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Short communications

Malignant hyperthermia developing during esophageal resection in an 82-year-old man

Norihito Nakamura[1], Tomomi Ueda[1], Reiri Ishikawa[1], Yosuke Tasaka[1], Kiyoshi Fukuuchi[1], and Nobukazu Sato[2]

[1]Department of Anesthesiology, Kawasaki Municipal Kawasaki Hospital, Kawasaki, Japan
[2]Deparment of Anesthesiology, Toho University School of Medicine, 6-11-1 Omorinishi, Ota-ku, Tokyo 143-8541, Japan

Abstract
Malignant hyperthermia (MH) is a rare but fatal complication that develops under general anesthesia. Reports on MH in patients over the age of 80 years are unusual. We experienced a case of MH in an 82-year-old patient during esophageal resection. Anesthesia was induced with propofol and succinylcholine, and maintained with sevoflurane. Neither masseter spasm nor rigidity of the limbs was seen during induction. Body temperature (BT) at induction was 36.0°C. Three hours after incision, the level of end-tidal CO_2 was elevated to 55 mmHg. We assumed that the rise in end-tidal CO_2 had occurred due to secretions in the airway. However, the BT, which had risen at 3 h after incision, continued to rise, and about 60 min later, the BT exceeded 39.0°C. A rise of more than 0.5°C in less than 15 min was seen, and MH was suspected. With dantrolene administration, the BT decreased from 40.9°C at maximum to 37.7°C. With continuous infusion of dantrolene when the patient was transferred to the intensive care unit (ICU), BT remained within the normal range. The next day re-operation was performed, without further complications or recurrence of MH during the postoperative period. Because it is necessary to initiate treatment in the early stage of MH, as soon as possible, although MH prevalence is low in the elderly, it is important to suspect MH when hypercapnia and/or hyperthermia are seen.

Key words Malignant hyperthermia · Elderly · Esophageal resection · Onset

The prevalence of malignant hyperthermia (MH) is reported to be 1: 10000–220000 during general anesthesia (GA) [1,2]. It is a rare but fatal complication that develops during surgery under GA, and is said to occur in 1 in every 60000 cases of GA in Japan. With the introduction of dantrolene, the mortality has decreased significantly [3], but MH is still a life-threatening condition, with a mortality of 15% in patients with fulminant MH (f-MH). MH is usually seen in young male patients, and 66% of patients are under the age of 30 years. Reports of episodes of MH in patients over the age of 80 are unusual. We report a case of MH in an 82-year-old patient during esophageal resection.

An 82-year-old man was admitted to hospital due to esophageal carcinoma. His height was 155 cm, and weight was 64 kg. There was no significant medical history or family history. The patient had smoked 30 cigarettes a day for 60 years. He had been diagnosed with esophageal squamous cell carcinoma by upper gastrointestinal endoscopy during a physical checkup. He was scheduled for transthoracic esophagectomy with video-assisted surgery and reconstruction.

Anesthesia was induced with propofol (150 mg) and succinylcholine (60 mg), and a 35-Fr double-lumen tracheal tube (Broncho-Cath; Tyco Healthcare, Athlone, Ireland) was used for intubation. Neither masseter spasm nor rigidity of the limbs was seen during induction. GA was maintained with sevoflurane 1.5% and epidural block, and muscle relaxation was achieved with vecuronium. Body temperature at induction was 36.0°C. The operation proceeded smoothly, but 3 h after incision, the level of end-tidal CO_2 (Et-CO_2) was elevated to 55 mmHg, and Pa_{CO_2} was increased, at 61 mmHg (pH 7.2). Because the patient had a long history of smoking and the amount of secretion was prominent, we assumed that the rise of Et-CO_2 had occurred due to secretion in the airway. Clinical course was observed only with tracheal tube suctioning. However, the patient's body temperature which had risen at 3 h after incision, continued to rise, and about 60 min after the rise of Et-CO_2 his body temperature exceeded 39.0°C. A rise of more than 0.5°C in less than 15 min was seen, and MH was suspected. The operation was suspended, and inten-

Address correspondence to: N. Sato
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Table 1. Changes in body temperature and blood gas analysis data

	3 h after incision	4.5 h after incision	30 min after treatment	After operation	Admission to ICU
Body temperature (°C)	37.7	40.9	37.7	35.9	34.1
pH	7.20	7.32	7.44	7.45	7.34
Pa_{CO_2} (mmHg)	61	74	40	41	44.7
BE ($mmol \cdot l^{-1}$)	–3.0	9.6	3.2	4.9	1.8

sive treatment of MH was commenced immediately, 1 $mg \cdot kg^{-1}$ dantrolene was administered, and additional doses were injected to suppress the symptoms. A total of 4 $mg \cdot kg^{-1}$ dantrolene was administered. Sevoflurane was discontinued and switched to propofol infusion. The anesthesia circuit was exchanged, and aggressive ventilation with 100% oxygen was performed to combat systemic acidosis, surface cooling was performed simultaneously. The patient's body temperature rose to 40.9°C at maximum, but the surface cooling and dantrolene infusion restored his body temperature to 37.7°C. Time-trend changes in body temperature and blood gas analysis are shown in Table 1. Because arterial blood analysis showed a normal level of Pa_{CO_2} (40 mmHg), no metabolic acidosis, and no electrolyte abnormalities, after the intensive treatment of MH, continuation of the operation was considered. However, frequent ventricular tachycardia was seen on the electrocardiogram, so the patient was moved to the intensive care unit (ICU). Dantrolene was infused continuously (240 $mg \cdot day^{-1}$) while he was in the ICU. After admission to the ICU, his body temperature remained within the normal range, and no signs of recurrence such as arrythmia, metabolic acidosis, or oliguria were seen on the next day, so re-operation was performed. Anesthesia was induced and maintained only with intravenous agents. The operation was carried out without further complications and no signs of recurrence of MH were seen during the postoperative period.

A genetic mutation of the ryanodine receptor, RYR1, a calcium channel receptor which controls the release of calcium, has been identified in some MH patients [4]. This mutation is inherited in an autosomal dominant manner. However, it is most likely that genetic mutation accounts for only a small portion of the etiology, as MH occurs predominantly in younger male patients. Considering the fact that the case in our patient was morphologically atypical, there is a possibility that this patient could have had the genetic mutation.

We used the diagnotic criteria of Morio et al. [5] for diagnosis in our patient, and this case was classified as fulminant-MH (f-MH) because of the significant hyperthermia. According to the clinical grading scale (CGS) of Larach et al. [6], our patient's characteristics were graded as category 6, and MH was suspected strongly. For definitive diagnosis, muscle biopsy is necessary, but this is only possible at a limited number of institutions in Japan. In our patient no muscle biopsy was carried out, and diagnosis was made based only on the clinical features.

It took us 60 min to suspect a diagnosis of MH our patient and to initiate treatment. In most cases the onset of MH is rapid, and occurs immediately after induction of anesthesia; however, in our patient it took 3 h before there were any signs of MH. The delayed onset, suspected to be due to the patients medication, old age, and atypical clinical features, caused us to misinterpret the rise of ET-CO_2 as an airway problem. The delay in diagnosis caused the body temperature to rise to 40.9°C at maximum. Early diagnosis and initiation of treatment are important prognostic factors; the mortality of MH is 2.6% when maximum body temperature is less than 40°C, but mortality rises to 53% when the maximum temperature exceeds 41.0°C [7]. Early detection, by suspecting MH even in our elderly patient, may have prevented a further rise in temperature.

The onset of MH is usually rapid, but there was a 3-h time period until onset in our patient. One of the reasons for this delayed onset involves the amount of skeletal muscle in the elderly. It is assumed that MH tends to occur in younger people because they have a large volume of skeletal muscle and a higher metabolic rate. It is also speculated that a certain extent of exposure to MH triggers MH in those who are susceptible [8], and then symptoms only become apparent several hours after induction [9,10]. It is important to suspect MH even in patients who seem at low risk, because there are some reports of onset in the postoperative period or an initial episode of MH in patients who have undergone previous GA without any complication [11]. Also, it is important to watch closely for signs of MH even in the postoperative period.

To summarize, we experienced an episode of MH in an elderly man. Because it is necessary to initiate treatment in the early stage of MH, as soon as possible, although the prevalence of MH is low in the elderly, it is important to suspect MH when hypercapnia and/or hyperthermia are seen.

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