Pressure-support ventilation in a child with merosin-deficient congenital muscular dystrophy under sevoflurane anesthesia

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Abstract: Merosin-deficient congenital muscular dystrophy (MD-CMD) is the most common and severe form of congenital muscular dystrophy and is characterized by progressive severe hypotonia due to the absence of the merosin chain around muscle fibers. The main anesthetic concerns include a possible association with malignant hyperthermia, the risk of anesthesia-induced rhabdomyolysis, a difficult airway and postoperative respiratory failure.

We report the case of an uneventful general anesthesia (GA) in a two-year-old boy with MD-CMD for the placement of an implantable venous access system. The goal of our anesthetic management was to reduce the risk of respiratory depression. We considered the possibility of loss of spontaneous ventilation against the known, but rare, risk of rhabdomyolysis and we choose for a balanced GA with sevoflurane, short acting opioids and a pressure support ventilation mode instead of a trigger-free anesthesia. Our anesthetic management and the perioperative concerns for this particular syndrome are described.

Key words:

INTRODUCTION

Congenital muscular dystrophies (CMD) are rare, autosomal recessive clinically and genetically heterogeneous myopathies. Merosin- or laminin α2-deficient congenital muscular dystrophy (MD-CMD) is the most common and severe form, representing 40% of all CMD with the prevalence of approximately 0.7/100,000. It is caused by a mutation in the laminin α2 gene (LAMA on chromosome 6q22-23) resulting in the absence of the merosin chain around muscle fibers. Patients with MD-CMD suffer from severe progressive muscle weakness resulting in contractures, scoliosis and restrictive pulmonary disease. Some of these patients may present with elevated creatinine kinase (CK), diffuse white matter hyperintensities on brain MRI and seizures (30% of patients) but most of these patients have normal intelligence. Approximately one third of MD-CMD patients also have cardiac abnormalities including arrhythmias and dilated cardiomyopathy.

Diagnosis is based on clinical findings, negative immunostaining of biopsied muscle for merosin, molecular genetics and specific abnormal white matter signal on MRI, if present. (1,2)

These patients may require anesthesia for diagnostic or surgical procedures. The main anesthetic concerns with general anesthesia (GA) for patients with MD-CMD are the potential association with malignant hyperthermia (MH), the risk of anesthesia-induced rhabdomyolysis (AIR) and subsequent hyperkalemia, but also a potential difficult airway and respiratory failure.

We describe the case of a child with MD-CMD who required GA for surgical placement of an implantable venous access system (IVACS).

CASE REPORT

A 2-year-4-months-old boy (11 kg) with known MD-CMD was admitted for severe hypoglycemia caused by the dysfunction of his gastrostomy feeding tube. His past history included chronic respiratory insufficiency requiring noninvasive ventilation support (BIPAP) since he was 5 months old. He had needed multiple intensive care admissions for respiratory infections. He presented with severe swallowing disorders that required total gastrostomy tube feedings. His cognitive development was completely normal. His past surgical history included muscle biopsy, placement of a gastrostomy tube and bronchoscopy at another institution.

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Written informed consent was obtained from the parents of the patient for the publication of this case.
Obtaining a peripheral intravenous (IV) access was a real challenge. To avoid GA, we tried placing a peripherally inserted central catheter (PICC) under local anesthesia (LA). Advantages of this option were a longer duration of stay, no risk of pneumothorax and more comfort for chest physiotherapy compared to a central venous catheter (CVC). Unfortunately, attempts to insert a PICC (size 3Fr, Bard®) under LA with ultrasound (US) guidance failed in both arms. Consequently he underwent an uneventful short GA with sevoflurane by facemask to insert a subclavian catheter under US guidance. In order to facilitate his future medical management, it was decided to insert an IVACS before hospital discharge.

Preoperative physical examination revealed no acute distress. His lung fields were clear to auscultation. He presented with a flat facies, limited mouth opening and neck contracture with fixed right lateral rotation of the head. Medications included salbutamol, ipratropium bromide and budesonide through a high-flow nebuliser, omeprazole, and amoxicillin-clavulanic acid. He also benefited from chest physiotherapy with percussion twice a day, sessions of cough augmentation with the Cough-Assist® device and noninvasive ventilation (Philips Respironics Trilogy ventilator) while sleeping. There was no familial history of muscle disorders or malignant hyperthermia. Echocardiography and an electrocardiogram performed 6 months earlier were within normal limits.

On the day of surgery, routine monitoring (ECG, pulse oximetry and NIBP) was placed. Room air oxygen saturation was 98-100%. To preserve his spontaneous ventilatory drive we choose to induce anesthesia with propofol (4mg/kg) and alfentanil (5µg/kg) and maintain it with sevoflurane (exhaled concentration of 2.5-3.5%). Mask ventilation was easy and spontaneous ventilation was assisted with a manual positive pressure through a Mapleson D breathing circuit. Neither a laryngeal mask (LMA) (SureSeal®Teleflex) size 2 nor a size 2 I-gel® (Intersurgical) could be inserted (one attempt each). We were finally able to place a size 1.5 LMA and the patient was mechanically ventilated on pressure support mode (Dräger Julian®) with a trigger value of 1.4L/min, a titrated minimal inspiratory aid (APr: 8-11 cm H₂O) and a small positive end-expiratory pressure (PEEP: 3 cm H₂O). Respiratory rate varied between 20-28/min. Body temperature was monitored with a nasopharyngeal probe and varied between 36.2 -37 °C. The surgical procedure consisted in denudation of the cephalic vein in the subclavian area. At the end of the surgery, the wound was locally infiltrated with ropivacaine 5% (2.5 mg/kg). The administration of sevoflurane was stopped and pressure support ventilation was gradually reduced until the patient could maintain satisfying spontaneous breathing. The laryngeal mask was removed and the patient was transferred to the PACU. His postoperative course was uneventful.

**DISCUSSION**

MD-CMD is the most common form of congenital muscular dystrophies. As with other types of muscular dystrophies, concerns remain about a possible risk of MH. MH is a pharmacogenetic condition that results in a hypermetabolic cascade initiated at the skeletal muscle cell on exposure to volatile anaesthetics and/or depolarizing muscle relaxants. MH susceptibility is conferred by specific inherited mutations, most commonly related to the ryanodine receptor (RyR1) involved in the excitation-contraction process of muscle cell (3). The ‘gold standard’ for diagnosis of MH is the in vitro caffeine-halothane contracture test. However, contracture tests performed on dystrophic muscles may be unreliable for two reasons. First, the underlying defect may produce abnormal contractures and a greater incidence of false positive results. Second muscle specimens are often of poor quality due to progressive fibrosis. Because of this, MH susceptibility cannot be determined and there is still debate about the risk of MH and a variety of muscular dystrophies. (4)

Patients with MD-CMD are not considered to be susceptible to MH. However a single case report (5) described a suspected MH episode in a child with MD-CMD undergoing a ‘trigger-free’ anesthesia and concluded that these patients might be susceptible to MH. Unfortunately the diagnosis of MH was questionable. Regarding MD-CMD, Scrivener et al reviewed their institutional experience of anesthesia in children with MD-CMD over a period of 20 years. They recorded a total of 16 GA (13 with volatile anesthetics and 3 with total intravenous anesthesia) performed on 10 patients, looking specifically at adverse events, complications and signs suggesting MH. No patients in that cohort developed features consistent with MH. They conclude that those children might be at no greater risk of developing MH than the general population. (6)

Presently, there is a growing awareness of the risk of AIR in children with a muscle disease (3). This life-threatening complication has been best documented in children with Duchenne muscular dystrophies.
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Merosin-deficient dystrophy (DMD) in whom rhabdomyolysis can occur after exposure to potent inhalational agents and/or the administration of succinylcholine.

Current understanding of the pathophysiology of AIR in DMD patients suggests that anesthetic agents stress already susceptible sarcolemma and impair muscle membrane stability. The increased membrane permeability and leakage of cellular contents lead to hyperkalemia, myoglobinemia, and raised CK-levels. Moreover, a functional change in the RYR-1 receptor, secondary to the absence of functional dystrophin, has been observed in DMD mice. The risk of AIR in other muscular diseases remains poorly defined. (7) Regarding MD-CMD, sarcolemma instability is different from DMD. In DMD the absence of dystrophin prevents the assembly of cytoskeletal and sarcolemma components and significantly impairs muscle cell membrane integrity. In MD-CMD the defect in laminin α2-chain (an extracellular ligand of the dystrophin-glycoprotein complex) does not appear to result in membrane instability, but because of its binding to the dystrophin complex, rhabdomyolysis is still possible. (5)

These concerns led to recommendations to use a ‘trigger-free’ anesthetic technique in children ‘at risk’. In 2008, experts of the Society for Pediatric Anesthesia met to discuss this matter, but no firm consensus was reached. (4)

Other significant concerns in MD-CMD are potential difficult airway management and postoperative respiratory failure. In this case, as surgery did not require endotracheal intubation nor muscle relaxation, we used a laryngeal mask airway and aimed at maintaining the child’s ventilatory drive by using pressure support ventilation. We considered the risk of loss of spontaneous ventilation against the known, but rare, risk of rhabdomyolysis. We choose to use a balanced anesthesia with alfentanil, propofol and sevoflurane instead of a trigger-free anesthesia with IV agents such as remifentanil and propofol because we felt that the risk of respiratory depression would be greater and cases of rhabdomyolysis with propofol have also been described (5). Our anesthetic and ventilatory approach proved to be successful even though the LMA was unexpectedly difficult to insert due to small mouth opening. In order to avoid postoperative respiratory depression, we used a low dose of short-acting opioid (alfentanil 5µg.kg⁻¹) and infiltrated the wound with local anesthetic to provide postoperative analgesia.

Conclusion

We present the case of an uneventful balanced GA in a two-year-old boy with MD-CMD. Perioperative risks include a possible, but theoretically low, risk of MH and AIR. The anesthesiologist should be alert and prepared to treat MH and other MH-like metabolic reactions. Other anesthetic concerns include a possible difficult airway and careful management of the respiratory function.

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References


