A case of elevated body temperature, end-tidal carbon dioxide, and creatine phosphokinase during repair of a right femur fracture in an adolescent male.

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Introduction: Mechanisms describing the clinical entity of malignant hyperthermia (MH) have focused upon the disruption of calcium metabolism in the skeletal muscle cell. In swine homozygous for this abnormality respond to stress in the same manner as humans heterozygous for this disorder respond to anesthetics. In swine, this defect has been deduced to be a single amino acid change, whereby, cysteine is substituted for arginine, resulting in a defective protein in the ryanodine receptor which potentates a hypermetabolic state. In humans, this defect can be seen between linkage polymorphisms in and near the skeletal muscle ryanodine receptor gene (RYR1) and MH, indicating that a mutation in RYR1 is the cause of at least some forms of MH(1), (2).

Case Report: We describe a single case of hypermetabolism whereby an adolescent was anesthetized for open reduction and internal fixation of his right femur. The patient was taken to the operating theatre, whereby a rapid sequence induction with sodium pentothal, 250 mg and succinylcholine, 100 mg were given IVP. Immediately following induction, it was noted that the patient's jaw was transiently stiff; however, this did not impede laryngoscopy. The anesthetic was maintained with N_20/O_2/fentanyl/isoflurane. During the course of the operation, the patient developed signs indicative of malignant hyperthermia, including tachycardia, elevated end-tidal CO_2, and elevated core body temperature. Both venous and arterial gas analysis was performed which demonstrated a respiratory acidosis, yet the presence of a metabolic acidosis was absent. More interestingly, arterial blood gas analysis demonstrated a relative hyperoxia given the patient's hypermetabolic state. ($_PaO2$ on FiO_2=1.0, 469 mmHg). In response to this clinical presentation, the patient was treated with dantrolene sodium, approximately 6.5 mg/kg. Immediately following infusion of this medication, the end-tidal CO_2 began to normalize and the temperature began to decrease. The patient had his femur repaired and was treated in the intensive care unit postoperatively. During the patient's post-operative course, the patient demonstrated an elevated value of creatine phosphokinase, values that exceeded 80,000 U/L. Moreover, during his postoperative course, the patient did not exhibit evidence of myoglobinuria. The patient demonstrated an unremarkable recovery and was discharged from the hospital on POD # 6.

Discussion: Malignant hyperthermia is characteristic of a hypermetabolic state whereby there is a disruption in the Ca^2+ metabolism within the skeletal muscle cell. This mechanism was initially believed to be as a result of a molecular defect in the ryanodine receptor, which is present in swine and human skeletal muscle cells. In swine, this defect has been reduced to be a single protein, resulting in a defective function that potentiates a hypermetabolic state. In contrast, humans possess a more complex genetic array. Linkage analysis has demonstrated multiple genetic foci with their corresponding protein products. We concur with the hypothesis that this discontinuity can represent the spectrum of phenotypes that MH may clinically manifest. Indeed, the patient may be deficient of a metabolic acidosis and relative hypoxia, yet possess a pathologic hypermetabolic state with a disruption of Ca^2+ metabolism in skeletal muscle cells leading to malignant hyperthermia(1).

References:

1) MacLennan, D and Phillips, M., Science, Vol. 256, May 8, 1992.
2) Gillard, E.F., et.al., Genomics 11, 751, 1991.