Upper Limb Extravasation Injury Following Remifentanil Infusion at the Limb Covered with Adhesive Wrapping for Hypothermia Prevention during Anesthesia of Pediatric Patient

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Abstract

We reported on a case involving a 41-day-old baby girl with a recurrent left supraglottic cyst and mild laryngomalacia who was scheduled for direct laryngoscopy and re-marsupialization. She sustained an extravasation injury following a remifentanil infusion during anesthesia, which was identified after the completion of surgery and the removal of surgical draping. The use of adhesive wrapping over the affected peripheral limbs to prevent hypothermia might have aggravated the ongoing extravasation injury. Immediate multidisciplinary management involving orthopedic and plastic reconstructive surgeries facilitated the smooth recovery of the patient. This case highlights the potential inadvertent complications that can arise intraoperatively during a continuous infusion of remifentanil in pediatric patients, as well as the aggravating factor of adhesive wrapping.

Keywords: Cyst, extravasation, hypothermia, pediatric, remifentanil

Introduction

Extravasation injuries in pediatric patients as a result of drug or fluid administration are not uncommon. Murphy *et al.*[1] stated that up to 70% of children in neonatal intensive care units develop some form of extravasation injury. However, there has been no reported incidence of this injury during anesthesia, nor have there been reports related to the infusion of remifentanil.

Remifentanil is an ultra-short acting opioid commonly used nowadays during total intravenous anesthesia (TIVA). Its enzymatic degradation within subcutaneous tissues and its cytotoxic properties within these layers are not fully understood.[2]

The aim of this case report is to highlight an inadvertent extravasation injury that occurred during remifentanil infusion, which we assumed was aggravated by the adhesive wrapping over the affected limb used to prevent hypothermia.

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Case Report

This case involved a full-term, 41-day-old baby girl with a body weight of 3.5 kg who was scheduled for elective laryngoscopy and re-marsupialization to treat a recurrent left supraglottic cyst with laryngomalacia. She arrived in the operation theater with a single 24 G intravenous (IV) cannula on the dorsal aspect of her left hand. Before induction, an electrocardiogram, pulse oximetry, and non-invasive blood pressure (NIBP) monitoring were applied to the patient. The NIBP was placed over the lower left

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limb. The patency of the IV branula was checked by flushing it with saline; no resistance was encountered. It was subsequently connected to an infusion tubing of remifentanil, which was diluted to 10 µg/mL. We used an Injectomat TIVA Agilia® (Fresenius Kabi, Germany) infusion pump for infusing the remifentanil.

After pre-oxygenation, the patient was induced via inhalation using 8% sevoflurane, followed by a remifentanil bolus of 1 µg/kg over 90 s. After successful induction, 0.5 mg/kg of atracurium was given via IV, and the patient was intubated with a 3.5 mm endotracheal tube. Anesthesia was maintained with a 0.3–0.5 µg/kg/min remifentanil infusion (equivalent to a 6.3–10.0 mL/h infusion rate) and 1%–2% sevoflurane. A nasopharyngeal temperature probe was inserted for temperature monitoring. Fluid maintenance was administered with a 14 mL/h Sterofundin® solution via the remifentanil infusion system. The patient's limbs were wrapped with Orthoban® cotton bandages and a plastic adhesive wrap as per hypothermia prevention measures. Another layer of plastic adhesive wrap was loosely applied to the anterior part of the body with a blanket layer to cover the patient from the chest down.

Intraoperatively, the patient was stable. No rise in temperature was detected. The infusion pump did not trigger any alarms throughout the surgery. At the end of the surgery, we noted that the left fingers were swollen. The infusions were stopped immediately, and all wrappings over the left upper limb were immediately removed. An assessment of the limb showed redness and swelling as well as multiple blisters, bullae, and skin abrasions over the fingers and the dorsal surface of the left hand [Figure 1]. Redness, skin abrasions, and some small blisters were also observed on the surface of the left forearm on the side where the IV branula had been placed. An immediate intraoperative referral was made to the orthopedic and plastic reconstructive surgical (PRS) teams for assessment. A diagnosis of extravasation injury was made, and the IV branula was carefully removed. Blisters were aspirated under sterile conditions, and a Bactigras® dressing was applied by the PRS team. The patient was admitted to the surgical intensive care unit for post-operative injury management and was kept ventilated under close observation for over 24 h before extubation. Multidisciplinary teams were involved in the patient's management, which included daily dressing and frequent assessment of the limb for signs of compartment. Prophylactic antibiotics, a cefuroxime IV, and adequate analgesia were also given. The limb healed progressively after a few days without further complications, and the patient was subsequently discharged.

Figure 1: Redness, blisters, and skin abrasions seen over the fingers and forearm due to extravasation injury

Discussion

An extravasation injury is defined as a condition in which there is an inadvertent leakage of fluid into the perivascular or subcutaneous space. It occurs in 0.1%–6% of adults and up to 11% of pediatric patients.[3] Various factors contribute to extravasation injuries, including the cytotoxicity and osmolality of a solution, properties of vasoconstrictors, infusion pressure, anatomical peculiarities, and inadvertent compression of venous flow. Prompt recognition and intervention are essential for minimizing extensive tissue injury.[4-6] However, perioperative conditions during surgery, such as full draping or the patient's prone position, can prevent anesthesiologists from regularly assessing IV infusions, thus delaying extravasation detection until the end of surgery. Among the clinical presentations of extravasation are limb edema, blisters, compartment syndrome, and tissue necrosis.[5]

In our case, the aim was to provide anesthesia with sevoflurane and a remifentanil infusion to facilitate the surgical procedure around the airway for a recurrent left supraglottic cyst with laryngomalacia. The IV line over the affected site was checked before use and confirmed to be well functioning. We noticed that the dorsal part of the hand up to the forearm over the non-dependent part was swollen with blisters at the remifentanil infusion site after undraping at the end of surgery. The rate of infusion was according to the calculated dosage, and we used a TIVA infusion pump, which allowed the delivery of remifentanil in µg/kg/min for pediatric patients. The baby's hand was at the side of her body, and there was no possible limb movement that might have led to the compression of the IV line. There was no alarm from the infusion pump that indicated any occlusion of the infusion throughout surgery. The only possible aggravating factor to the extravasation was our wrapping of the baby's limbs with Orthoban® soft cotton bandages, which were enforced with plastic adhesive wrap. This is one of the methods commonly practiced to reduce the effect of perioperative hypothermia in infants. Nevertheless, it is possible that the wrapping applied some compression, and the heat held by it also worsened the formation of blisters by vasodilation and the increase in permeability. In their case report, Kim *et al.*[7] postulated that the heat from a warm blanket was one of the factors that contributed to an extravasation injury that affected only the non-dependent part of the

hand; vasodilation led to an increase in permeability and accelerated inflammatory effects.

To the best of our knowledge, there have been no reported cases of extravasation injuries related to remifentanil infusion in pediatric patients. However, one case report discussed a 60-year-old man's delayed awakening after a craniotomy resulting from an accidental subcutaneous infusion of remifentanil, which was noticed after undraping at the end of surgery. In this case, the subcutaneous infusion presented with mild blistering, which was treated with warm compression and resolved after three days. Remifentanil degradation in subcutaneous tissue is not fully known, nor is its cytotoxic property within subcutaneous layers. A previous report found that no studies had been done regarding the enzymatic degradation of remifentanil in subcutaneous tissue.[2] We assumed that, due to remifentanil's non-cytotoxic properties, the extent of tissue injury in our case would not be too severe unless it caused tissue necrosis. However, remifentanil extravasation leads to irritation and swelling because it is not metabolized in subcutaneous tissue.

There have been a few other reported cases of extravasation injuries related to other drugs or solutions. Accidental infusion of phenylephrine infusion via a popliteal nerve block catheter was reported in a post-below-knee amputation case due to drug errors that resulted in a slightly mottled but warm stump with intact sensation. In this case, phentolamine was not given, but the subsequent correct drug infusion from the same catheter with ropivacaine was thought to have caused a sympathetic blockade, leading to a counter-effect of vasodilatation, which improved the effect of extravasation.[3] Extravasation of a propofol infusion has also been reported to result in significant edema, erythema, and warmth over the affected limb.[8] A review of the literature on extravasation injury resulted in 70 articles detailing 232 cases of extravasation involving 37 agents, including phenytoin, parenteral nutrition, calcium gluconate, potassium chloride, calcium chloride, dopamine, dextrose solutions, epinephrine, sodium bicarbonate, nafcillin, propofol, norepinephrine, mannitol, arginine, promethazine, vancomycin, tetracycline, dobutamine, vasopressin, sodium thiopental, acyclovir, amphotericin, ampicillin, cloxacillin, gentamicin, metronidazole, oxacillin, penicillin, amiodarone, albumin, furosemide, lipids, lorazepam, immunoglobulin, morphine, and sodium valproate.[9]

Early identification, prompt action, and immediate management involving multidisciplinary teams—particularly orthopedic and PRS teams—are crucial for the prevention of further complications. In our case, we referred intraoperatively to both the orthopedic and PRS teams after the complication was recognized, and the patient was closely observed in the surgical intensive care unit. Daily dressings, frequent assessment of the limb for signs of compartment, prophylactic antibiotics with a cefuroxime IV, and adequate analgesia were important in managing our patient until she was able to be discharged.

Of note, we did not give a naloxone IV to the patient because she was ventilated overnight in the surgical intensive care unit before being extubated the next day. If extubation had been planned earlier, a naloxone IV could have been considered depending on the patient's recovery, as was done in other reported cases.[2]

Conclusion

The infusion of remifentanil in pediatric patients whose limbs are covered with adhesive wrapping for hypothermia prevention may lead to inadvertent extravasation injuries. This type of injury is preventable with regular assessments of the infusion site during surgery and with the application of loose bandaging, if necessary.

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Conflicts of interest

There are no conflicts of interest.

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