output through sympathomimetic effects. These drugs offered a balanced approach, minimizing the need for large doses of systemic opioids, which could have negatively impacted the patient's respiratory function (Ross et al., 2019; Kritzmire et al., 2022).

The use of caudal analgesia played a pivotal role in managing peripopertive pain. In this case, a single-shot caudal analgesia technique was utilized, delivering Bupivacaine 0.25% via a caudal catheter. This technique provided effective regional analgesia, targeting the thoracolumbar area and reducing the need for high doses of systemic analgesics. In this patient, 7.5 mcg fentanyl was administered only during induction and 5 mcg was given 15 minutes after the caudal analgesia as a form of preemptive analgesia, right before the first incision was made. Single-shot caudal technique is particularly advantageous in neonates, as it offers prolonged pain relief with a single administration, minimizing the need for continuous dosing and decreasing the risk of local anesthetic toxicity. The calculated dose of 7.5-9 mg was appropriate for the patient's body weight, ensuring safety while achieving effective analgesia (Abdullayev et al., 2019).

Pros and cons of anesthetic techniques for infant laparoscopic surgery must also be considered. Sevoflurane, used as the main anesthetic agent, is advantageous due to its rapid onset, ease of titration, and minimal respiratory irritation. However, it can cause hypotension, which was carefully managed in this case through close monitoring. The combination of Fentanyl and Ketamine provided both analgesia and hemodynamic stability, but there is always a risk of respiratory depression with opioids, which was mitigated by using small, calculated doses. Additionally, caudal analgesia significantly reduced the need for opioids, helping to avoid these risks. The laparoscopic approach itself, while minimally invasive and associated with faster recovery, presents challenges such as the potential for increased intra-abdominal pressure and CO2 insufflation, which can affect venous return and pulmonary function. This was managed effectively through careful intraoperative monitoring and fluid management (Preeti et al., 2024).

Considerations for infants with PDA undergoing laparoscopic surgery are especially important. PDA, characterized by a left-to-right shunt, increases the risk of hemodynamic instability during surgery, particularly when insufflation of the abdomen with CO2 can raise pulmonary vascular resistance. This can lead to reduced oxygenation and increased cardiac workload. In this case, the patient's heart rate and oxygen saturation were closely monitored throughout the procedure, ensuring that the cardiovascular system remained stable despite these potential challenges. The choice of Sevoflurane, Fentanyl, and Ketamine, with additional caudal analgesia ensured that systemic vascular resistance was maintained without causing undue strain on the heart (Alejandro et al., n.d.; Nasr et al., 2023).

Conclusion

In conclusion, this case demonstrates a successful anesthetic approach for an infant with patent ductus arteriosus (PDA) undergoing laparoscopic duodenostomy, emphasizing the importance of individualized management strategies in neonates with complex cardiac and gastrointestinal conditions. Through careful selection of anesthetic agents, effective use of caudal analgesia, and vigilant intraoperative monitoring, the anesthetic team was able to achieve stable hemodynamic parameters and effective pain control, minimizing the risks associated with the patient's cardiac condition and laparoscopic surgical intervention. This case underscores the significance of a tailored, multi-modal anesthetic approach in neonatal surgeries with high-risk cardiac and respiratory considerations.

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