General Anesthesia for a Child With Methylmalonic Acidemia Undergoing Oral Care and Dental Treatment Before Kidney Transplantation

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Methylmalonic acidemia (MMA) is an autosomal recessive metabolic disorder of organic acids that causes various symptoms attributed to the accumulation of methylmalonic acids. We report the general anesthetic management of a 7-year-old girl with MMA who underwent periodontal treatment prior to kidney transplantation. One of our anesthetic goals was to maintain appropriate metabolism perioperatively, so we minimized her fasting time as short as possible and administered specially adjusted milk with simple carbohydrates preoperatively to reduce catabolism and promote anabolism. Consultation and cooperation with the patient's pediatrician were also essential, as was being prepared to appropriately manage perioperative emesis due to the minimized fasting time. This case demonstrates the importance of perioperative nutritional management for patients with MMA.

Key Words: Methylmalonic acidemia; Pediatric; General anesthesia; Congenital disorder of metabolism.

Methylmalonic acidemia (MMA) is an autosomal recessive genetic disorder affecting amino acid metabolism. MMA causes a variety of symptoms due to the accumulation of methylmalonic acid along with its by-products and can lead to intellectual disability, failure to thrive, and chronic renal disease. Elective procedures should be avoided during acute exacerbations, and patients with MMA should be evaluated preoperatively and optimized to minimize risks of metabolic acidosis and hyperammonemia. Proper nutritional management and reducing stress during the perioperative period are important anesthetic considerations.

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CASE PRESENTATION

We report the general anesthetic management of a 7-year-old girl (height 104.2 cm, weight 23.6 kg, body mass index 21.7 kg/m^2) with intellectual disability, chronic renal disease, and MMA that was identified during newborn screening. Although she had initially been able to eat normally, she gradually could not eat due to vomiting and underwent gastrostomy tube placement at 2 years of age. The patient also reported an extensive list of medications (Table 1) but denied any allergies. Due to her decreasing renal function (estimated glomerular filtration rate 25-30 mL/min/1.73 m^2; stage 4 chronic kidney disease), the patient was scheduled for an upcoming kidney transplant but required dental treatment due to poor oral hygiene with visible generalized calculus. She was noncompliant due to her intellectual disability and required general anesthesia for planned debridement/periodontal treatment.

Preoperative blood tests indicated moderate anemia based on a low hemoglobin (9.1 g/dL) and hematocrit (29.2%), and the patient's blood urea nitrogen (79 mg/dL), creatinine (1.49 mg/dL), and potassium (5.5 mmol/

Table 1. Patient's Medication List.

Medication	*Dosage*
Continued preoperatively	
Carglumic acid	1200 mg; 3×/day
Levocarnitine	1500 mg; 3×/day
Retinol/calciferol	1g; 3×/day
Ubidecarenone	30 mg; 3×/day
Tocopherol nicotinate	100 mg; 3×/day
Benfotiamine	100 mg; 3×/day
L-arginine hydrochloride	0.8 g; 3×/day
Sodium hydrogen carbonate	4g; 4×/day
Held preoperatively	
Febuxostat	2 mg; 1×/day
Daprodustat	1 mg; 1×/day
Lanthanum carbonate	750 mg; 3×/day
Enalapril	1.25 mg; 1×/day
Calcium polystyrene sulfonate	10 g; 2×/day
Montelukast	4 mg; 1×/day
L-carbocisteine	400 mg; 3×/day
Ambroxol	15 mg; 3×/day
Mosapride	5 mg; 3×/day

L) levels confirmed optimization of her metabolic status and renal dysfunction. An electrocardiogram was also obtained, which showed normal sinus rhythm at a rate of 98 beats/min. Preoperative physical examination confirmed the patient's intellectual disability (no meaningful speech/difficulty communicating), although no other noteworthy findings were observed. As one of our anesthetic goals was to optimize her metabolism perioperatively, her fasting time was set as short as possible, and we appropriately gave her simple carbohydrates to prevent serious catabolism and promote anabolism. Specially adjusted milk along with sucrose was administered through her gastrostomy tube until 4.5 hours before admission.

On the day of surgery, the patient presented with her parents appropriately NPO and having followed all preoperative instructions. Standard anesthetic monitoring was applied upon her arrival to the operating room, and general anesthesia was induced slowly via mask induction with sevoflurane (8%) and oxygen (80%). After obtaining intravenous (IV) access, atropine (0.2 mg), midazolam (1 mg), propofol (20 mg), and rocuronium (15 mg) were subsequently administered, and general anesthesia was maintained with desflurane (4%-5%) and oxygen (40%) along with a continuous infusion of remifentanil (0.2 μg/kg/min). A total of 1.5 mL of 2% lidocaine (30 mg) with 1:80 000 epinephrine (18.75 μg) was administered via infiltration for local anesthesia. Intraoperatively, IV fluids consisting of a 10% dextrose solution and a 1% dextrose plus acetic acid Ringer's solution were infused simultaneously at 80 mL/h and 20 mL/h, respectively. Arterial blood samples were taken from her right femoral artery before and after the operation (Table 2) and confirmed her metabolism was well maintained. The dental treatment was completed uneventfully, and she emerged from anesthesia clearly. She was transported to the ward after extubation, discharged home without incident, and received a kidney transplant from her father approximately 2 months later.

Table 2. Perioperative Arterial Blood Gas Analysis.

	After induction	*Before emergence*	*Normal values*
FiO_2, %	0.4	0.4	0.21
pH	7.457	7.376	7.35-7.45
pCO_2, mm Hg	30.0	36.1	35-45
pO_2, mm Hg	188	195	80-100
$cHCO_3$, mmol/L	22.6	21.5	24
Na^+, mmol/L	135	133	136-147
K^+, mmol/L	4.5	4.1	3.6-5.0
Cl^-, mmol/L	95	93	98-109
Glucose, mg/dL	162	172	65-95 (fasting)
Lactate, mg/dL	45	45	5-12
Anion gap, mmol/L	17.4	18.5	10-14
Base excess, mmol/L	−6.5	−5.0	−2.2 to +1.2

Although the patient's pH decreased, there was no rapid progression of acidosis perioperatively.

DISCUSSION

According to a newborn mass screening study, the frequency of MMA in Japan is 1:120 000. Its clinical symptoms are ketoacidosis and hyperammonemia that develops from the neonatal period to infancy and progresses to acute encephalopathy due to malnourishment, recurrent vomiting with dehydration, respiratory distress, and muscle hypotonia. Physical growth is also delayed, and intellectual disability, seizures, and stroke are common findings. In cases of severe hyperammonemia or metabolic acidosis, hemodialysis should be considered.

Preventing the development of acute MMA exacerbations was critical during the anesthetic management of this patient. We minimized the preoperative fasting time since prolonged hypoglycemia could cause increased catabolism. The patient was given a specially adjusted milk that excluded specific amino acids (isoleucine, valine, methionine, threonine, and glycine) to help prevent excessive production of methylmalonic acid preoperatively and postoperatively when her nutrition resumed immediately after surgery. In case of vomiting, we were prepared to immediately suction the patient, including suctioning through the gastrostomy tube as well. Arterial blood gas analysis to assess the patient's perioperative metabolic status was performed immediately after induction and after surgery to confirm

that her pH, blood glucose, and electrolytes were all within normal ranges.

Regarding the selection of anesthetic agents used in this case, we avoided nitrous oxide as it can further inhibit vitamin B_{12}–dependent enzymes and lead to increased methylmalonic acid accumulation.[1] Propofol was used in this case; however, it was administered only during induction since it contains polyunsaturated fats and may worsen MMA. It is preferable to use propofol sparingly and to avoid succinylcholine, atracurium, cis-atracurium, and propionic acid–derived nonsteroidal anti-inflammatory drugs.[2,3] We also used other anesthetic drugs that were short acting and less likely to be affected by the patient's chronic renal dysfunction (eg, volatile anesthetics and remifentanil).

CONCLUSION

This case report describes the general anesthetic management of a pediatric dental patient with MMA. Optimizing nutritional management by including minimizing fasting time and supplementing with dextrose-containing IV fluids was crucial to avoid an acute MMA exacerbation during the perioperative period.

NOTE

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