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Cytoreductive Surgery and Hyperthermic Intraperitoneal Chemotherapy in a 2-Year-Old Child with Abdominopelvic Rhabdomyosarcoma: A Case Report of Anaesthetic Concerns

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Abstract

Cytoreductive surgery (CRS) with hyperthermic intraperitoneal chemotherapy (HIPEC) is a well-established multimodal treatment in patients with peritoneal surface malignancies in adults. Children younger than 3 years rarely undergo such extensive surgeries with heated chemotherapy infusion intraoperatively. Only one such case is reported in the literature for CRS-HIPEC for an abdominopelvic rhabdomyosarcoma in a child of 2 years or less. We present the case of a 2-year-old child with abdominopelvic rhabdomyosarcoma undergoing CRS-HIPEC and discuss the perioperative concerns and challenges.

Keywords: Chemotherapy, children, cytoreductive surgery, hyperthermic, paediatrics, rhabdomyosarcoma

Main Points

- Abdominopelvic rhabdomyosarcoma is a very rare tumour.
- This article is the second reported case in the literature of abdominopelvic rhabdomyosarcoma undergoing a supramajor surgery like CRS-HIPEC in a very small child of 2 years.
- This case highlights the unique anaesthetic challenges during the cytoreductive phase namely major blood loss and wide temperature swings (hypothermia during long-duration surgery with the entire abdomen exposed and limited area for applying warming devices and hyperthermia during HIPEC phase).
- This paper also highlights the importance of fluid management, diuresis, electrolyte disturbances (hypocalcemia and hypokalemia), acid–base disturbances, hyperglycaemia, and lactic acidosis that may occur during perioperative management of CRS-HIPEC in small children.

Introduction

Cytoreductive surgery (CRS) with hyperthermic intraperitoneal chemotherapy (HIPEC) is a well-established multimodal treatment in patients with peritoneal surface malignancies.[1,2] It involves macroscopic resection of disease burden and metastases (CRS phase) and infusion of heated chemotherapy drugs into the peritoneal cavity (HIPEC phase) at a temperature of 41-43°C by a special Belmont pump.[3] We present the case of a 2-year-old child with abdominopelvic rhabdomyosarcoma (RMS) undergoing CRS-HIPEC. To the best of our knowledge, the youngest case reported in the literature for CRS-HIPEC in the paediatric population is a 2-year-old child for RMS.[4] This is the second such case of a young child posted for CRS-HIPEC for RMS.

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Case Presentation

A 2-year-old, 14 kg male child was diagnosed as a large lobulated abdominopelvic mass with necrotic change and hypermetabolic soft tissue components with multiple metastatic peritoneal deposits and ascites on positron emission tomography scan. On biopsy, it was diagnosed as RMS with no bone involvement. The child received four cycles of vincristine, actinomycin, and cyclophosphamide. There was no other significant history. The preoperative haemoglobin was 7.6 g/dL^{-1}, and all the other laboratory investigations were within normal limits. A preoperative echocardiogram showed a normal cardiac function with an ejection fraction of 55%.

The child was planned for a CRS-HIPEC. After performing the surgical safety checklist, the child was premedicated with oral midazolam 0.5 mg kg^{-1} with dextrose 25 minutes prior to being taken in the operating room (OR). Anaesthesia was induced with sevoflurane in oxygen and nitrous oxide with a closed circuit. Monitors like ECG, pulse oximetry, noninvasive blood pressure, and capnography were attached. Intravenous access was secured and adequate muscle relaxation was ensured with atracurium and then trachea was intubated with a 4.5 ID micro cuff tube. Controlled ventilation was started with tidal volume of 8 mL/kg^{-1} and respiratory rate of 18-22 per minute. Anaesthesia was maintained with sevoflurane in oxygen and nitrous oxide. Core body temperature was monitored with an oesophageal probe throughout the surgery. A right radial artery was cannulated for invasive blood pressure and serial arterial blood gases. A 5 Fr central venous catheter was inserted into the right internal jugular vein. A 19G epidural catheter was placed at $T_{11\text{-}12}$ vertebral level in the lateral decubitus position with the median approach to cover the upper abdominal incision which extended from the xiphisternum to the pubic symphysis. A forced-air warmer was used to warm the upper torso of the child.

An exploratory laparotomy was performed to assess the peritoneal carcinomatosis index which was 6. This was followed by a complete resection of the mass and near total peritonectomy. Intraoperatively, 1 litre of ringer lactate, 420 mL of 4% albumin were infused using a fluid warmer. Intraoperative fluids were guided by central venous pressure (CVP), invasive blood pressure and pulse pressure variation (PPV), heart rate, arterial blood gases (ABGs), serum lactate, and hourly urine output. Blood loss was 250 mL which was replaced by 250 mL of packed cells. One hour prior to beginning the HIPEC procedure, warming tools were stopped to allow passive cooling. Bilateral chest drains were placed before proceeding with HIPEC. Heated cisplatin (60 mg) was administrated at 41.5-42°C with 60 mg of cisplatin for 60 minutes using 1.7% peritoneal dialysate (Aculife Healthcare Pvt Ltd.) as the diluting agent using the open abdomen technique. During the HIPEC, the temperature was controlled with cold intravenous fluid (6°C) and the application of ice packs over the neck, forehead, and axilla. The maximum core body temperature reached during HIPEC was 37.5°C. The total duration of surgery was 6 hours. Total urine output during CRS phase was 150 mL and during HIPEC phase was 180 mL. ABG showed a pH of 7.23 at the end of surgery and arterial lactate at the end of surgery was 1.9 mmol L^{-1}.

In view of the haemodynamic shifts and extensive tissue dissection, the child was electively ventilated. The child was weaned from mechanical ventilation and extubated on the next day. No significant variation in creatinine values or renal function was observed. Postoperative analgesia management was done with epidural local anaesthetic infusion of 0.1% bupivacaine with 2 μg of fentanyl per mL with an infusion rate of 3 mL per hour. Pain secondary to chest drainage tubes and lower abdominal incision was not covered by epidural analgesia, so rescue doses of intravenous paracetamol 210 mg as and when required and fentanyl 10 μg boluses when required. The child was discharged from intensive care unit on the third postoperative day (POD). Oral sips were started on the second POD. The epidural catheter was removed on the fourth POD after checking the coagulation profile. The child was discharged from the hospital on the eighth POD with an uneventful post-operative course.

Consent has been obtained from the parents of the child for publication of the data.

Discussion

The rationale for HIPEC is to maximise the exposure of local tissues to high concentrations of heated chemotherapeutic agents (20–1000 times greater than plasma levels) with minimal effects on normal tissue.[5] The combination of CRS followed by synergistic effect of hyperthermia and chemotherapy provides long-term disease control.[2] This therapy has very specific indications in children, viz., desmoplastic small round cell tumour, RMS, and diffuse intraperitoneal spread of other malignant tumours.[6–8] During perioperative management, a detailed evaluation needs to be done as in any major surgery in children. Cancer patients are invariably nutritionally compromised and nutritional optimisation and anaemia management are usually needed. Apart from unique concerns of paediatric population for anaesthesia management, CRS and HIPEC procedure needs special care because of extensive tissue mobilisation, fluid shifts, and massive blood loss for a small child. During the long duration of surgery, hypothermia, coagulopathy, and haemodynamic instability are main concerns during CRS phase which often leads to systemic inflammatory response syndrome (SIRS) like status.[1] In our case, we used CVP and PPV to guide fluid therapy. There are no reliable cardiac output monitors validated in the paediatric population. Balanced salt solutions like lactated ringer is the preferred crystalloid and albumin is the preferred colloid.

Because of low blood reserve and low haemoglobin, it is advisable to replace blood loss with an equal quantity of packed red blood cells. Hypothermia prevention during CRS phase to avoid haemodynamic instability and coagulopathy is important.[1] ABG with lactate levels and urine output should also be used as surrogate markers to guide adequacy of resuscitation.

The HIPEC phase may be done by the open or closed abdominal technique. The three factors which are important during the HIPEC phase are the chemotherapeutic agent, the carrier solution, and the temperature of the infusate solution. Chemotherapeutic agents with platinum-based drugs like cisplatin, carboplatin, and oxaliplatin have synergistic effect with heat.[1] Cisplatin, which is used in RMS, may cause acute kidney injury (AKI) due to the platinum compound and a higher urine output needs to be maintained. This may require adequate fluid optimisation and maintaining euvolaemia,[9] maintenance of renal perfusion, use of vasopressors, and sometimes diuretics. Currently, isotonic saline or dextrose-based peritoneal solutions are recommended as a carrier solution for HIPEC, with most centres using 1.5% dextrose isotonic peritoneal dialysis solutions[10] which may cause hyperglycaemia. The temperature of the infusate is 41-43°C. This can lead to dangerous hyperthermia in the child. Active cooling with cold intravenous fluid, icepacks over axilla and neck is indicated during HIPEC phase, whereas passive cooling should be started around 30 minutes to 1 hour prior to starting HIPEC depending on core-body temperature. Despite all these measures if the temperature continues to raise the temperature of the infusate can be regulated. Arterial lactate usually steadily increases toward the end of CRS phase to the end of HIPEC phase. It may be due to hypoperfusion that leads to lactic acidosis and increased base deficit, despite adequate volume resuscitation, and second, it may occur as a result of hyperthermia during HIPEC phase which is known to increase the arterial lactate.[1] Serum potassium also needs to be monitored during the HIPEC phase, as force diuresis is known to cause hypokalemia and subsequent cardiac arrhythmias. During HIPEC phase, dextrose containing intravenous fluids (which is the normal practice in paediatric patients) should be avoided because it may worsen hyperglycaemia caused by dextrose containing carrier solution and hyperthermia. Previous studies on paediatric HIPEC showed a significant AKI with postoperative rise in serum creatinine but the children in these studies were much older.[9,11] For perioperative management of these patients, a fluid therapy of 6-15 mL $kg^{-1} h^{-1}$ is indicated for a urine output of 3 mL $kg^{-1} h^{-1}$.[11] In our case, we infused around 12 mL $kg^{-1} h^{-1}$ of crystalloid and 5 mL $kg^{-1} h^{-1}$ of albumin 4% as colloid and urine output was 2.1 mL $kg^{-1} h^{-1}$ during CRS phase and 12.8 mL $kg^{-1} h^{-1}$ during HIPEC phase. Postoperatively, these patients are known to have haemodynamic instability with a SIRS response, temperature fluctuations (rebound hypothermia after HIPEC phase), coagulopathy, AKI, persistent postoperative pain, and difficulty in weaning off the ventilator.[1] Adequate pain control with epidural local anaesthetics and intermittent short acting opioid if needed are required for smooth weaning from ventilator. There is no data of extubation in OR after surgery in such young patients with extensive surgery like CRS-HIPEC. Nutrition (oral, enteral, or if needed parenteral) should be started as soon as possible for a smooth postoperative period and recovery.

In conclusion, very small child undergoing CRS and HIPEC have their own set of unique challenges and need to be managed with special expertise.

Informed Consent: Written informed consent was obtained from the patient who participated in this study.

Peer-review: Externally peer-reviewed.

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