PREOXYGENATION AND PULSE OXIMETRY MAY DELAY DETECTION OF ESOPHAGEAL INTUBATION

Alan J. McShane, MB, BSc, and Jackie L. Martin, MD
Baltimore, Maryland

A case of delayed detection of esophageal intubation is described. Preoxygenation and pulse oximetry were used, and the first indication of tube misplacement was arterial desaturation indicated by the pulse oximeter. The combination of preoxygenation and pulse oximetry may contribute to delays in early detection of endotracheal tube misplacement for the following reasons: (1) preoxygenation results in a pulmonary reservoir of oxygen sufficient to maintain arterial hemoglobin saturation for an extended period of time; and (2) the maintenance of normal arterial saturations for an extended period after inadvertent esophageal tube placement may lead the practitioner to initially seek other causes of declining oxygen saturations. Although pulse oximetry is an acknowledged advance in patient monitoring, it must not be utilized as an early indication of correct endotracheal tube placement.

The pulse oximeter (Nellcor R., Hayward, Calif) has proven to be a reliable indicator of arterial hemoglobin oxygen saturation correlating with direct hemoglobin saturation measurements. This reliability has been demonstrated in young healthy volunteers,[1] patients with respiratory disorders and respiratory failure,[2] anesthetized and intensive care unit patients,[3] and during one-lung ventilation.[4] Because pulse oximeters provide continuous information and are noninvasive, reliable, and simple to use, they are becoming increasingly popular, especially in operating rooms and intensive care units. In the operating room they are usually attached to a finger at the beginning of the procedure when the other monitors are being applied. Baseline oxygen saturation is obtained and monitored throughout the operation. This report is of a case of delayed detection of esophageal intubation by pulse oximetry.

From the Department of Anesthesiology and Critical Care Medicine, The Johns Hopkins Medical Institutions, Baltimore, Maryland. Requests for reprints should be addressed to Dr. Alan J. McShane, Department of Anesthesiology and Critical Care Medicine, The Johns Hopkins Hospital, 600 N. Wolfe Street, Baltimore, MD 21205.

CASE REPORT

A 70-year-old black woman was admitted to the hospital for a Whipple procedure for carcinoma of the head of the pancreas. Her medical history included a 10-pack per year history of cigarette smoking, diet-controlled adult-onset diabetes mellitus, and peptic ulcer disease that had been treated surgically 26 years prior to this admission. The patient was receiving no regular medications.

Preoperative laboratory values and electrocardiogram (ECG) were unremarkable with the exception of a markedly elevated alkaline phosphatase and elevated bilirubin levels. Chest x-ray films revealed scattered calcified granulomas, a tortuous aorta, and slight cardiomegaly.

Physical examination revealed an alert, afebrile, and cachectic woman. Her blood pressure was 110/

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50 mmHg, pulse rate was 64 beats per minute, respiratory rate was 14/min, and she weighed 37.5 kg. She had moderate limitation of neck extension, a shortened lower jaw, and fixed upper dental bridges without limitation of oral opening. Cardiorespiratory examination was normal while abdominal examination revealed mild hepatomegaly. The patient was evaluated as an American Society of Anesthesiologists (ASA) III surgical candidate.

Following premedication with diphenhydramine 25 mg intramuscularly, the patient was taken to the operating room where an ECG monitor was attached and arterial and CVP monitoring lines were inserted in the left radial artery and left basilic vein, respectively. A digital pulse oximeter was applied to the middle finger of the left hand, and an uninterrupted digital readout of oxygen saturation was obtained. After preoxygenation, 50 μg of fentanyl and 1 mg pancuronium bromide were given intravenously. Anesthesia was induced with thiopental sodium 200 mg and succinylcholine 40 mg was given to facilitate intubation. The patient was easily ventilated by face mask.

Following an initial unsuccessful attempt at intubation, the trachea was thought to have been successfully intubated. Chest expansion upon manual ventilation appeared adequate and symmetrical, equal breath sounds were heard bilaterally, and the endotracheal tube was secured. The patient was then given an additional 4 mg of pancuronium bromide, connected to the ventilator, and turned into the left lateral decubitus position to facilitate placement of a thoracic epidural catheter for intraoperative and postoperative analgesia. While the catheter was being secured, approximately six minutes after intubation, the patient's oxygen saturation began to decrease. The endotracheal tube was withdrawn a few centimeters, as the initial thought was that it may have been displaced into a mainstem bronchus while positioning the patient, and the patient was ventilated with 100 percent oxygen. This maneuver, however, did not correct the oxygen saturation, which at this time was 70 percent. The patient was placed supine, the endotracheal tube removed, and ventilation with 100 percent oxygen through a mask was initiated. The patient's saturation at this stage was 30 percent, but ventilation with 100 percent oxygen through a mask returned it to 100 percent within one minute.

Initially, during this episode, the patient's pulse and blood pressure were stable at 80 beats per minute and 105/70 mmHg, respectively. During the rapid desaturation, the pulse increased to 95 beats per minute and the blood pressure to 180/100 mmHg; 100 percent oxygen and enflurane returned saturation to 100 percent, controlling both pulse and blood pressure. Oral intubation was then attempted again by another anesthesiologist, but the vocal cords were not visualized. Despite various maneuvers, the trachea could not be intubated in the usual fashion. A nasal fiberoptic-assisted intubation was required and was accomplished without great difficulty. A nasogastric tube was passed to facilitate deflation of the stomach, and the surgery proceeded uneventfully. Postoperative neurologic assessment was normal. The patient exhibited no recall of the aforementioned events. She made a good recovery and was discharged home 17 days later.

DISCUSSION

Failure to intubate the trachea, resulting in esophageal intubation, is a well-recognized cause of morbidity, and occasionally mortality, during anesthesia.[5,6] The most important factor in avoiding associated morbidity or mortality following such intubation is its early recognition and correction. Signs of successful tracheal intubation include visualization of the passage of the endotracheal tube through the vocal cords, symmetrical chest movement on compression of the reservoir bag in the anesthesia circuit, and bilateral air entry heard on auscultation at the lung apices and bases. The first of these was not possible as the cords were not seen at laryngoscopy. The other signs, however, were present, but, as previously reported,[3] these signs are not always reliable. Instruments that have proven useful in the early detection of esophageal tube misplacement include end-tidal carbon dioxide and transcutaneous oxygen tension monitors. While use of the former gives the quickest confirmation of endotracheal intubation, use of the latter at the beginning of the case would also indicate misplacement of the tube, as the partial pressure of oxygen falls long before hemoglobin saturation is affected. This device, however, has well-recognized limitations of its own.[7,8] Pulse oximetry following preoxygenation will not immediately indicate that the esophagus has been intubated, as hemoglobin may remain saturated for several minutes.

It has been shown that well-oxygenated, healthy volunteers can tolerate eight minutes of apnea.[9] Under general anesthesia with neuromuscular blockade, the metabolic rate is lower than normal and may fur-

ther prolong the period for which patients may remain apneic. The pulse oximeter measures arterial hemoglobin oxygen saturation, and because of the current widespread practice of preoxygenation prior to intubation, it may be many minutes after a misplaced intubation before saturation begins to fall. Because of this prolonged time interval with continued good oxygen saturation being recorded following intubation, misplacement of the endotracheal tube may not initially be suspected when oxygen saturation begins to decrease. The authors initially suspected endobronchial intubation because the patient had been placed in the lateral decubitus position while colleagues suspected failure of oxygen supply as the cause. Another possibility is dislodgement of a correctly placed endotracheal tube upon turning the patient. This possibility, however, seems unlikely based upon questioning of the participants. Such delays can potentially be fatal.

There is an increasing awareness that a substantial number (50 to 75 percent) of the approximately 2,000 anesthetic-related deaths each year in this country are preventable.[10,11] Indeed, most anesthetic mishaps appear to result from failure to recognize or adequately cope with a problem. A detailed analysis of the underlying causes of anesthetic morbidity and mortality demonstrate a significant reduction could be expected by routinely incorporating the concept of fail-safe monitoring.[12] Behind this concept lies the realization that clinical and machine errors can occur but that the presence of additional monitors decreases the likelihood of such events going undetected.

The pulse oximeter was the first indicator of esophageal intubation in this patient and contributed to the prevention of an adverse outcome. It is undoubtedly quicker to detect hemoglobin desaturation than the clinical sign of cyanosis, especially in many black patients.

Discussion with colleagues leads us to believe that normal pulse oximetry saturations, post-intubation, are often taken as corroborative evidence of successful endotracheal tube placement. It must be borne in mind that following preoxygenation, pulse oximetry is a reliable but late indicator of esophageal intubation. Diligent clinical observation, combined with end-tidal carbon dioxide monitoring, provides early confirmation of endotracheal tube placement.

The concept of, and need for, a fail-safe system for monitoring patients under anesthesia is gaining increasing acceptance. Pulse oximetry is far down the list of maneuvers and monitors used to indicate endotracheal tube placement. This report, however, does illustrate the usefulness of a battery of monitors, which decreases the absolute reliance on any one observation or measurement. Pulse oximeters have been utilized throughout The Johns Hopkins Hospital for the past several years and, as evidenced by this case report, have proven to be reliable fail-safe monitors. They give accurate and reliable information, are noninvasive, and easy to use. As such, pulse oximeters should be used in operating rooms at all times, recognizing the value of the information obtained while also acknowledging the limitations.

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