

## Anaesthetic Management of Methemoglobinemia for Right Osteotomy

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### Abstract

Methemoglobinemia is an uncommon but potentially fatal disorder occasionally causing cyanosis particularly in congenital methemoglobinemia. Because of low oxygen saturation, it is often mistaken for other causes of hypoxia by anaesthesiologists despite simple bedside tests. If severe it may lead to hypoxemia and death. We report a case of incidentally detected methemoglobinemia for right osteotomy.

**Key words:** Methemoglobinemia, osteotomy, pulse oximetry, oxidizing agent.

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### I. Introduction

Methemoglobinemia is a form of haemoglobinopathy where there is presence of higher level of methaemoglobin due to oxidation of the iron molecules to a ferric state ( $Fe^{3+}$ ) leading to tissue hypoxia of haemoglobin. In healthy humans methaemoglobin levels are <2% as it is reduced predominantly by cytochrome-B 5 reductase. There are two types of methemoglobinemia—acquired and congenital. Acquired methemoglobinemia is more common and caused by environmental oxidizing agents.

Congenital methemoglobinemia is a rare condition caused by cytochrome B5 reductase deficiency, cytochrome B5 deficiency, or hemoglobin M disease. The patients are more susceptible to exogenous oxidants because of their deficient enzymatic pathways.

We report a case of incidentally detected congenital methemoglobinemia for right osteotomy.

### II. Case Report

A 10 year old male patient, weighing 27kgs, ASA I, with no history of any drug allergies was admitted for right untreated clubfoot for corrective osteotomy and Ilizarov application. The patient past medical history was unremarkable. There was no history of any surgical intervention or exposure to any oxidizing agent. On physical examination, mild cyanotic lips and nails, clubbing (grade 4) were seen. On auscultation, no murmur was heard. The patient's initial pulse oximetry reading was 87% in right and, left upper limb, 88% in bilateral lower limb. Preoperative laboratory data showed a hematocrit of 40%, hemoglobin of 13.8 g/dl and white blood cell count of  $8.5 \times 10^3/\mu L$ . Cardiac evaluation was done. Electrocardiography showed normal sinus rhythm. Chest radiography showed clear lung fields and a heart of normal size and contour. An arterial blood sample was obtained for gas analysis, which revealed a pH of 7.58, arterial oxygen saturation of 99%, PaO<sub>2</sub> of 127.4 mmHg and base excess of 2.4mmol/L, lac 13.22. ECHO was done which was also normal. Patient was referred to paediatric medicine where congenital Methemoglobinemia was suspected because of the mismatch of SpO<sub>2</sub> and SaO<sub>2</sub> and haemoglobin electrophoresis and G-6-PD test advised. Patient was started on vitamin C tablet (Limcee 500mg 1/2-1/2). After 20 days he again came to us for the above procedure. Now mid tarsal/dorsal wedge osteotomy and Ilizarov application was planned. During the PAC visit, Vitamin C was asked to continue and high risk consent along with 8 hours fasting advised. Preoperatively vitals monitored, spO<sub>2</sub>- 90% on room air. He was shifted to the OT and standard monitoring done. Methylene blue was kept for the patient. Under all aseptic precaution spinal anaesthesia given using a 26 G spinal needle in L3-L4 space and 2ml of heavy sensoricaine given in right lateral position. Adequate level of block achieved till T10. Oxygen via face mask applied an inj. Midazolam 1 mg given. The procedure was uneventful and patient remained stable intraoperatively. The surgery lasted for 2 hour. The SpO<sub>2</sub> read 93% in the recovery room with oxygen support by facemask at a concentration of 40%, and oxygen was continuously used in the ward. The patient was advised to avoid exposure to oxidizing agents. The postoperative course was uneventful and the patient was discharged 4 days later.

### **III. Discussion**

Congenital methemoglobinemia is rarely diagnosed, and the true incidence remains unknown. Clinically significant methemoglobinemia may occur because of one of the following conditions: (1) a greatly increased production of methemoglobin; (2) an abnormal hemoglobin which, once oxidized, is resistant to reduction; (3) decreased activity of erythrocyte NADH-cytochrome B-5 reductase<sup>1, 2</sup>. Methemoglobin levels typically range from 10% to 35%. Patients have a normal life expectancy, and methemoglobin levels can be well controlled with methylene blue and ascorbic acid<sup>3</sup>. Oxidation is accelerated by many drugs and toxic chemicals, the former including lidocaine, benzocaine, prilocaine and nitrites, which are often used in the perioperative period<sup>4</sup>. There are many case reports about methemoglobinemia induced by topical anaesthetics, including lidocaine, benzocaine, and prilocaine<sup>5</sup>. The course of congenital methemoglobinemia is generally benign (seldom reaching methemoglobin levels above 30%), but prevention of exposure to oxidizing agents is still very important because of patients' deficient enzymatic pathways and decreased oxygen carrying capacity. Patients with undiagnosed congenital methemoglobinemia usually have methemoglobin levels between 15% and 30%. Cyanosis becomes apparent at methemoglobin levels over 15%, and patients generally become symptomatic only when their methemoglobin level exceeds 30%<sup>6</sup>. Severe methemoglobinemia (> 50%) usually occurs with exposure to oxidizing agents. Commonly described symptoms are dyspnoea, headache, light-headedness, confusion, and lethargy. Levels of methemoglobin exceeding 60–70% may be associated with vascular collapse, coma, and death<sup>7</sup>. Severity of symptoms may be exacerbated by complicating medical conditions and other factors, such as heart disease, anaemia, glucose-6-phosphate dehydrogenase (G6PD) deficiency, infancy and old age<sup>8</sup>. Therapy of methemoglobinemia is based on the degree of methemoglobin levels, severity of symptoms, the etiological process (acute or chronic), and the presence of complicating medical conditions (such as cardiovascular disease and pulmonary disease). In a patient with acute toxic methemoglobinemia, the first step in treatment consists of correcting metabolic abnormalities, discontinuing potential offending pharmaceuticals, and maintaining dextrose-containing fluids, which can adequately supply substrates for production of NADH and NADPH. Methylene blue is an effective treatment for patients with methemoglobinemia because it activates NADPH diaphorase, an enzyme capable of reducing methylene blue to leukomethylene blue, and the latter, via a non-enzymatic pathway, reduces methemoglobin to hemoglobin<sup>9</sup>. The intravenous administration of 1–2 mg/kg methylene blue over a period of 5 minutes is the preferred treatment dose. The response is prompt and a rapid decrease in methemoglobin can be expected within 1 hour. The administration of methylene blue can be repeated if necessary in 30–60 minutes provided the total does not exceed a maximum dosage of 7 mg/kg. It should be noted that excessive administration of methylene blue may produce hemolysis. A low pulse oximetry reading of 87% in an asymptomatic patient with neither cardiovascular nor pulmonary disease upon breathing ambient air was an unexpected finding. We focused our attention on the airway, pulmonary and cardiovascular systems in search of the cause, but nothing remarkable was noted. Because of a mismatch between SaO<sub>2</sub> and SpO<sub>2</sub>, and despite an escalation of oxygen therapy to 100% high-flow oxygen the saturations remained between 89% and 92%, this anomaly alerted us to the possibility of abnormal haemoglobin. A chest radiograph and echocardiogram revealed no abnormality. With the typical presentation of chocolate-brown coloured blood and normal arterial oxygen tension, this patient was likely to have methemoglobinemia. Further pulse oximetry makes use of only two wavelengths (660 nm and 940 nm), it can determine values of only two hemoglobin species- oxyhemoglobin and reduced hemoglobin<sup>10</sup>. The pulse oximetry readings may be inaccurate or not informative if patients have higher levels of methemoglobin, carboxyhemoglobin or other abnormal hemoglobin species. CO-oximetry, using multiple wavelengths, can measure the levels of hemoglobin, oxyhemoglobin, carboxyhemoglobin, and methemoglobin, and can demonstrate values in fractional saturation. In this patient, the diagnosis of methemoglobinemia was confirmed by analysis of methemoglobin, which was found to be 13.6%. Although mild cyanosis is generally the only symptom of type I disease, patients may later develop associated symptoms, such as fatigue and shortness of breath. If an early diagnosis is missed, these patients are likely to present later with a diagnostic conundrum and be subject to extensive investigation. This case represents the success of pulse oximetry screening in the early identification of subclinical hypoxemia in the patient. After the exclusion of other pathologies, a routine investigation of a capillary blood gas provided the information that led to the diagnosis of methemoglobinemia, which allowed for early and effective management. Performing a capillary blood gas analysis can therefore be routinely recommended after a positive pulse oximetry screen result to aid in differential diagnosis. Methemoglobinemia was diagnosed by paediatrician. Because of the stable hemodynamic and absence of metabolic acidosis, the patient's oxygen-carrying capacity could be adequate

### **IV. Conclusion**

Avoidance of exposure to oxidizing agents is important in patients with congenital methemoglobinemia because of their deficient enzymatic pathways and decreased oxygen-carrying capacity. Preoperative considerations for congenital methemoglobinemia include the supplementation of oxygen of higher concentration, examination of methemoglobin by CO-oximetry to determine whether the oxygenation is

adequate, avoidance of the use of oxidizing drugs (such as lidocaine, benzocaine, prilocaine, nitroglycerin), and treatment with methylene blue if methemoglobinemia deteriorates severely. If the patient is not responsive, exchange transfusion should be considered. To deliver safe anesthesia in patients with congenital methemoglobinemia, it is imperative to recognize the nature of this rare disease, and to know how to correctly treat the patient who has sustained oxygen desaturation.

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