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Challenges of Anesthetic Management in Pediatric Patients with Hernia Inguinalis Lateralis Dextra Reponibilis: A Case Report

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ABSTRACT

Introduction: Hernia inguinalis lateralis dextra reponibilis (HILD repr.) is a common condition in infants and children, but anesthetic management in these pediatric patients requires special attention. Children's unique physiological and pharmacological characteristics, potential comorbidities, and risk of postoperative pain demand a careful and integrated approach. **Case presentation:** This case report presents comprehensive anesthetic management of a 6-month-old male infant who underwent elective herniotomy for HILD repr. The anesthesia procedure involved induction with sevoflurane and fentanyl, maintenance of anesthesia with sevoflurane, and multimodal pain management with paracetamol and bupivacaine. The surgery was successful without complications, and the patient recovered well. **Conclusion:** This case highlights the importance of implementing modern anesthetic practices in pediatric patients with HILD repr., including selection of appropriate anesthetic agents, close monitoring, and multimodal pain management. Specific challenges such as unique airway anatomy, variability in drug pharmacokinetics, and risk of perioperative complications are also highlighted. The successful anesthetic management of this case highlights the importance of an individualized approach and close monitoring to optimize clinical outcomes and minimize complications in pediatric patients with HILD repr.

1. Introduction

Inguinal hernia, as one of the most prevalent congenital anomalies among infants and children, demands special attention in the realm of pediatric health. Specifically, hernia inguinalis lateralis dextra reponibilis (HILD repr.), which is characterized by protrusion of abdominal contents through a dilated internal inguinal annulus, is the most common subtype of inguinal hernia. The prevalence of HILD repr. is high, reaching 1-5% of the pediatric population, making it an important focus in discussions regarding anesthetic management in pediatric patients. Anesthetic management in pediatric patients undergoing elective Herniotomy for HILD repr. is not a simple procedure. This complexity arises from several crucial factors that demand in-depth attention from medical professionals. Children's unique physiological and pharmacological characteristics significantly influence their response to anesthetic agents as well as their potential risk of anesthetic complications. Immature organ systems, limited functional capacity, and variability in drug pharmacokinetics in children are important considerations in the selection and administration of anesthesia. The presence of comorbidities or accompanying medical conditions in pediatric patients also adds to the complexity of anesthesia management. Conditions such as congenital heart disease, respiratory disorders, or metabolic abnormalities may affect the response to anesthesia and increase the risk of perioperative complications. Therefore, a comprehensive and integrated individual approach is necessary to ensure patient safety and well-being during the anesthesia process. In addition, postoperative pain is a major concern in the anesthetic management of pediatric patients with HILD repr. Herniotomy procedures, although relatively minor, can trigger a significant pain response in children. Uncontrolled pain not only interferes with patient comfort, but can also negatively impact the recovery process, increase the risk of postoperative complications, and prolong hospital stays. Thus, effective and integrated multimodal pain management becomes an important pillar in optimizing clinical outcomes.[1,2]

In recent decades, the field of pediatric anesthesia has experienced rapid progress driven by continuous research and innovation. These developments cover a wide range of aspects, from selecting safer and more effective anesthetic agents to more sophisticated physiological monitoring and integrated multimodal pain management. One important advance is the use of modern inhalation anesthetic agents such as sevoflurane and desflurane. These agents offer faster and smoother induction, quicker recovery, and fewer side effects compared to previous generations of inhaled anesthetic agents. Additionally, the use of intravenous opioid analgesics such as fentanyl and remifentanil has enabled more effective intraoperative pain management with better controlled side effects. Physiological monitoring has also progressed significantly with the advent of advanced technologies such as neuromonitoring, depth of anesthesia monitoring, and invasive hemodynamic monitoring. This technology enables more accurate and real-time monitoring of the patient's brain function, level of consciousness and hemodynamic status, thereby enabling early detection and intervention of potential complications. Multimodal pain management, involving the combined use of multiple analgesic modalities such as opioid analgesics, non-opioid analgesics, local anesthetics, and regional analgesia techniques, has become standard practice in pediatric anesthesia. This approach aims to maximize analgesia, minimize side effects, and improve the quality of patient recovery.[3-5]

This case report presents a comprehensive narrative regarding the anesthetic management of a 6-month-old male infant with HILD repr. who underwent elective herniotomy. This case highlights several important aspects relevant to current clinical practice. This case illustrates the application of modern anesthetic management principles in a pediatric patient with HILD repr., including selection of appropriate anesthetic agents, close monitoring, and multimodal pain management. This case highlights the special challenges and considerations in anesthetic management of pediatric patients with HILD repr., such as unique airway anatomy, variability in drug pharmacokinetics, and risk of perioperative complications. This case provides valuable insight into strategies to optimize clinical outcomes and minimize complications in pediatric patients with HILD repr., such as prevention of hypothermia, aggressive pain management, and effective communication with parents.

2. Case Presentation

A 6 month old baby boy, weighing 7 kilograms, was brought by his parents to the hospital emergency unit with the main complaint of a lump in the right scrotal area. The lump is first noticed by parents two days before the hospital visit and appears mainly when the baby is crying or pushing. The lump disappears spontaneously when the baby is calm or lying down. Apart from these complaints, the baby did not show other symptoms such as fever, vomiting, or changes in bowel movements. The mother's pregnancy and delivery history was reported as normal, without any significant complications. The baby was born at term with a birth weight of 3.2 kilograms. There is no history of congenital disease or allergy history in the family. Baby immunizations have been completed according to schedule.

Physical examination showed that the baby was in good general condition, active, and did not appear to be in pain. Vital signs were within normal limits: temperature 36.5°C, pulse 120 beats per minute, respiratory rate 30 breaths per minute, and oxygen saturation 98% in room air. Abdominal examination did not reveal any distension or tenderness. On examination of the external genitalia, a soft lump measuring approximately 2 cm x 2 cm was felt in the right scrotum. The lump can be reduced easily and does not cause pain on palpation. The right testis was palpable normally in the scrotum. There were no signs of inflammation or infection in the inguinal area. To confirm the diagnosis and evaluate the contents of the hernia, an abdominal ultrasound (USG) examination is performed. The ultrasound results showed a picture of a lateral inguinal hernia in the dextra reponibilis with the contents of the small intestine in the hernia sac. There were no signs of intestinal obstruction or strangulation.

Based on the history, physical examination and ultrasound results, the diagnosis was made as a right lateral inguinal hernia. The decision to perform elective Herniotomy is taken after considering the patient's age, good general condition, and the absence of signs of complications such as incarceration or strangulation. Before surgery, a pre-anesthetic evaluation is performed to assess anesthetic risks and optimize the patient's condition. Routine laboratory examinations such as complete blood count, liver and kidney function, electrolytes, and blood sugar are carried out. Laboratory examination results showed values within normal limits. Patients were fasted for 6 hours before surgery according to pre-anesthesia fasting guidelines for infants. Intravenous fluid administration was initiated to maintain hydration and prevent hypoglycemia. The patient's parents are given an explanation regarding the anesthesia and surgical procedures, as well as the risks and complications that may occur. Approval for medical treatment (informed consent) was obtained from the parents after adequate explanation.

Anesthetic management of pediatric patients requires special attention due to unique physiologic and pharmacologic characteristics. In this case, it was decided to use general anesthesia with inhalation and intravenous techniques. Induction of anesthesia was performed with 8% sevoflurane in oxygen via a face mask. Sevoflurane was chosen because of its rapid onset, smooth induction, and minimal side effects on the cardiovascular and respiratory systems. Once the patient was asleep, intravenous access was established and fentanyl 1 mcg/kg was administered intravenously to provide intraoperative analgesia. Anesthesia was maintained with 2–3% sevoflurane in a mixture of oxygen and air. Close monitoring is carried out on vital signs, including blood pressure, heart rate, oxygen saturation, body temperature, and end-expiratory gas concentration. Electrocardiogram (ECG) and capnography are used to monitor heart and respiratory function. Fentanyl 1 mcg/kg was administered intravenously before skin incision to provide intraoperative analgesia. During surgery, additional fentanyl is administered as needed based on the patient's pain response. Intravenous fluids are administered at an appropriate rate to maintain fluid and electrolyte balance. The patient's body temperature is closely monitored and maintained within the normal range using a room heater and warm IV fluids. Herniotomy is performed with an open approach. A skin incision was made in the right inguinal region, and the hernia sac was identified and freed from surrounding tissue. The contents of the hernia are reduced back into the abdominal cavity, and the hernia sac is ligated and excised. The inguinal ring is reinforced with sutures to prevent hernia recurrence. The surgical wound is closed layer by layer.

After surgery was completed, sevoflurane was discontinued and the patient was given 100% oxygen. Once the patient is conscious and breathing is adequate spontaneously, the endotracheal tube is removed. The patient was transferred to the recovery room and monitored closely. Paracetamol 15 mg/kg was given intravenously after the operation was completed. Local infiltration with 0.25% bupivacaine in the surgical area was also performed to provide regional analgesia. Ondansetron 0.1 mg/kg is given intravenously to prevent postoperative nausea and vomiting. The patient was sent home on the same day after meeting the discharge criteria, namely fully conscious, stable vital signs, no nausea or vomiting, controlled pain, and able to drink without vomiting. Parents are given instructions regarding caring for surgical wounds, administering pain medication, and danger signs to look out for. A follow-up visit to the pediatric surgery clinic is scheduled in one week.

Table 1. Anesthetic management in 6-month-old baby boys with hernia inguinalis lateralis dextra reponibilis.

Anesthesia stage	Time	Procedure	Drug /Dose	Parameter monitoring	Value
Pre-induction	-10 minutes	Giving 100% oxygen via mask	-	Oxygen saturation (SpO_2)	99%
Induction	0 minutes	Sevoflurane 8% in oxygen	-	SpO_2	98%
	2 minutes	Installation of intravenous access	-	Blood pressure (BP)	85/50 mmHg
				Heart rate (HR)	125 times/minute
	3 minutes	Fentanyl 1 mcg/kg IV	7 mcg	-	-
	5 minutes	Laryngoscopy and intubation	-	-	-
Maintenance	10 minutes	Sevoflurane 2-3% in O_2/air	-	SpO_2	99%
				BP	90/55 mmHg
				HR	118 times/minute
				$ETCO_2$	35 mmHg
	25 minutes	Additional fentanyl 0.5 mcg/kg IV	3.5 mcg	-	-
				Body temperature	36.7°C
	40 minutes	Infusion of RL fluid 10 mL/kg/hour	-	-	-
End of operation	60 minutes	Sevoflurane was discontinued	-	-	-
		100% Oxygen	-	SpO_2	100%
		Extubate	-	-	-
Postoperative	70 minutes	Paracetamol 15 mg/kg IV	105 mg	FLACC pain score	2
		Bupivacaine 0.25% local infiltration	2 mL	-	-
		Ondansetron 0.1 mg/kg IV	0.7 mg	-	-

3. Discussion

Anesthetic management of pediatric patients, especially infants, is a complex field and demands an in-depth understanding of the physiological and pharmacological differences between children and adults. Infants, as rapidly developing individuals, have unique characteristics that influence their response to anesthetic drugs, and anesthetic techniques, as well as the risk of perioperative complications. Babies have a higher basal metabolic rate (BMR) than adults. BMR is the amount of energy the body needs to maintain basic functions at rest. This high metabolic rate is caused by rapid growth, high cellular activity, and greater energy requirements to maintain body temperature. As a result, babies require a higher dose of anesthetic medication per kilogram of body weight than adults to achieve the same effect. Babies have a smaller blood volume per kilogram of body weight than adults. This small blood volume affects the pharmacokinetics of anesthetic drugs, especially drugs that are bound to plasma proteins. Plasma concentrations of free drugs may be higher in infants, increasing the risk of side effects and toxicity. In addition, small blood volumes also make babies more susceptible to hypovolemia and hemodynamic changes during anesthesia. The baby's organs, such as the liver, kidneys, and brain, are not yet fully mature. Immature liver function can affect the metabolism of anesthetic drugs, especially drugs that are metabolized in the liver. As a result, the half-life of the drug may be longer in infants, increasing the risk of drug accumulation and prolonged side effects. Immature kidney function can also affect drug excretion, requiring dose adjustments in infants. The anatomy of a baby's airway is different from that of an adult. The baby's larynx is located higher on the neck, the epiglottis is more omega-shaped, and the airway diameter is smaller. These differences can make tracheal intubation in babies more difficult and require special skills. In addition, infants have a smaller functional residual capacity and a faster respiratory rate, so they are more susceptible to hypoxemia and hypercarbia if ventilation is inadequate. Babies have a larger body surface area to volume ratio than adults. This makes them more susceptible to heat loss and hypothermia, especially during anesthesia when the body's temperature regulation mechanisms are disrupted. Hypothermia in babies can cause various complications, including bradycardia, hypotension, blood clotting disorders, and increased risk of infection.[6-10]

Absorption of anesthetic drugs in infants can be influenced by several factors, including higher tissue perfusion, thinner skin, and increased intestinal mucosal permeability. Medicines given intramuscularly or subcutaneously may be absorbed more quickly in infants, requiring dose adjustments. The distribution of anesthetic drugs in infants is influenced by a higher proportion of total body water, lower plasma protein levels, and an immature blood-brain barrier. Water-soluble medications may have a larger volume of distribution in infants, requiring higher initial doses. Drugs bound to plasma proteins may have higher free drug concentrations in the infant, increasing the risk of side effects. Medicines that cross the blood-brain barrier can have a stronger effect on the baby, requiring lower doses. The metabolism of anesthetic drugs in infants is influenced by immature liver function. The liver enzymes responsible for drug metabolism are not yet fully developed in babies, so drug metabolism can be slower. As a result, the half-life of the drug may be longer in infants, increasing the risk of drug accumulation and prolonged side effects. Excretion of anesthetic drugs in infants is influenced by immature kidney function. The glomerular filtration rate in babies is lower than in adults, so drug excretion can be slower. This may cause drug accumulation and increase the risk of toxicity.[11-13]

Choosing the right anesthetic agent for babies is a crucial decision that requires careful consideration. Safety profile, effectiveness, rapid onset and offset, and minimal side effects are the main factors that must be evaluated. In this context, sevoflurane as an inhalation agent and fentanyl as an intravenous agent become prominent options due to their favorable characteristics. Sevoflurane is an inhalation anesthetic agent that has gained significant popularity in pediatric anesthesia practice. The main advantage of sevoflurane lies in its rapid and smooth induction, thereby minimizing anxiety and agitation in the baby when entering the anesthesia stage. This smooth induction is essential to reduce stress on the baby and ensure a more positive anesthesia experience. One important aspect that makes sevoflurane a safe choice for babies is its minimal effects on the cardiovascular and respiratory systems. Babies have a unique and vulnerable physiology, so the anesthetic agent used must have minimal impact on the function of vital organs. Sevoflurane has been shown to be relatively safe for use in babies with normal organ function, as it does not cause significant changes in blood pressure, heart rate, or breathing patterns. The safety profile of sevoflurane has been studied extensively, and study results indicate that this agent has good tolerability in infants. Serious side effects are rare, and most reported side effects are mild and temporary, such as nausea, vomiting, or postoperative agitation. This safety and good tolerability make sevoflurane a reliable choice for anesthesia in infants. Fentanyl is a synthetic opioid that has long been used in anesthetic practice to provide intraoperative analgesia. The main advantage of fentanyl lies in its rapid onset and offset, meaning its analgesic effects can be felt quickly after administration and disappear quickly after surgery is completed. This rapid onset and offset is critical to ensure the baby's comfort during surgery and minimize the risk of postoperative respiratory depression. Fentanyl has a powerful analgesic effect, which is able to overcome the pain associated with surgical procedures. The use of fentanyl in combination with sevoflurane allows the use of lower doses of sevoflurane, thereby reducing the risk of undesirable side effects, such as respiratory depression. This combination provides an optimal balance between analgesia and safety so that babies can undergo surgery comfortably and safely. Fentanyl has been used widely in pediatric anesthesia practice for many years, and its safety and effectiveness have been proven in numerous clinical studies. The use of fentanyl in infants has become standard practice in many surgical procedures, as this agent is able to provide effective analgesia with minimal risk of side effects. In addition to sevoflurane and fentanyl, there are several other anesthetic agents that can be considered for infants, such as propofol, ketamine, and nitrous oxide. Selection of the appropriate anesthetic agent should be based on the clinical condition of the infant, the type of surgical procedure, and the anesthesiologist's preference. Propofol is an intravenous anesthetic agent that has rapid onset and offset, as well as good antiemetic effects. However, propofol can cause cardiovascular depression in infants, so its use should be done with caution. Ketamine is a dissociative anesthetic agent that has analgesic and amnestic effects. Ketamine can increase blood pressure and heart rate, so its use in babies with hypertension or heart disease should be avoided. Nitrous oxide is an inhalation anesthetic agent that has mild analgesic and anxiolytic effects. Nitrous oxide is often used in combination with other anesthetic agents to reduce the need for stronger anesthetic agents.[14-17]

Anesthetic monitoring of infants is a crucial aspect of medical practice to ensure patient safety and well-being during surgical or diagnostic procedures requiring anesthesia. Infants, especially newborns and premature infants, have unique physiologies and are susceptible to rapid changes during anesthesia. Therefore, careful and thorough monitoring of various parameters is essential to identify and treat potential complications as early as possible. Anesthetic monitoring in infants involves observing and measuring various physiological and pharmacological parameters. These parameters provide important information about the hemodynamic, respiratory, neurological, and metabolic status of the baby during anesthesia. Systolic, diastolic, and mean blood pressure are monitored to assess cardiac function and tissue perfusion. A decrease in blood pressure (hypotension) may indicate hypovolemia, myocardial depression, or excessive vasodilation. Heart rate is monitored to assess heart function and heart rhythm. Bradycardia (slow heart rate) or tachycardia (fast heart rate) may indicate a heart problem or a side effect of anesthetic medication. Oxygen saturation (SpO_2) measures the percentage of hemoglobin bound by oxygen in arterial blood. A decrease in SpO_2 (hypoxemia) may indicate breathing or circulation problems. Body temperature is monitored to prevent hypothermia (low body temperature) or hyperthermia (high body temperature), which can affect organ function and metabolism. End expiratory gas concentration ($ETCO_2$) is the concentration of carbon dioxide (CO_2) at the end of expiration. It provides information about alveolar ventilation and tissue perfusion. An increase in $ETCO_2$ may indicate hypoventilation, while a decrease in $ETCO_2$ may indicate hyperventilation or decreased cardiac output. ECG records the heart's electrical activity and is used to monitor heart rhythm and detect arrhythmias (heart rhythm disturbances). Arrhythmias can occur due to various factors, including hypoxia, electrolyte imbalance, or side effects of anesthetic drugs. Capnography is a method of continuously monitoring CO_2 concentrations in exhaled air. It provides information about alveolar ventilation, tissue perfusion, and metabolism. Capnography can detect apnea (stopping breathing), hypoventilation, airway obstruction, and pulmonary embolism. Various methods and technologies are used to monitor the above parameters during anesthesia in infants. Pulse Oximetry is used to measure SpO_2 through sensors placed on the fingers or feet. Non-invasive Capnography to Measure $ETCO_2$ through sensors placed near the nose and mouth. An ECG is an electrode placed on the chest to record the electrical activity of the heart. Non-invasive blood pressure measurement using a blood pressure cuff to measure blood pressure periodically. Arterial Cannulation Allows continuous measurement of arterial blood pressure and sampling of arterial blood for blood gas analysis. Central venous catheter allows the administration of fluids and medications directly into the central circulation and measurement of central venous pressure. Monitoring allows early detection of physiologic changes that may indicate complications, such as hypotension, hypoxemia, or arrhythmia. This allows early intervention to prevent or minimize the impact of complications. Monitoring helps assess the depth of anesthesia and ensures the baby is not too conscious or too deeply anesthetized. Monitoring allows adjustments to the dose of anesthetic drugs and other interventions based on the baby's physiological response. Careful monitoring reduces the risk of complications and improves overall patient safety.

Anesthetic monitoring of infants is an important component of safe and effective anesthetic management. By carefully monitoring various physiological and pharmacological parameters, we can detect and treat complications as early as possible, optimize anesthetic management, and improve patient safety. Recent developments in monitoring technology continue to improve our ability to monitor babies during anesthesia and provide better care.[16-18]

Postoperative pain management in infants is a crucial aspect of pediatric health care. Babies who have recently undergone surgery are prone to significant pain, which can negatively impact their recovery and overall well-being. Therefore, a comprehensive and effective approach to pain management is essential to ensure patient comfort, speed healing, and prevent long-term complications. One increasingly popular approach in the management of postoperative pain in infants is the multimodal approach, which involves the use of several different analgesic modalities simultaneously. This approach aims to address multiple pain mechanisms and provide optimal analgesia with minimal side effects. In this case, the combination of intravenous paracetamol and local infiltration of bupivacaine is an effective and safe option for the management of postoperative pain in infants. Paracetamol, also known as acetaminophen, is a non-opioid analgesic widely used in clinical practice. This drug has a mechanism of action that is not fully understood but is thought to involve the inhibition of prostaglandin synthesis in the central and peripheral nervous systems. Prostaglandins are chemical compounds that play an important role in the transmission of pain and inflammation signals. By inhibiting prostaglandin production, paracetamol can reduce the sensation of pain and reduce fever. Paracetamol is effective in reducing mild to moderate pain, including post-operative pain in babies. This drug has a good safety profile, especially at therapeutic doses. Common side effects are usually mild and tolerable, such as nausea, vomiting, and allergic reactions. However, long-term or high doses of paracetamol can cause liver damage, so liver function monitoring is necessary in patients receiving long-term paracetamol therapy. Bupivacaine is an amide local anesthetic that works by blocking sodium channels in nerve cell membranes. This inhibits the conduction of nerve impulses, thereby producing a local anesthetic effect at the injection area. Bupivacaine has a relatively rapid onset of action and long duration of action, making it a suitable choice for postoperative analgesia. In the context of postoperative pain management in infants, bupivacaine can be administered via local infiltration around the surgical site. This technique involves the injection of bupivacaine directly into the injured tissue, thereby providing effective regional analgesia. Bupivacaine blocks the transmission of pain signals from the surgical area, thereby reducing the sensation of pain felt by the baby. The combination of intravenous paracetamol and local infiltration of bupivacaine provides a synergistic effect in the management of postoperative pain in infants. Paracetamol works systemically to reduce overall pain, while bupivacaine provides regional analgesia focused on the surgical site. This multimodal approach allows achieving optimal analgesia with lower doses of each drug, thereby minimizing the risk of side effects. The use of intravenous paracetamol provides rapid onset of action and consistent analgesia. This medication may be given before, during, or after surgery to reduce acute pain and speed recovery. Local infiltration of bupivacaine provides effective analgesia at the surgical site, reducing the need for additional systemic analgesics. The combination of these two drugs allows achieving adequate analgesia with minimal side effects on the baby. The combination of several different analgesic modalities allows achieving more effective analgesia than the use of one modality alone. The use of lower doses of each drug reduces the risk of side effects associated with the use of high-dose analgesics. Effective pain management can speed up the healing process and reduce the risk of post-operative complications. Babies who are free from pain will be more comfortable and calm, making care easier and improving quality of life. Although paracetamol and bupivacaine are relatively safe for use in infants, several safety considerations need to be taken into account. The dose of paracetamol and bupivacaine must be adjusted according to the baby's weight and age. Overdose can cause serious side effects, including liver damage and respiratory depression. Infants receiving paracetamol and bupivacaine should be closely monitored for signs of side effects, such as allergic reactions, nausea, vomiting, and respiratory distress. The infant's medical history, including drug allergies and underlying medical conditions, should be evaluated prior to administration of paracetamol and bupivacaine. Postoperative pain management in infants is an important aspect of pediatric health care. A multimodal approach with a combination of intravenous paracetamol and local infiltration of bupivacaine is an effective and safe option to achieve optimal analgesia with minimal side effects. This approach provides significant benefits for patients, including accelerated recovery, increased comfort, and reduced risk of complications. However, the use of paracetamol and bupivacaine in infants should be done with caution and under strict medical supervision to ensure the safety and effectiveness of therapy.[18-20]

4. Conclusion

Anesthetic management of pediatric patients with hernia inguinalis lateralis dextra reponibilis requires an individualized approach that takes into account the unique characteristics of the patient. Selection of appropriate anesthetic agents, close monitoring during surgery, as well as effective postoperative pain management, are essential to ensure optimal results and minimize the risk of complications.

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