Local Perfusion Failure Caused by the Incorrect Attachment of an SpO_2 Sensor During General Anesthesia

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We present a case in which excessive pressure caused local perfusion failure and a decrease in peripheral oxygen saturation (SpO_2) readings in a 10-year-old boy undergoing general anesthesia for a cleft lip and alveolus operation. The pulse oximeter sensor was placed on his left index finger and held in place using adhesive tape before the induction of general anesthesia. Roughly 90 minutes into the operation, his SpO_2 became unstable, decreasing rapidly to 85% and returning to 94% repeatedly. As we suspected a problem with the sensor, it was replaced, and his SpO_2 readings returned to 100%. However, inspection of his index finger revealed dark purple skin near the sensor, indicating constriction of the underlying vessels attributed to excessive pressure from the adhesive tape. Proper sensor placement is crucial for accurate SpO_2 monitoring.

Key Words: Pulse oximeter; Percutaneous arterial oxygen saturation; Hypoxemia; Peripheral hypoperfusion.

Pulse oximetry monitoring is essential during general anesthesia, as it aids in detecting and preventing hypoxemia.[1] However, the accuracy of peripheral oxygen saturation (SpO_2) measurements can be affected by sensor-related factors and peripheral blood perfusion.[2] We describe a case in which local perfusion failure caused a decrease in SpO_2 values.

CASE PRESENTATION

A 10-year-old boy (height, 146 cm; weight, 53 kg; body mass index, 24.9 kg/m^2) with cleft lip and alveolus was admitted to our hospital to undergo alveolar bone graft surgery. Prior to induction, standard anesthetic monitors were applied, which included an OXIMAX N-25 Nellcor Oxisensor III (Covidien Japan) pulse oximeter sensor that was attached to his left index finger using adhesive tape for SpO_2 monitoring (Figure). After induction of general anesthesia, ventilation of the patient was maintained mechanically using a volume-controlled ventilation mode with a fraction of inspired oxygen (FiO_2) ranging from 0.4 to 0.45.

Approximately 90 minutes into the procedure, the patient's SpO_2 became unstable, fluctuating between 85% and 95% repeatedly. At this time, his blood pressure was 81/42 mm Hg, and his pulse was 124 beats/min. This alerted us to a potentially problematic situation; however, appropriate endotracheal tube insertion depth was confirmed via normal lung auscultation bilaterally. No audible leaks were detected, and there were no abnormalities noted within the capnography waveforms. Oxygen was then administered at 6 L/min, increasing the FiO_2 to 0.95, but his SpO_2 remained at 94% to 95%. No airway secretions were aspirated. After we reset the FiO_2 to 0.4, an arterial blood gas analysis was performed, which showed no abnormalities and an arterial oxygen saturation (SaO_2) of 99.1% and a partial pressure of oxygen (PaO_2) of 121 mm Hg. Therefore, we suspected the low SpO_2 values were caused by sensor malfunction. Another pulse oximeter sensor was attached to the patient's left toe, which produced readings ranging from 98% to 100%. We then noticed that the skin at the tip of the patient's left index finger appeared dark and discolored, indicating likely local peripheral circulation failure. A new probe was then attached to the left middle finger, which showed an SpO_2 value of 100%. The case was

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Figure. Pulse Oximeter Probe Used in the Case

This pulse oximeter probe features adhesive tape designed to help probe retention on the patient's finger.

completed without further issues, and the patient recovered from anesthesia and was discharged home.

Upon follow-up, we noted that the discoloration of the fingertips had completely healed. There were no lingering problems with the child's fingers, nor any other long-term problems. At the time of the postoperative visit, perfusion to the left index finger was found to be normal with a capillary refilling time of less than 0.5 seconds and no sensory or motor deficits.

DISCUSSION

Human factors such as inadequate airway management are frequently the cause of hypoxemia detected during general anesthesia.[3] However, critical factors such as airway and ventilation disturbances, improper medication administration, and pulmonary aspiration must also be checked. In this case, an arterial blood gas analysis was performed with an FiO_2 of 0.4, which showed slightly reduced ventilation ($PaCO_2$, 48 mm Hg) but a modestly elevated PaO_2 of 121 mm Hg. This finding was consistent with the increased FiO_2. Furthermore, the PaO_2:FiO_2 ratio was 303, which indicated normal oxygenation efficiency, and the SaO_2 was 99.1%, suggesting that general hypoxemia was not the cause of the decreased SpO_2 values.

Because the pulse oximeter sensor was strongly suspected to be malfunctioning, the patient's fingers were evaluated, at which time it was noted that the finger on which the sensor was attached was discolored. When another pulse oximeter sensor was applied to different sites on the same side (ie, left toe and middle finger), the SpO_2 readings were confirmed to be 100%. It is likely that the adhesive tape was simply too tight, causing excessive pressure and resulting in hypoperfusion as the case progressed. This situation was also likely exacerbated by the lower blood pressures during the case, resulting in inaccurate SpO_2 readings.

Experimental evidence suggests that local hypoperfusion can cause inaccurate SpO_2 values due to reduced blood flow and weakened or absent arterial pulsations. It is also possible that general anesthesia caused vasodilation of peripheral vessels in our patient, and this caused a slight increase in finger volume that ultimately led to constriction of the finger by the restrictive sensor/adhesive tape. This led to decreased circulation in the fingertip and a decrease in SpO_2 values occurring 90 minutes into the operation. However, the patient did not complain about tightness after the sensor was initially placed before induction of anesthesia, nor were abnormal vital signs observed. Inadequate attachment and lack of confirmation also may have led to taping that was too tight.

In cases of suspected pulse oximeter abnormalities, checking the sensor position and the general condition of the tissues where it is attached is crucial, particularly in young patients. Furthermore, when diagnosing a pulse oximeter abnormality, it is important to comprehensively evaluate capnography and other anesthetic monitors for problems while also reviewing the patient's vital signs, such as blood pressure and pulse rate. Considerations for obtaining an arterial blood gas analysis may also be indicated. If an abnormal SpO_2 value is detected, the first thing that should be done is to verify the fit and positioning of the pulse oximeter probe. When applying the pulse oximeter tape-type probe, it is important not to wrap the tape too tightly.

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REFERENCES

1. Lamiell JM. Pulse oximetry. *Probl Crit Care*. 1991;5:44–54.
2. Japanese Respiratory Society. Q & A the handbook of pulse oximetry. In Japanese. Accessed April 8, 2023. https://www.jrs.or.jp/file/pulse-oximeter_medical.pdf
3. Hatori E, Morisaki H. Frequency and causes of hypoxemia—don't talk about anesthesia management without a stable oxygen supply. Article in Japanese. *LiSA*. 2013;20(12):1206–1210.