

## A Case of Fulminant Malignant Hyperthermia During Sevoflurane Anesthesia Using Laryngeal Mask Airway

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(Received for Publication: June 11, 2008)

### Abstract

An 11-year-old boy underwent orthopedic surgery under sevoflurane anesthesia using a laryngeal mask airway (LMA). End-tidal carbon dioxide concentration (ETCO<sub>2</sub>) increased just after induction of anesthesia. This phenomenon was attributed to a problem with the LMA, which was exchanged for a new one. However, ETCO<sub>2</sub> continued rising and tachycardia and spontaneous respiration developed. A presumptive diagnosis of malignant hyperthermia (MH) was made. Subsequent management including discontinuation of sevoflurane, hyperventilation, general cooling and dantrolene administration resulted in complete resolution of the critical conditions.

MH is rare, but can be fatal unless managed promptly. Early identification and treatment are crucial to improve prognosis. Rising ETCO<sub>2</sub> is one of the earliest signs of MH, but the diagnosis in this case was delayed because the changes were misattributed to LMA use.

Care must be taken with estimating ETCO<sub>2</sub> values when using an LMA, as changes may represent inaccuracies due to leakage and/or dislocation, particularly in MH that early detection of rising ETCO<sub>2</sub> is crucial for management.

To anticipate MH susceptibility before anesthesia, cautious preoperative interview focused on MH susceptibility related conditions such as episode of general spasm, myalgia and/or colored urine even after short duration of exercise are also important as well as abnormal anesthetic history within relatives.

### Key Words

malignant hyperthermia, laryngeal mask airway, end-tidal carbon dioxide concentration

### Introduction

Malignant hyperthermia (MH) is a life-threatening complication related to anesthesia and is characterized by abnormally increased hypermetabolic response after exposure to volatile anesthetics and/or depolarizing muscle relaxants in susceptible individuals<sup>1)</sup>. MH is very rare, but condition quickly and progressively deteriorates to death if appropriate management is not provided. Early

detection and intervention are crucial to achieving optimal prognosis.

This report describes a case of fulminant MH in which end-tidal CO<sub>2</sub> concentration (ETCO<sub>2</sub>) increased just after induction of anesthesia. Although this represents one of the earliest signs of MH, the change was initially misattributed to trouble with the laryngeal mask airway (LMA). Subsequent prompt management resolved critical conditions completely.

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### Case Report

A healthy 11-year-old boy weighing 34 kg, American society for anesthesiologists (ASA) physical status 1, was scheduled for orthopedic surgery for fracture of the right forearm following an accident during a track and field event. Past medical history was unremarkable. Family history elicited preoperatively from mother revealed another son (6 years old) and grandfather had undergone general anesthesia several times without apparent complications. Results of routine preoperative laboratory examinations were unremarkable except for a slight elevation in serum creatinine phosphokinase (CPK) level (402 IU/L; normal, <197 IU/L). This was considered a post-traumatic change.

On arrival in the operating room, standard monitoring including noninvasive blood pressure cuff, pulse oximetry and electrocardiography were applied. General anesthesia was then induced using 7% sevoflurane and 66% nitrous oxide in oxygen via a facemask, and an LMA (#3 pro-seal type) was inserted after administration of 2 mg of vecuronium. Trivial leakage from the pharynx was noted at a peak airway pressure (PIP) of 20 mmHg, but tidal volume at PIP 15 mmHg seemed adequate on inspection of chest wall movement. A rectal temperature probe and capnography were also applied for monitoring. Vital signs after these procedures were: arterial blood pressure (BP), 120/50 mmHg; heart rate (HR), 110 beats/min; rectal temperature, 36.3°C; SPO<sub>2</sub>, 99%; and ETCO<sub>2</sub>, 44 mmHg. General anesthesia was maintained with 66% nitrous oxide in oxygen and 2% sevoflurane. The lungs were ventilated using the pressure control method at PIP 16 mmHg and a respiratory rate (RR) of 10 breaths/min. Within 15 min after induction, ETCO<sub>2</sub> had gradually increased to 55 mmHg. The anesthetic circuit and CO<sub>2</sub> absorber unit were re-checked, but no sign of rebreathing phenomenon was apparent. Piping rales were not audible on auscultation. Although fit of the LMA did not seem to have changed since insertion, the mask was removed to check internal and external appearance and pilot balloon, but no problems were identified. A new LMA of the same size was inserted smoothly. To decrease ETCO<sub>2</sub>, PIP and RR were increased to 20 mmHg and 14 breaths/min, respectively. ETCO<sub>2</sub> dropped to 46 mmHg. Surgery was started after 35 min of induction with a tourniquet at 220 mmHg. Within 10 min after

starting surgery, HR and ETCO<sub>2</sub> started to increase rapidly, reaching 168 beats/min and 82 mmHg, respectively. Application of 3% sevoflurane, 0.05 mg fentanyl and manual hyperventilation failed to control hyperdynamic conditions. Spontaneous ventilation and motion in the extremities also developed. Although body temperature had been kept within normal range (36.7°C), a presumptive diagnosis of MH was considered. Sevoflurane was discontinued and manual hyperventilation with 100% oxygen was started. Surgeons were warned that the patient was probably in MH crisis and were requested to finish the operation as soon as possible. Anesthetic method was changed to continuous infusion of propofol (8 mg/kg/h). Surgical drapes were removed and general cooling was initiated using cold saline both on the body surface and irrigated through the stomach. ETCO<sub>2</sub> reached 93 mmHg. Dantrolene (1.4 mg/kg) was administered 10 min after discontinuation of sevoflurane. Shortly thereafter, HR and ETCO<sub>2</sub> normalized to 90–100 beats/min and 30–40 mmHg, respectively. Body temperature kept rising for the next 30 min, reaching 38.2°C, but returning to 37.4°C by the end of the operation. Analysis of arterial blood obtained at this point revealed normal results except for elevated CPK (1204 IU/L). The surgical procedure was completed in 105 min and the LMA was removed in the operating room.

The patient was transferred to the intensive care unit (ICU), where he received active hydration with K-free solution (6–8 mg/kg/h) to prevent renal dysfunction<sup>2)</sup> from hemoglobinemia, and detection of recrudescence<sup>3)</sup> under closed monitoring. Myoglobinuria along with high serum levels of myoglobin (>3000 µg/L, exceeding the upper limit of measurement) were observed on the day of operation, but normalized from the next day. CPK and glutamic oxaloacetic transaminase (GOT) levels peaked at 39,980 IU/L and 773 IU/L, respectively. These values gradually normalized by postoperative day 11 (Table 1). Recovery was uneventful during the 72 h of ICU stay and the patient was discharged from hospital on postoperative day 7 without any sequelae.

During the ICU stay, the mother was closely interviewed about family medical history, revealing an episode more than 20 years ago in which her nephew died the day after surgery under general anesthesia. She also revealed that she and her 14-year-old son had a tendency to experience general

**Table 1.** Changes in CPK and GOT Values During Perioperative Period

	Pre Ope	Intra Ope (10:30)*	Day of the Ope (12:24)*	POD 1	POD 2	POD 11
CPK (IU/L)	409	1204	39980	27820	13300	196
GOT (IU/L)	29	37	773	770	517	28

POD: Post Operative Day

\*: Start of anesthesia (9:10), Start of operation (9:45)

spasms with myalgia lasting several days even after short durations of exercise.

### Discussion

MH is a heritable disorder of calcium channel regulation within skeletal muscle, triggered by certain anesthetics. Symptoms are mainly based on abnormally increased hypermetabolic reactions, including tachycardia, cardiac arrhythmia, unstable blood pressure, cyanosis, muscle rigidity, acidosis and increased body temperature. Continuous muscle contraction causes hyperpotassemia and myoglobinuria as a result of rhabdomyolysis.

The mortality rate for fulminant-type MH is up to 15 %, even in recent reports from Japan<sup>4</sup>. Early diagnosis and prompt intervention are necessary for good outcome. Despite the name, hyperthermia does not develop until the late phase of MH. Symptoms are thus sometimes misdiagnosed as inadequate anesthesia depth and analgesia, inappropriate breathing circuit, tourniquet ischemia, thyroid storm or sepsis, particularly in atypical cases<sup>5</sup>.

To clinically diagnose MH from an intraoperative episode, a clinical grading scale (CGS) was established<sup>6</sup>. Score according to this scale for the present case was: 0 for muscle rigidity; 15 for muscle breakdown (CPK >20,000); 15 for ETCO<sub>2</sub> >55 mmHg; 15 for rapid increase in body temperature; 3 for sinus tachycardia; and 5 for rapid improvement of MH signs after administration of dantrolene. Presence of MH was thus considered as almost certain, give the score of 53.

From the perspective of severity, MH was classified as fulminant, abortive type. This case was classified as fulminant MH based on fulfillment of both Criterion A (body temperature >38.0°C, increasing by >0.5°C/15 min) and Criterion B (tachycardia, respiratory acidosis and myoglobinuria<sup>7</sup>).

In past decades, widespread intraoperative use

of capnography has led to the identification of hypercapnia as one of the most reliable and earliest signs of MH<sup>8</sup>. In the present case, ETCO<sub>2</sub> increased just after administration of sevoflurane. The airway was secured using on LMA. This tool was developed as a device for airway management in addition to the conventional endotracheal tube by Brain in 1981<sup>9</sup>. Advantages such as hemodynamic stability during insertion and reduced effect on the vocal cords have made this device popular, particularly for minor surgery. The frequency of LMA use has been increasing. Basically, this device was designed for secure airways to pack around the pharynx, and sealing ability on the airway is inferior to that of the conventional endotracheal tube. ETCO<sub>2</sub> values are thus occasionally inaccurate due to leakage, dislocation or kinking<sup>10</sup>. Initially, the cause of hypercapnia in this case was assumed to be problems with the LMA, and unnecessary exchange was performed. A search of the literature yielded no case reports of MH crisis under LMA management. Vigilance is required regarding ETCO<sub>2</sub> values, which could be inaccurate as a result of leakage and/or dislocation, particularly in MH.

Once MH had been diagnosed, prompt intervention including discontinuation of sevoflurane, general cooling, hyperventilation with 100 % oxygen and administration of dantrolene was performed within 10 min. Symptoms dramatically improved without any complications. A favorable outcome was achieved thanks to this prompt and adequate management.

Since MH is an inherited disease, the most important step is preoperative identification of susceptible patients. Clinically, anesthetic interviews related to MH episodes have been performed. A weak point in this case was that susceptibility remained undetected preoperatively. The patient was not considered at risk of MH, as close family

members had previously undergone general anesthesia uneventfully. However, postoperative interview revealed an abnormal medical history with sudden death after surgery in a remote relative. Moreover, a tendency for general spasms with pain even after short duration of exercise, which was considered plausibly related to MH<sup>11)</sup>, was also revealed among family members.

For anticipation of MH susceptibility before anesthesia, cautious preoperative interview focused on MH susceptibility related conditions such as episode of general spasm, myalgia, and/or colored urine even after short duration of exercise are also important as well as abnormal anesthetic history within relatives.

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## ラリンジアルマスク管理でのセボフルラン麻酔中に生じた 劇症型悪性高熱症の1例

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### 抄 録

11歳の男児に対し上腕骨骨折の手術がラリンジアルマスク(LMA)を用いたセボフルラン麻酔で行われた。呼気終末二酸化炭素濃度(ETCO<sub>2</sub>)は麻酔導入直後から上昇していたが、LMA使用に伴うリークと認識され、新品への交換がなされた。しかしETCO<sub>2</sub>はさらに上昇し続け、頻脈、自発呼吸も出現した。この時点でようやく悪性高熱症が疑われた。その後はセボフルラン投与中止、過換気、全身冷却とダントロレン投与が迅速に行われ、患者は合併症なく退院した。

悪性高熱症は稀ではあるが一旦発症した場合、適切に対処しないと死に至る疾患であり、早期発見・治療介入が最重要である。本症例では最も早期に現れる徴候の1つであるETCO<sub>2</sub>上昇をLMA使用によるトラブルと誤認したために対処が少し遅れた。LMAを使用する場合、リークや位置異常からETCO<sub>2</sub>値が不正確になることもある。これはETCO<sub>2</sub>上昇が最も早期に出現する徴候である悪性高熱症の初期診断を困難にするため注意が必要である。

発症の予防には術前からの悪性高熱症素因の予測が重要であるが、麻酔前問診では血縁者の麻酔歴だけでなく、軽い運動後での全身筋硬直、筋肉痛や着色尿など、素因とされているエピソードの有無の確認も重要である。

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