

**ANAESTHETIC MANAGEMENT OF THE PATIENT WITH CONGENITAL METHEMOGLOBINEMIA WITH GASTRIC OUTLET OBSTRUCTION POSTED FOR GASTROJEJUNSTOMY****Dr Rithika C**

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ABSTRACT

Background: Methemoglobinemia is an uncommon hematological condition in which hemoglobin contains iron in an oxidized (Fe^{3+}) state with limited oxygen carrying ability. It can be congenital or acquired. Anesthetic management of methemoglobinemia poses a great challenge, as there is a risk of refractory hypoxemic crisis in the perioperative period. **Case:** Here, we present a case of a 28-year-old male with congenital methemoglobinemia who presented with gastric outlet obstruction for open gastrojejunostomy under general anesthesia. He had a deficiency of cytochrome B5 reductase, which contributed to 36% of methemoglobin levels on co-oximetry, which was managed with intravenous methylene blue. The patient recovered without any hypoxemic insult. **Conclusion:** Anesthetic management of patients with moderate (20% - 50%) methemoglobinemia can be successful with extreme precautions to avoid events that can increase the methemoglobin levels and adequate preparation and availability of intravenous methylene blue.

KEYWORDS :**INTRODUCTION**

Methemoglobinemia is an uncommon hematological disorder with life-threatening potential where hemoglobin is in oxidized-ferric form, which is unable to bind and transport oxygen. These patients are refractory to supplemental oxygen therapy. Anesthetic management of patients with methemoglobinemia is a great challenge for anesthesiologists to be aware of potential risks of hypoxemia, refractory to conventional management, and be prepared with expert help with a backup plan to handle severe hypoxemic episodes. It is essential to take extreme precautions to avoid hypoxemic episodes. Conditions such as metabolic acidosis can also increase the methemoglobin percentage in the blood, posing a huge risk to life.

Case Report

A 28-year-old male, a case of congenital methemoglobinemia (Type 1), came to the hospital with complaints of pain abdomen and vomiting since 6 months diagnosed as gastric outlet obstruction posted for open gastrojejunostomy with Preoperative vitals blood pressure of 130/80 mm hg and pulse rate of 90/ min and saturation of 98% . The patient was induced with Inj. Propofol (2 mg/kg) preceded by Inj. Fentanyl (2 mcg/kg) and endotracheal intubation facilitated by Inj. Atracurium at 0.5 mg/kg, with an endotracheal tube of size 8.5 mm, by direct laryngoscopy and position confirmed by five-point auscultation and capnography tracing. The patient was put on VCV mode on the ventilator with Intraop vitals of blood pressure of 100/60mm hg and pulse rate of 76/ min with saturation of 87% with 6/litres of oxygen and not improving with with 10/l of oxygen and peep. On incision dark brown colour blood was found. Peripherals were cold and cyanotic not improving with warm Fluids and peripheral warming was done. Surgery aborted and patient shifted to icu with saturation of 85% on room air. Cyanosis of fingers was observed. Patient was evaluated for whole exome sequencing for ruling out genetic causes and patient had cytochrome B5 reductase deficiency and co-oximetry analysis revealed methemoglobin value level of 36% and classified as moderate methemoglobinemia. Patient was started on ascorbic acid and methylene blue with Arterial blood gas of pH 7.398, PaCO_2 42.1, PaO_2 82.7, HCO_3 25.1 and SO_2 94.9% . Patient was monitored and was on ascorbic acid and intravenous methylene blue and patient was posted for surgery. During preoperative evaluation, the patient was not anemic, not cyanosed, and had stable hemodynamics without any other systemic illness, but clinical findings of refractory hypoxemia were confirmed with supplementary oxygen. Airway and systemic examinations were normal. Blood parameters, chest x-ray and echocardiography are normal. After explaining the potential risks of life-threatening hypoxic crises during the perioperative period, informed written consent was obtained. With all standard ASA monitors, SpO_2 of 88% on room air, intravenous methylene blue was started. Preoxygenation done. The patient was induced with Inj. Propofol (2 mg/kg) preceded by Inj. Fentanyl (2 mcg/kg) and endotracheal intubation was facilitated by Inj. Atracurium at 0.5 mg/kg, with an endotracheal tube of size 8.5mm, by direct laryngoscopy with and position confirmed by five-point auscultation

and capnography tracing. The patient was put on VCV mode on the ventilator. Anesthesia maintained with O_2 (FiO_2 -1.0), sevoflurane (MAC-0.7-1.0), and intermittent maintenance doses of atracurium and fentanyl. Inj. Methylene Blue was kept ready in a dilution of 1 mg/ml. NSAIDs and other drugs precipitating methemoglobinemia, like lidocaine, EMLA, N_2O , and metoclopramide, were avoided. Adequate hydration was maintained with Ringer's lactate solution. Temperature was maintained between 35°C and 36°C . The patient was mechanically ventilated to ensure normocapnia and oxygen saturation at the baseline level. Intraoperatively, saturation was maintained. At the end of surgery, residual neuromuscular blockade was reversed with Injection Neostigmine (2.5mg) and Inj. Glycopyrrolate (0.5 mg). After confirmation of adequate ventilation and muscle power, the patient's trachea was extubated and shifted to ICU with O_2 at 6 L/min for monitoring. The patient was hemodynamically stable, maintaining oxygen saturation around 95% for the first two postoperative days, and was discharged well on postoperative day 4.

DISCUSSION

Methemoglobinemia can be congenital or acquired. Congenital is further classified into Type 1, due to NADH cytochrome b5 reductase deficiency (autosomal recessive pattern), & Type 2, due to the presence of abnormal hemoglobin HbM (autosomal dominant pattern). Acquired methemoglobinemia caused by exogenous chemicals or drugs is more common. It can be of three types: direct – benzocaine, prilocaine; indirect – nitrates; and metabolic activation by drugs – aniline, and dapsone [1]. It is essential to avoid the use of these drugs intraoperatively.

Normally, blood contains 1% - 2% MetHb, and it is controlled by NADH cytochrome b5 reductase. In methemoglobinemia, the oxygen dissociation curve is shifted to the left, resulting in more oxygen affinity.

Severity of Methemoglobinemia is Better Indicated by Percentage.

Methemoglobin Concentration	Signs and Symptoms
0-3%	No Symptoms
10-20%	Mild symptoms. Cyanosis. Chocolate brown blood
20-50%	Dyspnea, decreased exercise tolerance, fatigue, HA, dizziness, tachycardia
>50%	CNS hypoxia, seizures, coma, dysrhythmias, ischemia, tachypnea, metabolic acidosis
>70%	Severe hypoxia, death

The physiological reason for normal PaO₂ in people with methemoglobinemia, severe anemia, and carbon monoxide poisoning is that the PaO₂ will not be impacted by either the hemoglobin's binding properties or quantity. To reiterate, alveolar PO₂ and lung architecture (alveolar-capillary interface) are the sole factors that affect PaO₂, not hemoglobin concentration or features.

DIAGNOSIS

Methemoglobinemia is diagnosed based on history and clinical findings, which include refractory hypoxemia to supplemental oxygen and the presence of chocolate colored blood, which can be confirmed by arterial blood gas analysis with co-oximetry. Methemoglobinemia should be suspected in patients that appear cyanotic and have a low pulse oximetry reading yet have no apparent respiratory or cardiovascular conditions to explain the low saturation. PaO₂ values will be normal but not consistent with the pulse oximeter measured saturation. The gold standard measurement of hemoglobin species requires the use of cooximetry. Co-oximetry measures light absorption at four distinct wavelengths that characterizes deoxyhemoglobin, oxyhemoglobin, carboxyhemoglobin and methemoglobin.

TREATMENT

The treatment for symptomatic methemoglobinemia is immediate IV methylene blue and identification and removal of the offending drug or toxin. In some patients, daily oral therapy with methylene blue, ascorbic acid or riboflavin may be effective. Long-term therapy with IV methylene blue may be required for those who fail to respond to oral therapy.

Therapy is titrated based on the patient's symptoms and methemoglobin concentration. Treatment is recommended for asymptomatic patients with an HbM level exceeding 30% and symptomatic patients with an HbM level of 20%. Patients with cardiovascular compromise, lung diseases, carbon monoxide poisoning or anemia may need immediate treatment even with HbM levels as low as 10%. Methylene blue acts as the cofactor in the hemoglobin reduction pathway, thereby increasing the enzymatic reduction of HbM. It is administered IV at 1-2 ml/kg and may be repeated in 30-60 minutes if symptoms persist. Adverse effects of the drug include nausea, vomiting, diarrhea, diaphoresis, dyspnea and, rarely, anaphylactoid reactions. Doses greater than 7 mg/kg can directly oxidize hemoglobin to MetHb. Additional therapies to increase oxygen delivery include exchange transfusions, homologous transfusions and hyperbaric oxygen therapy.

Anaesthesia Management

While providing safe anesthesia to a patient with congenital methemoglobinemia, Anesthesiologists must consider the following concerns. Steps are to be taken to avoid events that can precipitate hypoxia and metabolic acidosis such as massive blood loss, hypotension, hypothermia and hypoventilation, because these can trigger ischemia and acidosis as well. Continuous monitoring of oxygen saturation with intermittent evaluation by co-oximeter is preferable to diagnose hypoxia due to an increase in methemoglobin levels. A variation of up to 20% from baseline oxygen saturation levels may be acceptable. Intravenous methylene blue, appropriately diluted and dosed, should be readily available as per the patient's needs. Avoid oxidizing agents such as lidocaine, benzocaine, and prilocaine, and nitroglycerine should be ensured. The hypoxemic episodes resulting from increased methemoglobin levels is generally resistant to supplementary oxygen therapy. Hence, arrangements for the availability of exchange transfusions if the patient does not respond to conventional treatment should be considered, and a backup plan should be formulated for safe anesthesia. Oxygen saturation monitoring and CO-oximetry. These patients require posting for surgery; Monitoring during the intraoperative period may be challenging. Pulse oximetry determines the relative amounts of oxy- and deoxyhemoglobin based on the distinct absorption spectra of two light wavelengths (660 nm and 940 nm) emitted throughout a vascular bed. Normal oxyhemoglobin has a greater absorbance at 940 nm and deoxyhemoglobin at 660 nm. Neural pulsation, inadequate perfusion, motion artifacts, nail polish, and ambient light interference from ambient light are some of the variables that can interfere with pulse oximetry readings. At 660 nm, methemoglobin and oxyhemoglobin both have comparable absorption. Therefore, pulse oximetry provides a falsely increased arterial oxygen saturation when there is an increase in methemoglobin levels. As a result, people with congenital Hb M variants such as those in our review who had HbM — should have

inconsistently low SpO₂. PaO₂ on ABG is also not impacted by HbM concentrations. In fact, PaO₂ may be extremely high (> 100 mm Hg) because of oxygen supplementation in view of hypoxia (SpO₂: 85% - 88%). This observed difference between the calculated oxygen saturation from a standard blood gas machine and the reading from a pulse oximeter is known as the "saturation gap". This once again leads to an erroneous assumption that there is no significant problem. In conclusion, we suggest that when a patient with congenital methemoglobinemia presents for surgical management, we have to be aware of the potential risk of perioperative hypoxemia, which will be refractory to conventional hypoxia management. Anesthetic management requires high levels of vigilance and prompt treatment of hypoxia using the antidote. Hence, Precautions must be taken to avoid factors that trigger hypoxemia such as hypotension, blood loss, pain, and hyperthermia and avoid methemoglobinemia triggering drugs in the perioperative period. It is essential to ensure the availability of intravenous methylene blue, availability of facilities for exchange transfusion and hyperbaric oxygen therapy to handle hypoxemic events.

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