

A Case Report of Malignant Hyperthermia in a Young Male Veteran Diagnosed with an Early Rise of ETCO₂ during Shoulder Arthroscopy



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Abstract

Malignant hyperthermia (MH) is a chain reaction of symptoms triggered in susceptible individuals by commonly used inhalational agents and also muscle relaxants such as succinylcholine [1]. We describe a case of malignant hyperthermia in a young male diagnosed with earliest rise in ETCO₂ concentration. A 37-year-old male underwent right shoulder arthroscopy due to labral tear. Patient was intubated with use of succinylcholine and propofol, general anesthesia was given with sevoflurane. Within 10 minutes of anesthesia, patient developed hypoxemia and ETCO₂ started rising, minute ventilation was increased with 100% oxygen, yet ETCO₂ raised to maximum level of 80mmHg. Initially, it was thought that patient is suffering from bronchospasm and was treated accordingly. Patient condition did not improve and within an hour he developed signs like hypercarbia, tachypnea, tachycardia, hyperthermia, and laboratory findings of hyperkalemia, rhabdomyolysis were noticed. Sevoflurane was stopped immediately; further management was done with intravenous dantrolene along with D50W, Insulin and nebulized albuterol. Surgical procedure was completed with intravenous propofol. MH expert was consulted over hotline. Patient had complete recovery and was discharged from hospital without any significant sequelae. This case demonstrates significance of monitoring ETCO₂ concentration for early identification and management of this life-threatening condition.

Keywords: Malignant hyperthermia; ETCO₂; Shoulder arthroscopy; Succinylcholine; Veteran

Abbreviations: ETCO₂: End-Tidal Carbon Dioxide; D50W: Dextrose Water 50%; ICU: Intensive Care Unit; MH: Malignant Hyperthermia

Introduction

Malignant hyperthermia (MH) is a chain reaction of symptoms that are triggered in susceptible individuals by commonly used inhalational agents such as halothane, enflurane, isoflurane, sevoflurane and also muscle relaxants such as succinylcholine. The symptoms of MH include a greatly increased body metabolism, high fever and muscle rigidity [1,2]. Following is the case of malignant hyperthermia in a young male diagnosed with earliest rise in ETCO₂ concentration.

Clinical Objective

Our case demonstrates the efficacy and significance of monitoring ETCO₂ concentration for early identification and management of malignant hyperthermia, a life-threatening condition.

Case Report

A 37-year-old Caucasian male veteran had elective arthroscopy of right shoulder due to labral tear at our health care facility. Patient was induced with propofol and succinylcholine, general anesthesia was maintained with sevoflurane. After few minutes into procedure, oxygen saturation dropped to

69% along with rise in ETCO₂; initially bronchospasm was considered, so patient was hyperventilated, nebulized albuterol was administered, saturation improved to 90s. Other concerning clinical issues encountered were development of tachycardia, hyperthermia and rise in ETCO₂ despite attempts to increase minute ventilation. Due to presence of these findings diagnosis of malignant hyperthermia was strongly considered. Dantrolene was administered empirically. Sevoflurane was stopped and switched over to propofol infusion. Laboratory findings include hyperkalemia (K=6.7), lactic acidosis (LA=3.9), elevated CPK and myoglobin levels (114,806 & 61,900 respectively) and arterial blood gases consistent with acute hypercarbic respiratory failure. Patient was treated with intravenous 50% dextrose, insulin, β-2agonist nebulization and dantrolene. Patient had adequate clinical response with resolution of tachycardia and improvement in ETCO₂ to 30s. Patient also had arterial and foley's catheter placed. Patient was also noticed to have tea colored urine which was thought to be secondary to rhabdomyolysis. Surgical procedure was completed and he was transferred to the ICU for further care. In ICU patient management was done in consultation with expert from malignant hyperthermia hotline. Patient was aggressively hydrated with intravenous

normal saline and also received intravenous dantrolene every 6 hours for 48 hours. Patient condition was significantly improved by day third in ICU; dantrolene was discontinued to avoid unnecessary muscle relaxation. Patient was extubated on day third, he complained of pain in left arm which was thought to be secondary to rhabdomyolysis. He was later transferred to medical floor and was discharged from hospital in stable condition.

Discussion

During an acute event of malignant hyperthermia, intracellular calcium increases in skeletal muscle, causing uncontrolled muscle contractions. The ryanodine receptor (RYR1) gene encodes the key channel which mediates calcium release in skeletal muscle during excitation-contraction coupling, and mutations in this gene are considered to account for susceptibility to MH (MHS) in more than 50% of cases [3]. The aberrant receptor once triggered by specific agents like in this case by (succinylcholine [4]/ sevoflurane) or other halogenated inhalation agents, allows release of excess calcium into the cytosol of skeletal muscle. This patient had no previous history of allergies but developed symptoms of malignant hyperthermia after receiving sevoflurane and succinylcholine.

In this case, increase in concentration of exhaled carbon dioxide (ETCO₂) served as an earliest sign of malignant hyperthermia. Multiple other signs of hypermetabolic activity observed throughout the event included tachycardia, tachypnea, hyperthermia and respiratory acidosis. Hyperthermia is a proportionally late sign and temperature was not spiked high in our case. Lyses of overactive muscle cells turns out in releasing of intracellular potassium and the resultant hyperkalemia can induce fatal cardiac dysrhythmias. Subsequently, the enormous release of cellular contents creates electrolyte disturbances, further increases metabolic acidosis as well as myoglobinuria. It can also lead to significant renal failure [5].

Successful management of the acute MH episode involves early diagnosis with immediate and early administration of dantrolene [6]. In 1975 Harrison et al. [7] first described that dantrolene could be effective in treatment of malignant hyperthermia. The mortality rate from MH was reduced from 80% to 10% following the development of dantrolene [7]. Dantrolene sodium inhibits the release of calcium from the SR by binding to RYR1 and reverses the effects of MH i.e. uncouples depolarization with contraction. Fast contracting twitch muscles are affected more than slow contracting antigravity muscles. In contrast to pronounced effects on skeletal muscle, effects of dantrolene on cardiac muscle contractility are mild or absent [8]. The recommended dose of dantrolene is 2-3mg/kg every 5 minutes, up to a total dose of 10mg/kg if needed [5]. This patient underwent a rapid improvement with the initial dose of dantrolene.

In addition to dantrolene, other immediate interventions include discontinuation of the triggering agents. Hyperthermia should be treated by internal cooling with cold infusion fluids

and external surface cooling with ice packs placed in the axillae and groin or specific cooling devices until body temperature reaches 38.5°C [9]. In our case, patient was hyperventilated with 100% O₂ to compensate for the increased metabolic oxygen demand. Serial arterial blood gases were drawn to assess and watch metabolic acidosis, electrolyte imbalances, and other markers release during muscle metabolism. To treat hyperkalemia with potassium level of 6.7, EKG changes consistent with hyperkalemia were noted and he was empirically given Insulin and dextrose. Sodium bicarbonate was also given to treat metabolic acidosis. In order to manage malignant hyperthermia, high suspicion to recognize early symptoms is of particular importance. An abrupt rise in end tidal CO₂ may occur simultaneously with administration of succinylcholine [10,11]. In this case, anesthesiologist noted early rise in ETCO₂ and promptly intervention was done as evidenced by the absence of morbidity and minimal changes in laboratory values. After stabilization and completion of procedure, he was admitted to intensive care unit for 72 hours to monitor any complications as well as possible recrudescence of symptoms. MH hotline was also called to consult MH expert.

Interestingly, there are some reports of fulminant MH-like episodes occurring in the absence of anesthetic agents. MH episodes in the wake state have been described after excessive alcohol consumption, drug abuse, and extreme emotional and physical stress [12-14]. While genetic testing is under development, a muscle biopsy test is the final confirmation of malignant hyperthermia susceptibility [6,15]. For about 30 years, the in vitro contracture test using halothane and caffeine has been the gold standard for determining susceptibility to MH independent of a clinical MH event. Following a surgical muscle biopsy, live muscles specimens are exposed to defined concentrations of halothane or caffeine. If developing contracture forces exceed given thresholds after exposure to halothane and/or caffeine, the patient is diagnosed to be MHS (susceptible). Absence of development of significant contracture following exposure to these agents leads to a diagnosis of MHN (non-susceptible) [16]. Since MH is an autosomal dominant with variable penetrance, testing is also recommended for family members of patients with a positive contracture test. For our patient and MH-positive family members, non-triggering anesthesia should be used for surgeries in future. Even without a positive history of MH, any physician using potent inhalation anesthetics or succinylcholine must be prepared to treat MH. Dantrolene and sterile water for injection must be promptly accessible. Further information can be obtained at the Web site for Malignant Hyperthermia Association of the United States (MHAUS) and by calling their emergency 24 hour hotline at 1-800-644-9737 [17].

Conclusion

Our case draws attention to any physician using potent inhalational anesthetics or succinylcholine; must be prepared to treat MH and risks should always be considered high even in patients without positive history of malignant hyperthermia.

Additionally, it also demonstrates the efficacy and significance of monitoring ETCO₂ concentration for early identification and management of this life threatening condition. MH emergency hotline contact number should be saved at readily accessible place to make call in timely manner.

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