

Treatment of Malignant Hyperthermia without Dantrolene in a 14-year-old Boy

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To the Editor: Malignant hyperthermia (MH) is a rare but potentially fatal, inherited skeletal muscle disorder that is mostly induced by the ingestion of the depolarizing relaxant, i.e., succinylcholine or volatile anesthetics.^[1] Its incidence is reportedly 1/5000 to 1/100,000 in general anesthesia patients, and children seem to be more susceptible than adults.^[2] According to MH treatment guidelines of the Malignant Hyperthermia Association of the United States (MHAUS) and European Malignant Hyperthermia Group (EMHG), dantrolene should be administered as soon as possible in suspected case.^[3,4] Unfortunately, dantrolene is not readily available worldwide. Here, we reported a highly suspected MH case treated without dantrolene. We believe that physicians, especially in countries that dantrolene is not readily available, would be interested in our experiences.

A 14-year-old boy with normal blood test results and vital signs, without any significant personal or family history, scheduled for the reduction of an upper right humeral fracture. General anesthesia was induced with a combination of propofol (2.5 mg/kg), sufentanil (1 µg/kg), and cisatracurium (0.15 mg/kg) and maintained with a combination of 2% sevoflurane, propofol 5 mg·kg⁻¹·h⁻¹, and remifentanil 0.2 µg·kg⁻¹·min⁻¹. Eighty minutes after the induction of anesthesia, a slight increase in end-tidal partial pressure of carbon dioxide (P_{ET}CO₂) was observed which was from 40 to 50 mmHg (1 mmHg = 0.133 kPa). We performed manual ventilation, the P_{ET}CO₂ decreased, and a small elevation in airway pressure was perceived. The CO₂ absorbent was replaced, and ventilation parameters were adjusted. In the following several minutes, the P_{ET}CO₂ hovered at 40–50 mmHg and suddenly increased to 80–113 mmHg. At the same time, a severe increase in heart rate to 185 was emerged along with a significant decrease in noninvasive blood pressure to 60/30 mmHg. Simultaneously, the boy started to run a fever. His nasopharyngeal temperature (NT) detected by an electronic temperature probe was 38.6°C and reached to 41.3°C in 5 min. A great deal of vapor and condensation water emerged in the artificial circle.

An MH crisis was suspected. Unfortunately, dantrolene was unavailable in our hospital. Stop inhaling sevoflurane, high-frequency manual ventilation with pure oxygen using an amended Mapleson D system (Gale Med, Taiwan, China) was administered instantly, and a series of rescue measures as well

including a radial arterial and femoral vein line, vasoactive agents (dopamine and dobutamine 5–10 µg·kg⁻¹·min⁻¹), speeding intravenous (i.v.) infusion with lactated Ringer's solution to maintain excessive urine, surface cooling, and then gastric, rectal, and bladder lavage with ice-cold normal saline in addition to other supporting treatments [Figure 1]. Blood gas analysis, creatine phosphokinase (CK), myoglobin, cardiac troponin I (cTnI), liver and renal function, blood electrolytes, and coagulation function were continuously monitored.

Approximately, 50 min later, the boy's temperature began to decrease, 60 min later to 36.0°C, and 2 h later to the lowest of 33.0°C, then it begun to recover gradually, 8 h later to 37.0°C and maintained normal. One hour and 40 min after the MH attack, the peak serum myoglobin value was 1114 mg/L (normal value <110 mg/L) and decreased to a very low level in the following 2 days. The first plasma CK level was 1342 U/L at 6 h after the attack and gradually increased to 1812 U/L on the third morning (normal value, 30–170 U/L). Plasma cTnI concentration peaked to 2.14 mg/L at 11 h after the MH attack and gradually decreased to 0.3 mg/L on the third afternoon (normal value <0.06 mg/L). The fibrinogen and D-dimer levels were slightly elevated in the first few hours but returned to normal on the 3rd day. The prothrombin time (PT) value was normal, and activated partial thromboplastin time (APTT) maintained to 2–3 folds prolonged due to 15 U·kg⁻¹·h⁻¹ of heparin sodium bumped intravenously followed by a loading dose of 25 U/kg i.v., but there was no bleeding tendency during operation and Intensive Care Unit stay. Seven-day postoperative, the boy was discharged from hospital without obvious complications, and his parents refused further examinations to confirm the MH suspect. No long-term complications were observed in outpatient visits at 1, 6, and 12 months after the surgery.

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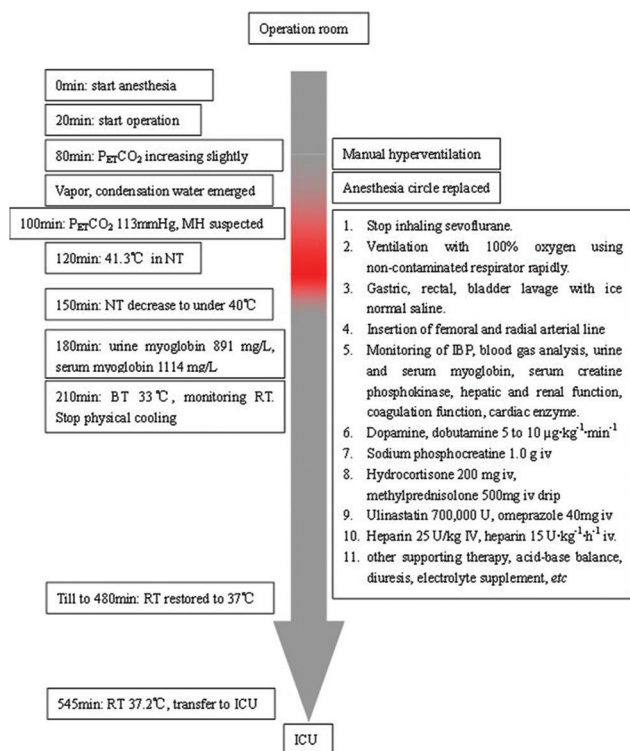


Figure 1: Episode of the suspected malignant hyperthermia crisis. NT: Nasopharyngeal temperature; BT: Body temperature; RT: Rectal temperature; P_{ET}CO₂: End-tidal partial pressure of carbon dioxide; IBP: Invasive blood pressure (right radial arterial); ICU: Intensive Care Unit.

According to the clinical grading scale for the diagnosis of MH widely used in North America and Europe, the score reached to 38 comprising 15 for P_{ET}CO₂ >55 mmHg, 15 for a rapid increase in body temperature, 5 for serum myoglobin >170 mg/L, and 3 for tachycardia, which ranked the patient as “very likely” to have MH.^[4]

A severe increase in body temperature is the most characteristic feature of MH crisis. Fail to control body temperature easily leads to death.^[5] As a specific remedy, dantrolene can correct the dysfunction of calcium ion channels of the endoplasmic reticulum, therefore quickly restoring body temperature to normal. In fact, administration of dantrolene as soon as possible is the most important measure recommended by the MHAUS and EMHG.^[3,4] However, in countries such as China, importing and using dantrolene are not approved; thus, treatment on MH is a big challenge. Which makes physical cooling is vitally important. In the present case, we poured alcohol over the boy’s chest and abdomen and blowing with a fan, and then combined with gastric, rectal, and bladder lavage with ice-cold normal saline. Furthermore, we stop the cooling process when NT decreased to 36.0°C rather than 38°C (EMHG recommended) to preventing re-increase. Consequently, the boy experienced the lowest NT of 33°C and

restored normal, which might suggest that slight overcorrection of body temperature is appropriate when dantrolene is unavailable.

One of the most specific and typical signs of MH is a significant increase in P_{ET}CO₂.^[2] We observed a peak P_{ET}CO₂ of 113 mmHg at 10 min after MH was suspected, but it decreased to normal under hyperventilation conditions, which was performed using an amended Mapleson D system with frequency of 40–60 times/min for unavailable of the nonsevoflurane-contaminated anesthesia machine at that time. However, the blood gas analysis indicated that the arterial partial pressure of oxygen (PaO₂) was relatively low during the MH crisis (61.8–134.0 mmHg under pure oxygen ventilation). Which implied that a severe ratio of ventilation and blood flow (V/Q) imbalance emerged, and as far as we know, this is a fairly rare phenomenon in MH. It is required additional MH cases to determine whether this was a curious coincidence.

Hyperkalemia has repeatedly been reported in MH but did not observe in the present case.^[2] However, the more interesting phenomenon we observed was a significant decrease in serum sodium to 117.0 and 118.4 mmol/L, which occurred at 16 h after the MH attack and tested by a blood gas analyzer and verified by a dry type biochemistry analyzer, respectively. We have not retrieved similar phenomenon, and we cannot explain it as well. Whatever, it might imply that series monitoring of serum electrolyte is necessary.

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Conflicts of interest

There are no conflicts of interest.

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