Intraoperative decrease in pulse oximeter readings following injection of isosulfan blue

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Purpose: Sentinel lymph node mapping, involving injection of isosulfan blue dye around a tumour, is beginning to be used in patients with carcinoma of the breast. Absorption of the dye into the circulation may interfere with pulse oximetry, causing falsely low readings. This report describes changes in pulse oximeter readings following injection of isosulfan blue for sentinel lymph node mapping in a patient with carcinoma of the breast.

Clinical Features: An 83-yr-old female patient underwent sentinel node biopsy of the axilla followed by partial mastectomy for carcinoma of the left breast. Isosulfan blue was injected in the area of the tumour in the left breast. The SpO₂ began to decrease 15 min after dye injection, reaching a nadir of 89-90% 30 min after injection. Arterial blood gas analysis showed normal arterial partial pressure of oxygen. Pulse oximeter readings did not return to normal until more than six hours after dye injection.

Conclusion: Review of the literature reveals a small number of case reports of similar occurrences of low pulse oximeter readings following injection of isosulfan blue or patent blue dye for lymphatic mapping. Data from these reports and the case described here suggest that the latency, magnitude and duration of effect on pulse oximeter readings following injection of these dyes is highly variable. It is important to rule out other causes of low pulse oximeter readings when this effect occurs; normal oxygenation can be verified with arterial blood gas analysis. Co-oximetry can be done to rule out methemoglobinemia as a cause of decreased SpO₂.

Objectif : La cartographie des ganglions lymphatiques de Troisier, comportant l'injection de colorant bleu isosulfane autour d'une tumeur, est utilisée depuis peu dans les cas de cancer du sein. L'absorption du colorant dans la circulation peut interférer sur l'oxymétrie de pouls en causant de fausses valeurs à la baisse. Le présent article décrit ce genre de changements survenus à la suite de l'injection de colorant bleu isosulfane pour la cartographie d'un ganglion de Troisier chez une patiente atteinte d'un cancer du sein.

Éléments cliniques : Une femme de 83 ans a subi, à l'aisselle, une biopsie d'un ganglion de Troisier suivie d'une mastectomie partielle pour un cancer du sein gauche. Du bleu isosulfane a été injecté autour de la tumeur. La SpO₂ a commencé à baisser 15 min après l'injection du colorant et a atteint un creux de 89-90 %, 30 min après l'injection. La gazométrie artérielle a montré une SpO₂ normale. Les valeurs de l'oxymétrie pulsée sont revenues à la normale plus de six heures après l'injection de colorant.

Conclusion : On retrouve peu de cas documentés de baisse semblable des valeurs d'oxymétrie pulsée après l'injection de bleu isosulfane ou de colorant bleu spécial pour la cartographie lymphatique. Les données recueillies laissent croire que le temps de latence, l'importance et la durée de l'effet des valeurs de l'oxymétrie pulsée réalisée après une injection de ces colorants sont très variables. Il faut exclure d'autres causes de la baisse des relevés d'oxymétrie quand cet effet se manifeste; l'oxygénation normale peut se vérifier par la gazométrie artérielle. La co-oxymétrie peut permettre d'écarter la possibilité de méthémoglobinémie comme cause de la baisse de SpO₂.

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PULSE oximetry relies on the differing absorption of red light by oxyhemoglobin and deoxyhemoglobin, allowing calculation of the percentage of hemoglobin that is saturated with oxygen (SpO_2). Any substance which absorbs light in the red wavelengths may interfere with the ability of a pulse oximeter to measure oxygen saturation accurately. Dyes such as methylene blue and patent blue five have been reported to cause artificially low SpO_2 readings.¹⁻⁵

Recently, isosulfan blue (Lymphazurin 1%) has begun to be used to facilitate sentinel lymph node biopsy for carcinoma of the breast. In this technique, dye is injected into the area surrounding the tumour. Dye is absorbed into the lymphatics and causes visible discolouration of the lymphatic channels and nodes draining the area of the tumour. Selective biopsy and histopathological analysis of lymph nodes stained by the dye ("sentinel nodes") may provide diagnostic information of equal value to that provided by more extensive axillary node biopsy. One report has been published of intraoperative decrease in SpO_2 following injection of isosulfan blue into the uterine cervix.⁶ Reports of this dye's ability to affect pulse oximetry during breast surgery have not appeared in the literature to date. Therefore, report of a case in which isosulfan blue was used intraoperatively for sentinel node biopsy for carcinoma of the breast is presented below.

Case report

An 83-yr-old woman with biopsy-proven adenocarcinoma of the left breast was booked to have a sentinel node biopsy of the left axilla followed by a partial left mastectomy. General anesthesia was induced with propofol and fentanyl and maintained with desflurane, oxygen and nitrous oxide. Inspired fraction of oxygen was maintained at 0.40. Muscle relaxation was maintained with rocuronium. The patient was hemodynamically stable and SpO_2 measured with an Ohmeda RGM 5250 analyzer, remained at 98-99%. The surgeon injected 5 ml of 1% isosulfan blue (Lymphazurin 1%, U.S. Surgical Corporation, Norwalk, CT) around the tumour mass, aspirating carefully to avoid intravascular injection. Fifteen minutes after the dye injection, the pulse oximeter reading began to decrease, reaching a minimum of 89-90% 30 min after the injection. Blood pressure and heart rate remained stable. Other causes of intraoperative desaturation such as pneumothorax, malposition of the endotracheal tube or bronchospasm were ruled out clinically. A portion of the patient's face was uncovered, revealing a greyish discolouration of the skin. Arterial blood gas analysis performed 35 min after dye injection revealed a pH of 7.427, PaCO_2 of 39.9 mm Hg, PaO_2 of 190.2 mm Hg, HCO_3 of 26.3 mEq·l⁻¹ and O_2 satu-

ration (SaO_2) of 99.3% with inspired oxygen fraction of 0.4. Co-oximetry was not available.

At the completion of surgery 90 min after the dye injection, SpO_2 was measured as 93%. The patient was stable in the recovery room and was transferred to the surgical ward on oxygen via nasal cannula at 2 l·min⁻¹. Pulse oximetry measurement on the ward showed that the patient's SpO_2 returned to 99% by seven hours following dye injection. The greyish discolouration of her skin was beginning to fade by this time.

Discussion

Pulse oximeters use two wavelengths of light, usually 660 and 940 nm, to determine oxyhemoglobin content of blood via a spectrophotometric process. Pulse oximeters may be unable to accurately determine oxyhemoglobin content in the presence of dyes which absorb red light (for example, isosulfan blue which has its peak absorption at 646 nm),⁶ or in the presence of carboxyhemoglobin or methemoglobin. Measurement of arterial oxygen saturation (SaO_2) and PaO_2 of an arterial blood sample using a blood gas analyzer permits differentiation between decreases in measured SpO_2 due to absorption of the dye into the circulation and true decreases in SpO_2 . In addition, some blood gas analyzers incorporate co-oximeters which use four or more light wavelengths in order to differentiate among oxyhemoglobin, deoxyhemoglobin, carboxyhemoglobin and methemoglobin. Co-oximetry would allow methemoglobinemia to be ruled out as a cause of spurious decreases in SpO_2 . This may be relevant as methylene blue may cause methemoglobinemia when administered in high doses, although there is no mention in the literature of isosulfan blue causing this effect.

Most previous reports of changes in SpO_2 resulting from dyes have described transient decreases in SpO_2 which resolved in minutes,^{1,4} although Morell *et al.* reported a decrease in SpO_2 of several hours' duration following intradermal injection of patent blue dye.⁵ The only other report of changes in SpO_2 after injection of isosulfan blue described a decrease in SpO_2 from 98% to 89-90% beginning five minutes after injection of the dye into the uterine cervix and lasting for 10 min.⁶ In the patient described in the present report, SpO_2 did not return to normal until more than six hours after the dye had been injected. The reason for the longer duration of the dye's effect on SpO_2 in the present case is uncertain. Coleman *et al.*⁶ suggested that, as isosulfan blue is eliminated primarily by biliary excretion, patients with impaired hepatobiliary function may demonstrate prolonged duration of action of effects of the dye when absorbed intravascularly. While liver function tests were not done on the patient described in the present report,

she had no history of hepatic or biliary disease and no clinical findings to suggest that this may have been the case. It is possible that in previous reports the absorption of dye may have occurred over a brief period of time, producing in effect an intravenous bolus of dye, whereas in the present case absorption may have continued over a more prolonged period of time.

The value of sentinel node biopsy in predicting axillary disease in patients with carcinoma of the breast is uncertain. A multicentre NSABP (National Surgical Adjuvant Breast and Bowel Project) study is underway to evaluate this. If the sensitivity and specificity of sentinel node biopsy prove to be high, it is not unreasonable to expect that most axillary node dissections will be replaced by sentinel node biopsies. Therefore, the type of incident described in this report will probably become increasingly common. However, the frequency with which decreased SpO₂ occurs following injection of isosulfan blue into the breast has not been reported.

Finally, although dye absorption may be suspected as the cause of an intraoperative decrease in SpO₂, it is important to rule out causes of real arterial hypoxemia. In the case reported here, checking the F_IO₂ displayed on the Ohmeda 5250 gas analyzer and the O₂ analyzer on the anaesthesia machine did not indicate delivery of a hypoxic gas mixture. Increasing the F_IO₂ to 1.0 to rule out delivery of a hypoxic gas mixture could also be considered, although this was not done in the case reported here. Integrity of the anesthetic breathing circuit should be checked. Inadvertent endobronchial intubation should be ruled out by checking for bilateral breath sounds and verifying that the endotracheal tube is appropriately positioned. A suction catheter can be passed down the tube to rule out kinking or obstruction. Pneumothorax should be ruled out by checking for equal air entry bilaterally, absence of tracheal deviation, and absence of hyperresonance on percussion of the chest. Chest X-ray can be performed if necessary. If pneumothorax is suspected, administration of nitrous oxide should be discontinued and, if tension pneumothorax is suspected, needle decompression of the affected hemithorax should be performed immediately. Breath sounds should be auscultated for expiratory wheeze or prolongation of the expiratory phase, and peak inspiratory pressure and shape of the expired CO₂ waveform should be checked to rule out bronchospasm. Causes of ventilation-perfusion mismatch such as atelectasis or pulmonary edema must be ruled out. The pulse oximeter probe may be replaced or moved to another site on the patient to rule out probe malfunction or poor sensing due to local hypoperfusion or vasoconstriction.

In summary, a case is presented in which intraoperative decrease in SpO₂ occurred following injection of

isosulfan blue dye into the breast for sentinel lymph node mapping. The most likely explanation for this change is absorption of dye into the circulation from the injection site. Arterial blood gases showed PaO₂ and SaO₂ consistent with the oxygen delivery, confirming the suspicion that the pulse oximeter was delivering falsely low readings. However, when intraoperative desaturation occurs, it is important to rule out possible causes of desaturation such as pneumothorax, bronchospasm or endotracheal tube malpositioning. The duration of the effect on SpO₂ in this patient was greater than six hours, much longer than the five minutes duration reported by Coleman *et al.*⁶ following isosulfan blue injection into the cervix. Data from the present case and others reported in the literature^{3,5,6} indicate that, following dye injection for lymphatic mapping, the magnitude and duration of effect on SpO₂ are highly variable.

Addendum

During revision of this case report, another incident of intraoperative desaturation following administration of isosulfan blue for axillary sentinel node mapping was observed in another hospital. The SpO₂ decreased from 99% to 89% despite increasing inspired O₂ from 40% to 100%. Arterial blood gas analysis with co-oximetry was available at this hospital, and showed a PaO₂ of 449 mm Hg and methemoglobin, expressed as a fraction of total hemoglobin, of 0.005 (normal range 0 to 0.020). This demonstrates that co-oximetry was able to rule out methemoglobinemia as a cause of decreased SpO₂ in this patient.

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