Anesthesia for Endoscopy

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KEYWORDS

• Pneumoperitoneum • Gas embolism • One-lung ventilation • V/Q mismatch • Capnothorax • CO_2

KEY POINTS

- Anesthetists should focus on only anesthetic management and not be distracted by setting up the endoscopic equipment.
- No single anesthetic protocol has proved superior to other protocols for endoscopic surgery.
- Insufflation induces significant cardiovascular and respiratory changes.
- One-lung ventilation devices should be placed with a bronchoscope.

INTRODUCTION

Compared with laparotomy or thoracotomy, endoscopic surgery in human and veterinary patients has been shown to have multiple benefits, including reduction of the stress response, better respiratory function postoperatively, less postoperative pain and discomfort, and shorter stay in hospital.[1–7] Endoscopic surgery has disadvantages, such as limited visualization of the surgical field, longer duration of surgery, pathophysiologic changes caused by insufflation of gas into the abdominal cavity, and difficulty in evaluating the amount of blood loss, but the benefits overcome these disadvantages.[7–9] For these reasons, endoscopic surgery has become popular in veterinary medicine despite equipment costs.

Endoscopic surgery can be classified as an elective procedure or a nonelective procedure. Elective procedures, such as gastropexy and ovariectomy, are usually performed on young healthy patients. Although anesthetic management on these patients seems simple and straightforward, endoscopic surgery can induce significant systemic changes even in healthy patients and may be associated with complications.[8–10]

Patients undergoing nonelective procedures, such as adrenalectomy, cholecystectomy, portosystemic shunt ligation, lung lobectomy, mass biopsy, and liver biopsy, often have comorbidities. These patients have the same or worse systemic changes

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compared with healthy patients, and the rate of complications might be higher than in healthy patients. In addition to these concerns associated with endoscopic surgery, patients' comorbidities affect anesthetic management adversely.[11]

Anesthetists must understand the possible systemic changes and complications that are associated with endoscopic surgery before anesthetizing any patient, even a healthy one. Although it is important to know how comorbidities affect anesthetic management, this article focuses only on anesthetic management of patients undergoing endoscopic surgery and specifically on the systemic changes and complications that can occur.

EFFECT OF PNEUMOPERITONEUM

Endoscopic surgery, especially laparoscopic procedures, requires insufflation of a gas such as helium, argon, nitrous oxide, or carbon dioxide (CO_2) into the abdominal cavity to improve visibility of the surgical field.[9,12,13] CO_2 is the gas most commonly used because it has ideal characteristics: it quickly dissolves in blood, so large amounts can be stored in the blood thus reducing the likelihood of CO_2 thromboembolism; CO_2 is quickly eliminated by exhalation through the lungs; there is no anesthetic effect at clinical concentrations; it is noninflammable; and it does not irritate tissues.[8,9,14] Insufflation of the abdominal cavity with any gas produces pneumoperitoneum, and requires special equipment and techniques.

After placement of a needle or first port using a closed technique (Veress needle) or open technique (Hasson technique), gas insufflation is started before placing the next port. Insufflation creates more space between the body wall and abdominal organs, thus reducing the incidence of abdominal organ damage associated with port placement.

As gas insufflation proceeds, intra-abdominal pressure (IAP) increases. IAP is one of the most critical aspects of laparoscopic surgery because increased CO_2 levels and IAP induce hemodynamic and ventilatory changes.[8,9] During insufflation, IAP and gas flow rate should be monitored closely and adjusted as needed to avoid high pressures.

High IAP induces peripheral vasoconstriction and increases arterial blood pressure.[8,9] This vasoconstriction is caused by the release of neurohormonal factors such as vasopressin and catecholamines.[8,15,16] Increased IAP also compresses the abdominal venous system, which reduces return of blood to the heart.[9] These two effects have been shown in human patients to decrease cardiac output by 20% to 42%.[9,17,18] These hemodynamic changes are most likely to occur when IAP is more than 12 mm Hg in dogs.[19]

Increase of IAP displaces the diaphragm cranially, which reduces lung compliance and functional residual capacity (FRC).[8,9] These changes also increase physiologic dead space in the lung because of ventilation and perfusion (V/Q) mismatch. Therefore, increasing minute ventilation is necessary after inducing pneumoperitoneum to prevent hypoventilation or hypoxemia.[9]

When pneumoperitoneum is created by insufflating CO_2, the CO_2 diffuses through the peritoneum and into vessels where it is absorbed by blood; this results in increasing partial pressures of CO_2 in arterial blood (Pa_{CO_2}), which causes acidemia.[8] Usually, the amount of CO_2 taken up through the peritoneum is too small to cause severe acidemia, but, if peritoneal microvascular damage occurs or blood vessels in the peritoneal cavity are lacerated during insertion of the ports or organ manipulation, CO_2 can diffuse directly into the blood, which can induce severe acidemia.[9]

Brain and renal function can also be affected by pneumoperitoneum. There is a direct correlation between cerebral blood flow (CBF) and intracranial pressure (ICP); as CBF