Elevated End-tidal Carbon Dioxide during Thoracoscopy:
An Unusual Cause

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THE advent of video-assisted thoracoscopy has simplified the diagnosis and treatment of many disease states while allowing physicians to avoid the morbidity associated with open thoracotomy. Carbon dioxide insufflation often is used to assist the surgeon in maintaining adequate exposure. We report a case in which the use of carbon dioxide resulted in an artifactual increase of end-tidal carbon dioxide tension.

Case Report
A 46-year-old male patient previously in good health presented to our institution with an incidental x-ray finding of a mass in the apex of his right lung. Past medical history was unremarkable except for a 35 pack/yr history of smoking. He had undergone two computed tomography-guided needle biopsies, both of which were nondiagnostic, and video-assisted thoracoscopy and biopsy was planned.

In the operating room, a left radial arterial catheter was inserted, as was a lumbar epidural for postoperative analgesia. Anesthesia was induced with fentanyl, midazolam, and thiopental, and muscle relaxation was achieved with vecuronium. Anesthesia was maintained with isoflurane in 100% O₂. Pulse oximetry, end-tidal carbon dioxide tension (EtCO₂), and end-tidal volatile agent concentration were measured using an Ohmeda 5250 RGM gas monitor. The initial plan was to insert a Mallinckrodt BronchoCath 41F left double-lumen tube.

On laryngoscopy, the larynx was found to be unexpectedly anterior, making placement of the endobronchial tube difficult, and an 8.0 mm Pycon Univent Inoue tube was inserted. Bilateral and equal breath sounds were heard. Fiberoptic bronchoscopy was performed, and the right main bronchus cannulated easily with the bronchial blocker. The short length of the patient’s right main bronchus was noted at this time. The patient was turned to the left lateral decubitus position, the bronchoscope was reinserted, and the bronchial blocker inflated. Because of the proximate takeoff of the right upper lobe (RUL), the bronchial blocker had to be repositioned several times to achieve isolation of the RUL, and some herniation of the balloon into the carina seemed unavoidable. The thoracoscope was introduced, and the lumen of the bronchial blocker opened to atmospheric pressure. The right lower and middle lobes began to collapse immediately. There was no ventilation of the RUL noted on the video monitor; however, as suspected from the position of the blocker, the RUL collapsed very slowly, if at all. Carbon dioxide was introduced into the right pleural cavity to a pressure of 11–12 mmHg, and the RUL collapsed easily. The surgical team then began to dissect the area in question at the right apex, which was adherent to the chest wall and contained numerous bullae.

Shortly thereafter, the capnometer, which had been reading 35 mmHg EtCO₂, began intermittently to show EtCO₂ tensions in the 70–108 mmHg range. The pattern on the capnometer was quite unusual, as several sequential tidal volumes with the increased carbon dioxide readings were interspersed with tidal volumes showing the previous normal value of 35 mmHg. Inspired carbon dioxide remained at zero. Breath sounds were checked immediately and heard clearly throughout the left chest. A sample of arterial blood was drawn and sent for analysis. The first thought was that this represented a mechanical artifact, and a new capnometer was brought into the operating room. This second capnometer showed a pattern identical to that of the first. Oxygen saturation was unchanged at 99–100%, as were blood pressure and pulse at 120–130/60 mmHg and sinus rhythm 60–70 beats per minute, respectively. The blood gas results returned shortly thereafter, with pH of 7.33, a carbon dioxide tension of 44 mmHg, a partial pressure of oxygen of 298 mmHg, and a bicarbonate concentration of 24 mEq/l. At this point it was thought the capnometer was detecting exogenous carbon dioxide from the pleural space, and the surgical team was so informed. The increased carbon dioxide readings continued, becoming more frequent until they were nearly constant for a few minutes, at which point the surgeons staped the area on which they were working. Only after this was accomplished did the EtCO₂ decrease. Visibility beyond the adhesions proved very difficult, and the decision was made to perform open thoracotomy. During further dissection was performed, large
systemic vessels were noted inside the mass which appeared to originate from the parietal pleura. We obtained a biopsy sample, which revealed scar tissue but showed no sign of tumor. Hemostasis was obtained, two chest tubes were inserted, and the chest was closed. Five mg of preservative-free morphine in 10 ml saline was injected via the epidural after negative aspiration. Emergence was uneventful, the trachea was extubated, and the patient was transferred to the postanesthesia care unit in stable condition.

Discussion

The introduction of carbon dioxide into the pleural cavity is often used to facilitate thoracoscopy. Systemic absorption of carbon dioxide during this procedure has not been studied but has not been reported to cause significant systemic hypercarbia. The absorption of carbon dioxide during laparoscopy recently has been shown to result in a slow, steady increase in EtCO_2_ to a plateau value, which is maintained as long as carbon dioxide is insufflated. The pattern of EtCO_2 we observed differed markedly from that seen in laparoscopy. Tidal volumes with EtCO_2 values of 80–108 mmHg were interspersed randomly with the preexisting values of 30–35 mmHg. The detector in the Ohmeda 5250 gas monitor saturates at 15% CO_2_, which is very close to our observed maximum reading of 108 mmHg.

Both postmortem and in vitro studies have shown marked variability in the length of the right main bronchus. Placement of the Univent’s blocker in the right main bronchus so that it herniates slightly into the RUL bronchus is recommended to secure its position for right-sided procedures. The shorter the length of the right main bronchus, the more difficult it will be to isolate the RUL without herniation of the blocker into the carina, and in the extreme case, this may be unavoidable. The quality of the RUL seal may be affected adversely by a short right main bronchus. In our case, the dissection at the right apex opened a communication between the pleural space and the RUL bronchus, allowing carbon dioxide under pressure to leak around the blocker balloon into the trachea where it was detected by the capnometer (fig. 1). Obviously, this also could occur with a left double-lumen tube during a left-sided procedure if the endobronchial cuff is too distal and fails to occlude the origin of the left upper lobe. It is interesting to note that had a left double-lumen tube been used in our case, carbon dioxide exiting the right main bronchus would have escaped undetected.

This case carries several implications for the management of patients undergoing carbon dioxide insufflation to facilitate thoracoscopy. First, the differential diagnosis of a sudden increase in EtCO_2 should be expanded to include the possibility of exogenous carbon dioxide from the pleural space entering the bronchi. Arterial blood gases can be used to differentiate the latter phenomenon from that caused by high venous carbon dioxide tension. It would seem prudent to check this before any manipulation of the endobronchial tube or blocker is performed. Second, a fluctuating EtCO_2 during insufflation may indicate malposition of the endobronchial portion of either device.

In summary, if a communication between the pleural space and the bronchi is preexisting or is created during the course of thoracoscopy, exogenous carbon dioxide may be detected by the capnometer. The intermittent nature of increased EtCO_2 readings in our case made us suspect the exogenous source of carbon dioxide, but the increased EtCO_2 just as easily could have been constant. The combination of a short right main bronchus and the use of a Univent tube during right tho-

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1 Univent tube package insert. Fuji Systems, Tokyo, Japan.
Racoscropy may predispose a patient to this phenomenon, as could distal placement of the endobronchial cuff of a left double-lumen tube during left thoracoscopy. Therefore, increased EtCO₂ during thoracoscopy may not reflect arterial carbon dioxide tension if carbon dioxide insufflation is being used.

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References