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CASE OF MALIGNANT HYPERTHERMIA IN A CHILD OF AFRICAN DESCENT AT A TERTIARY HOSPITAL, NAIROBI KENYA

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SUMMARY

Malignant Hyperthermia is a dreaded complication of certain anaesthetics. Predisposition to the condition is genetic and occurs due to the mutations in autosomal dominant genes coding for defective receptors in skeletald muscles involving ryanodine receptor 1 (RyR 1) and voltage-dependent L-type calcium channel (Dihydropyridine receptor-DHPR) The common agents which are thought to precipitate this catastrophic complication are inhalation agents such as sevoflurane and muscle relaxants such as suxamethonium. It is advised to immediately stop the administration of the offending agents and administer dantrolene sodium which can alleviate the condition. Although such events are rarely reported in the African continent, there are many such reports from the developed countries. In this report, a 4-year-old child who presented for adenotonsillectomy developed malignant hyperthermia and required repeated doses of dantrolene sodium and was successfully rescued.

INTRODUCTION:

Malignant hyperthermia (MH) is an autosomal dominant disorder of skeletal muscle in humans resulting from defective ryanodine receptor 1 (RyR 1) receptors, and voltage-dependent L-type calcium channel (Dihydropyridine receptor-DHPR). The defective receptors are associated with impaired magnesium control of calcium release from the sarcoplasmic reticulum leading to massive intracytosolic calcium elevation. The elevated cytosolic calcium facilitates prolonged interaction of contractile myofilaments leading to rigidity, adenosine triphosphate (ATP) hydrolysis in an attempt to pump back Ca++ to sarcoplasmic stores (heat/hyperthermia), glycogen hydrolysis and incomplete oxidation of glucose (lactic acidosis), increased mitochondrial intake of oxygen and production of CO^2(hypercarbia)(1). The

diagnosis is usually clinical characterized by a rapidly increasing temperature, end-tidal carbon dioxide, hypoxia, tachycardia and generalized muscle rigidity. The onset and duration are varied from immediate occurrence after exposure to postoperative. In our report, we present a patient who developed malignant hyperthermia with bradycardia on exposure to sevoflurane within a few minutes.

Case report:

A 4-year-old male child weighing 15 kg with a diagnosis of adenotonsiller hypertrophy was scheduled for adenotonsillectomy. Pre-operative vitals signs were unremarkable. Anaesthesia was induced with a mixture of sevoflurane (8%) in 50% nitrous oxide and oxygen, and intravenous atracurium (5mg). Monitoring included temperature probe on the axilla, Non- invasive blood pressure (NIBP) cuff on the arm, pulse oximetry, continuous Electrocardiography (ECG) and capnography. After 4 minutes following anaesthesia induction vital signs changed: the heart rate to 50 beats per minute (bpm) (ECG in sinus rhythm), systolic blood pressure to 50 mmHg, saturation to 88%, temperature to 38^0C and the end-tidal CO_2 ($ETCO_2$) rose to 81mmHg with jaw rigidity. The ventilator circuit was checked for obstruction, and other causes of hypoventilation including bronchospasm were eliminated. Additional doses of atracurium and fentanyl were administered to rule out inadequate muscle relaxation and analgesia. Also, sevoflurane was changed to isoflurane for maintenance of anaesthesia. There was improvement in vital signs so the surgery continued that lasted 30 minutes. Following reversal of muscle relaxation with neostigmine and glycopyrrolate, it was observed that the temperature rose to 41^0C, the $ETCO_2$ to 150 mmHg, and the jaw rigidity worsened (Table 1). An arterial blood gas showed base excess of -20. A clinical diagnosis of malignant hyperthermia was made. Consequently emergency 'A call for help' was activated. The anaesthesia circuit were changed and flushed with 100% oxygen. Immediate interventions included sponging with ice-cold water; infusion of cold normal saline. Intravenous dantrolene sodium was administered in 20 mg doses three times, each over 30 minutes. After 100 minutes, the temperature, $ETCO_2$, blood pressure and jaw rigidity stabilized back to normal (Table 1). The patient was then transferred to the intensive care unit (ICU). On arrival in the ICU, a further 20mg of dantrolene was administered to prevent recrudescence. Other supportive treatments included infusion of midazolam for sedation, morphine for analgesia, paracetamol, dexamethasone, and furosemide. A nephrologist consultation was sought to manage the acidosis, calcium and magnesium levels. (Electro encephalography (EEG) monitoring in the ICU showed no epileptiform activity.

The patient was extubated on the second day of admission to the ICU and transferred to the ward. The postoperative course was uneventful.

Table 1: Intraoperative Vital Signs and Response to Dantrolene

Time	BP(SBP/DBP mmHg)	HR(BPM)	SPO_2(%)	$ETCO_2$ (mmHg)	Temp(^{0}C)	Remarks
At Induction	105/49	107	100	37	3.6.5	
At end of surgery	100/49	121	98	60	37.8	
Reversal of muscle relaxant	80/40	150	94	100	38.0	
5 mins after reversal	96/36	169	95	139	39.5	
20 mins after reversal	80/30	170	94	150	41.5	Intravenous dantrolene sodium 20 mg administered.
50 mins after reversal	73/30	120	98	60	38.3	
55 mins after reversal	85/45	130	98	54	38.0	Intravenous dantrolene sodium 20 mg administered.
70 mins after reversal	86/31	138	49	100	38.0	Intravenous dantrolene sodium 20 mg administered.

Abbreviations: BP(SBP/DBP-Blood Pressure(systolic blood pressure/Diastolic Blood Pressure; $ETCO_2$-End Tidal CO_2;; HR(BPM)-Heart Rate (Beats per minute)

DISCUSSION

This case is interesting in several aspects. This is the first reported case of MH in Kenya; MH is rarely reported in people of African race; the initial presentation of hypotension and bradycardia are unusual; administration of non-depolarising muscle relaxants suppressed the clinical signs until after the reversal.

MH is a condition that has been associated with volatile inhalation agents and depolarizing (succinylecholine) muscle relaxants. In our case report, we present a child who developed MH classical signs after reversing effects of muscle relaxants. Larach et al. developed a scoring system to assist in diagnosis of malignant hyperthermia. In the current patient with a score of 60 (> 50), the diagnosis was almost certain (2).

Even though the onset of these symptoms occurred at induction with sevoflurane, they were suppressed by muscle relaxants but became prominent after the administration of reversal agents. Such variation in events to fulminant presentation have been described (3)

The differential diagnoses for MH include inadequate muscle relaxation, Endo tracheal tube (ETT) blockage or placement. These were ruled out by the addition of muscle relaxants, and inspection of capnography trace. Diseases that could also present similarly are thyroid storm, chromaffin tumours and phaeochromocytoma crisis, which. However, these are usually not associated with muscle rigidity.

This patient promptly responded to dantrolene which is indicated for the treatment of MH. It has also been used with success in other hyperthermic conditions not limited to MH(4). Although practices vary, the American and European guidelines both recommend initial dosing of 2-25 mg/Kg, continuation up to 10 mg/Kg; termination when the temperature drops to 38.5 ^{0}C and $ETCO_2$ below 50 mmHg (5). Our patient responded to small repeated bolus doses of 20 mg.

It is recommended, in addition to dantrolene, to institute supportive measures to dissipate body heat including ice-cold cooling, fanning, gastric and urethral lavage (6). Since recrudescence is a possibility in the immediate post-crisis treatment, the patients should be managed in the ICU for at least 24-35 hours (7).

Some reports have described successful and complete recovery with supportive measures, without the use of dantrolene (8, 9). Therefore, cooling measures, induced diuresis and correction of arrhythmias are an integral part of treatment that can supplant dantrolene when not available.

When diagnosed early and prompt treatment is instituted, the mortality and complications are very low. The common complications are altered level of conscious, cerebral oedema or coma, cardiac dysfunction, pulmonary oedema, Disseminated intravascular Coagulopathy (DIC) or renal involvement (8).

In conclusion, we report a case of a 4-year-old child of Kenyan African descent who presented with classic features of MH following exposure to anaesthetics. The use of dantrolene together with supportive measures ensured unremarkable recovery. A high degree of suspicion helps in diagnosing this rapidly progressive disorder.

CredIT Statement?

Authors contribution):

1. OG-conceptualization, original manuscript drafting, editing versions and submission
2. BO- conceptualization, Gertrude Children Hospital, review, editing and approval of final version
3. Acknowledgement-Gertrude Children Hospital, Mutaiga, Nairobi, Kenya

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