HSPI The Open Access Publisher

IJCAR INTERNATIONAL JOURNAL OF ISSN 2640-2866 CLINICAL ANESTHESIA AND RESEARCH

Case Report

Anesthetic Management of a Rare Case of a Lactating Mother with Congenital Methemoglobinemia Undergoing Laparoscopic Surgery: A Case Report

Sanjeev Kumar S[1]*, Muthurajan N[2], Sharon Clement Wilson[3], Elizabeth[4] and Neil Wilson[5]

[1]Consultant, Department of Anaesthesiology and Critical care, Meridian Hospitals, Chennai, India

[2]Head and Senior Consultant, Department of Anaesthesiology and Critical care, Meridian Hospitals, Chennai, India

[3]Consultant, Department of Pulmonology, Meridian Hospitals, Chennai, India

[4]Senior Registrar, Department of Anaesthesiology and Critical care, Meridian Hospitals, Chennai, India

[5]Consultant, Department of Emergency Medicine, Meridian Hospitals, Chennai, India

More Information

***Address for correspondence:**
Dr. Sanjeev Kumar S, Consultant, Department of Anaesthesiology and Critical Care, Meridian Hospitals, Chennai, India,
Email: sanjeevdoc02@gmail.com

Submitted: April 21, 2025
Approved: April 28, 2025
Published: April 29, 2025

How to cite this article: Sanjeev Kumar S, Muthurajan N, Wilson SC, Elizabeth, Wilson N. Anesthetic Management of a Rare Case of a Lactating Mother with Congenital Methemoglobinemia Undergoing Laparoscopic Surgery: A Case Report. Int J Clin Anesth Res. 2025; 9(1): 026-029. Available from: https://dx.doi.org/10.29328/journal.ijcar.1001031

Keywords: Congenital methemoglobinemia;, Cytochrome B5 reductase deficiency; Anesthetic management; Co-oximetry; Intravenous methylene blue

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 24-year-old female with congenital methemoglobinemia who presented with gallstone disease for laparoscopic cholecystectomy under general anesthesia. She had a deficiency of cytochrome B5 reductase, which contributed to 26% of methemoglobin levels on co-oximetry. Despite taking considerable precautions to avoid hypoxemic episodes and metabolic acidosis, an episode of desaturation happened at the end of the procedure, which was managed with intravenous methylene blue. The patient recovered without any hypoxemic insult.

Conclusion: Anesthetic management of patients with moderate (20% - 30%) 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.

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 24-year-old female, a case of congenital methemoglobinemia (Type 1), came to the hospital with

complaints of non-radiating right upper quadrant pain, with evidence of cholelithiasis on USG abdomen and a plan for laparoscopic cholecystectomy. 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. Co-oximetry analysis revealed a methemoglobin level of 26.8%, classified as moderate of methemoglobinemia. Airway and systemic examinations were normal. Blood parameters, chest x-ray and echocardiography are normal (Table 1).

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, preoxygenation done. 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 7.0mm, by direct laryngoscopy with Cormack-Lehane Grade 2b view, 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, SpO_2 was maintained between 82% and 90%, with FiO_2 1.0. At the end of surgery, residual neuromuscular blockade was reversed with Inj. Neostigmine (2.5 mg) and Inj. Glycopyrrolate (0.5 mg). Prior to extubation, the patient experienced desaturation to a SpO_2 value of 30%. Inj. Methylene blue was given at a dose of 1 mg/kg in aliquots of 20 mg. In about 30-40 seconds her saturation improved to 100%. 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.

Table 1: Comparison of conventional ABG and Co-oximetry

Parameters	Conventional ABG	Co-oximetry
pH	7.40	7.41
pO_2	92.3	125
pCO_2	36.4	34.3
HCO_3-	22.9	22
SaO_2	97.3	99
MetHb	Not recorded	26.8%

Discussion

Etiopathology

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 [2-4]. 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 [5,6]. Severity of methemoglobinemia is better indicated by percentage (Table 2).

The physiological reason for normal PaO_2 in people with methemoglobinemia, severe anemia, and carbon monoxide poisoning is that the PaO_2 will not be impacted by either the hemoglobin's binding properties or quantity. To reiterate, alveolar PO_2 and lung architecture (alveolar-capillary interface) are the sole factors that affect PaO_2, 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. PaO_2 values will be normal but not consistent with the pulse oximeter measured saturation. The gold standard measurement of hemoglobin species requires the use of co-oximetry. Co-oximetry measures light absorption at four distinct wavelengths that characterizes deoxyhemoglobin, oxyhemoglobin, carboxyhemoglobin and methemoglobin [1,8].

Treatment

The treatment for symptomatic methemoglobinemia is

Table 2: Signs and Symptoms [7].

Methemoglobin (MetHb) level	Symptoms	Signs
< 10%	Asymptomatic	Low pulse oximeter reading
10% - 30%	Asymptomatic/confusion	Cyanosis, Dark brown colour blood
30% - 50%	Confusion, chest pain, headache, fatigue	Dyspnea, dizziness, syncope
50% - 70%	Confusion, chest pain, headache, fatigue	Tachypnea, metabolic acidosis, dysrhythmias, seizure, delirium, coma
> 70%		Circulatory collapse, death

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% [9,10].

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.

Anesthetic 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 nitroglycerin 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 [1].

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 SpO_2. PaO_2 on ABG is also not impacted by HbM concentrations. In fact, PaO_2 may be extremely high (> 100 mm Hg) because of oxygen supplementation in view of hypoxia (SpO_2: 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 [11,12].

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 [8]. 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.

References

1. Lin CY, Yang JM, Chen CT, Hsu YW, Huang CJ, Chen CC, et al. Anesthetic management of a patient with congenital methemoglobinemia. Acta Anesthesiol Taiwan. 2009;47(3):143-146. Available from: https://doi.org/10.1016/s1875-4597(09)60042-4

2. Hall DL, Moses MK, Weaver JM, Yanich JP, Voyles JW, Reed DN. Dental anesthesia management of methemoglobinemia-susceptible patients: A case report and review of literature. Anesth Prog. 2004;51(1):24-27. Available from: https://pubmed.ncbi.nlm.nih.gov/15106687/

3. Guay J. Methemoglobinemia related to local anesthetics: A summary of 242 episodes. Anesth Analg. 2009;108(3):837-845. Available from: https://doi.org/10.1213/ane.0b013e318187c4b1

4. Chowdhary S, Bukoye B, Bhansali AM. Risk of topical anesthetic-induced methemoglobinemia – a 10-year retrospective case-control study. JAMA Intern Med. 2013;173(9):771-776. Available from: https://doi.org/10.1001/jamainternmed.2013.75

5. Opera AD. Hematological disorders. In: Hines RL, Marschall KE, editors. Stoelting's Anesthesia and Coexisting Disease. 7th ed. Philadelphia: Elsevier; 2018. p. 486. Available from: https://shop.elsevier.com/books/stoeltings-anesthesia-and-co-existing-disease/marschall/978-0-323-40137-1

6. Karimbanakkal F, Rajesh MC, Kuriakose S, Veetil PP, Puzhakkal S. Anesthetic management of a patient with methemoglobinemia: Case

report and review of literature. BMH Med J. 2023;11(1):9-13. Available from: https://www.babymhospital.org/BMH_MJ/index.php/BMHMJ/article/view/376/762

7. Iolascon A, Bianchi P, Andolfo I, Russo R, Barcellini W, Fermo E, et al. Recommendations of diagnosis and treatment of methemoglobinemia. Am J Hematol. 2021;96(12):1666-1678. Available from: https://doi.org/10.1002/ajh.26340

8. Baraka AS, Ayoub CM, Kaddoum RN, Maalouli JM, Chehab IR, Hadi UM. Severe oxyhemoglobin desaturation during the induction of anesthesia in a patient with congenital methemoglobinemia. Anesthesiology. 2001;95(5):1296-97. Available from: https://doi.org/10.1097/00000542-200111000-00041

9. Naik S, Jaiswal A, Agarwal M, Goel A. Anesthetic concerns of patients planned for urgent surgery with incidental diagnosis of methemoglobinemia in Hansen's disease: A case report. J Anesth Clin Res. 2022;13(8):1-3. Available from: http://dx.doi.org/10.35248/2155-6148.22.13.1078

10. Manchikalapati A, Webb L, Waddell K, Newman J. A near miss: Anesthetic-induced methemoglobinemia leading to near extracorporeal cannulation. Crit Care Med. 2003;51(1):161.

11. Verhovsek M, Henderson MP, Cox G, Luo H-Y, Steinberg MH, Chui DHK. Erratum to: Unexpectedly low pulse oximetry measurements associated with variant hemoglobins: A systematic review. Am J Hematol. 2011;86(8):722–725. Available from: https://doi.org/10.1002/ajh.22074

12. Tandale S, Dave NM, Garasia M. Methemoglobinemia: What the anesthetist must know. Indian J Anesth. 2013;57(4):427–428. Available from: https://doi.org/10.4103/0019-5049.118525

13. Butterworth JF, Mackey DC, Wasnick JD, Morgan GE, Mikhail MS, editors. Morgan & Mikhail's Clinical Anesthesiology. 6th ed. McGraw-Hill Education; 2018. p. 216-217, 462-463. Available from: https://accessmedicine.mhmedical.com/content.aspx?bookid=2444&sectionid=189634642

14. Cho SS, Park YD, Noh JH, Kang KO, Jun HJ, Yoon JS. Anesthetic experience of methemoglobinemia detected during general anesthesia for gastrectomy of advanced gastric cancer – a case report. Korean J Anesthesiol. 2010;59(5):340-343. Available from: https://doi.org/10.4097/kjae.2010.59.5.340

15. Williams L, Wilkins. Pao_2, Sao_2, O_2 content. Dr. Martin's is all you really need to know to interpret arterial blood gases. 2nd ed.