Subcutaneous emphysema and potential airway compromise in laparoscopic-assisted procedures: A case report

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A case report involving the formation of subcutaneous emphysema in close proximity to the trachea in an ASA physical status I patient is reported. The patient presented for a routine laparoscopic-assisted cholecystectomy with carbon dioxide insufflation. Anesthetic management was unremarkable during the first 2 hours of the procedure.

As the case was being concluded, supraclavicular edema with crepitus was noted about the neck and chest region. Peak airway pressures during the procedure ranged from 18 to 34 cm H2O and ETCO2 briefly reached a peak of 42 mmHg. Evaluation of the airway revealed substantial supraglottic edema with encroachment around the endotracheal tube. The patient was kept intubated and sedated and observed in the surgical intensive care unit. The subcutaneous emphysema subsequently resolved over a course of 14 hours.

The patient was extubated without difficulty and there was no further sequelae noted. Possible mechanisms of subcutaneous emphysema and related sequelae are presented along with a discussion of airway assessment and postoperative airway management.

Key words: Anesthesia complications, laparoscopic surgery, subcutaneous emphysema.

Introduction

The recent explosive growth of laparoscopic-assisted procedures has led many surgeons to re-evaluate their surgical approach to intra-abdominal procedures. Many view laparoscopy as a benign procedure, but it is not without associated complications. Among the major complications are gas embolism, bowel perforation, pneumothorax, pneumomediastinum, hemorrhage, and subcutaneous emphysema. The case reported here involves an ASA physical status I patient undergoing an elective laparoscopic cholecystectomy who developed bilateral supraclavicular subcutaneous emphysema. On direct inspection of the airway, substantial supraglottic edema was noted and the decision was made to leave the patient intubated postoperatively.

The intent of this case study is to inform anesthesiists of potential airway complications resulting from subcutaneous emphysema in and around airway structures. The potential etiology for subcutaneous emphysema and related sequelae in relation to laparoscopic procedures will also be reviewed.

Case summary

A healthy ASA physical status I, 59-kg, 46-year-old female presented for laparoscopic cholecystectomy with intraoperative cholangiogram. Her medical and surgical history were unremarkable. All preoperative laboratory values were within normal limits. No preoperative medications were given. The patient was monitored using pulse oximetry, five-lead electrocardiogram with ST seg-
Discussion

As the use of laparoscopy with CO₂ insufflation becomes the standard of surgical therapy for intraabdominal procedures, complications associated with these procedures may be seen more frequently. The incidence of major complications, such as hemorrhage, gas embolism, cardiovascular collapse, pneumothorax, pneumomediastinum with subcutaneous emphysema, perforation of viscera, and peritonitis, have been reported to vary from 0.6% to 2.4%.

Subcutaneous emphysema is a complication of various etiologies. It can result from endotracheal intubation, positive pressure ventilation, and/or induced pneumoperitoneum during laparoscopic procedures. Subcutaneous emphysema resulting from endotracheal intubation is usually associated with lung abnormalities, such as congenital or acquired bullae and/or the use of high inspiratory pressures resulting in pneumothorax.

Subcutaneous emphysema that results from pneumoperitoneum from CO₂ insufflation can develop from various mechanisms. First, the improper placement of the Verres needle that does not completely penetrate into the peritoneal cavity prior to insufflation can lead to an accumulation of CO₂ in the subcutaneous tissue or between the fascia and the peritoneum. The incidence of this complication ranges from 0.43% to 2%. Second, CO₂ may also dissect into the subcutaneous tissue through a trochar site after a pneumoperitoneum has been established. In this mechanism, subcutaneous emphysema of the neck, face, and chest wall usually occurs in conjunction with pneumomediastinum and/or pneumothorax. This is attributed to the passage of the insufflated gas through weak points or defects in the diaphragm. A third mechanism involves the insufflated gas dissecting along the aorta and inferior vena cava openings in the diaphragm which could cause pneumoretroperitoneum.

The presentation of subcutaneous emphysema without pneumothorax can most likely be attributed to insufflation into the subcutaneous tissue during the initial needle puncture or to the partial withdrawal of the trochar from the abdominal wall during the procedure. Excessive manipulation, rotation, or angulation of the trochar from the original plane of its insertion could also cause gas to escape from the peritoneum. A fourth mechanism involves excessive intra-abdominal pressures. The pressure should generally be maintained in the range of 10 to 20 mmHg. Higher pressures may predispose the patient to the development of subcutaneous emphysema by creating an excessive pressure buildup, therefore exacerbating the po-
pential for dissection of CO₂ out of the peritoneal cavity.¹

The development of automatic insufflation devices to regulate insufflation pressures may lead to a decrease in the vigilance of monitoring the intra-abdominal pressures. The device is set with pressure limits, and insufflation stops when these limits are reached. However, cases have been reported where intra-abdominal pressure devices continue to insufflate to undesirable pressure.²⁸⁹

In the case presented, intra-abdominal pressures remained in the high normal range, not exceeding 18 mmHg. Anesthetists must be alert to the fact that surgeons may try to compensate for difficult or poor exposure by setting the insufflation device on the continuous maximum flow mode. Thus, continuous monitoring of intra-abdominal pressure and peak airway pressures are essential. Adequate neuromuscular blockade is also essential to provide an optimally compliant abdominal wall, and thus minimize large increases in intra-abdominal pressures and peak inspiratory pressures.³⁴

Recommendation

The formation of subcutaneous emphysema demands prompt evaluation of the patient's respiratory status. To rule out pneumothorax and/or pneumomediastinum, bilateral breath sounds should be auscultated. Evaluation of endotracheal tube placement must be verified, CO₂ wave analysis should be conducted, and arterial blood gas analysis may be required. The surgeon should laparoscopically inspect the diaphragm for defects and prepare to promptly conclude the procedure. Further evaluation should also include chest and abdominal x-rays to confirm or exclude other pathology, such as pneumomediastinum or pneumothorax.

The patient with bulleia or emphysematous disease may be predisposed to a pneumothorax secondary to the higher inspiratory pressures caused by the pneumoperitoneum. If such a history exists, N₂O should be avoided and inspiratory pressures carefully monitored. In the presence of a pneumothorax, N₂O should be immediately discontinued, the pneumoperitoneum deflated, and the need for needle thoracostomy entertained.

During laparoscopy, the insufflation gas is CO₂, which diffuses approximately 20 times more readily than O₂, making subcutaneous emphysema often evanescent in nature. However, in some cases, the subcutaneous emphysema may compromise the airway for routine extubation. Laryngoscopy with direct visualization of the supraglottic structures in combination with fiberoptic visualization of the subglottic structures is necessary for airway analysis and management.

This case study reinforces the fact that a thorough airway and respiratory evaluation is mandatory in the presence of subcutaneous emphysema about the head, neck, and chest region. Supraglottic and subglottic edema requires detailed evaluation and treatment to minimize the potential for airway compromise.

REFERENCES


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(rocuronium bromide) Injection should be administered in carefully adjusted dosages by or under the supervision of experienced clinicians who are familiar with the use of neuromuscular blocking agents. Use of this drug requires regular monitoring of the patient to document recovery and antagonism of neuromuscular blockade. The use of a peripheral nerve stimulator to monitor drug response need for additional relaxation and adequacy of spontaneous recovery or antagonism.

ZEMURON has no known effect on consciousness, pain threshold, or cerebrovascular tone. Therefore, its administration must be accomplished by adequate anesthesia or sedation.

In patients with myasthenia gravis or myotonic (Eaton-Lambert) syndrome, small doses of nondepolarizing neuromuscular blocking agents may have profound effects. In such patients, peripheral neuro-monitoring and use of sympathomimetic drugs may be necessary to protect the patient from respiratory depression.

There are no controlled studies documenting the use of ZEMURON (rocuronium bromide) administered after a 1 mg/kg dose of succinylcholine when T1 returned to 75% of control was 36 minutes (17–51, n=12) without succinylcholine. Use of inhalation anesthetics has been shown to enhance the activity of other neuromuscular blocking agents. Clinicians should be familiar with early signs, confirmatory diagnosis and treatment of adverse experiences in greater than 1% of patients:—NONE

Adverse experiences in less than 1% of patients:—NONE

Proteins A and B have been described for infants receiving neuromuscular blocking agents, due to the limited role of the kidney in the excretion of ZEMURON (rocuronium bromide). Injection under isoflurane and/or nitrous oxide anesthesia. Under such circumstances the management is the same as that described for development of this resistance is not known, receptor up-regulation may be a contributing factor (see Drug Interactions).

None known.

Antagonism of Neuromuscular Blockade

ANTAGONISTS (such as NEOSTIGMINE) should not be administered prior to the demonstration of spontaneous recovery from neuromuscular blockade. The use of a nerve stimulator to document recovery and antagonism of neuromuscular blockade is recommended. For the drug to achieve onset of effect.

Drug Interactions: The use of ZEMURON (rocuronium bromide) injection before succinylcholine, for the purpose of attenuating some of the side effects of succinylcholine, has not been studied. If ZEMURON is administered following administration of succinylcholine, it should be given only if prolonged paralysis is anticipated. If ZEMURON is 0.6 mg/kg administered after a 1 mg/kg dose of succinylcholine when T1 returned to 75% of control was 36 minutes (range: 17–51) vs. 47 minutes (25 to 75% of control) in ral duction of patients 27 to 11 minutes was similar to 28 to 20 minutes in normal patients (see Pharmacokinetics subsection of CLINICAL PHARMACOLOGY).

Laboratory Tests: None known.

DRUGS: the use of ZEMURON (rocuronium bromide) injection in children less than 3 months of age has not been studied. See Pharmacodynamics subsection of CLINICAL PHARMACOLOGY and Use in Pediatrics subsection of DOSAGE AND ADMINISTRATION for clinical experience and recommendations for use in infants and children. Adverse reactions:

Adverse reactions which influence the therapeutic action of ZEMURON (rocuronium bromide) agents such as ZEMURON (rocuronium bromide) injection include certain antibiotics (e.g., amphenicloids; vancomycin; tetracyclines; bacitracin; polymyxins; colistin and sodium colistimethate). If these antibiotics are administered in conjunction with ZEMURON, prolongation of neuromuscular block should be considered a possibility.

Other: Experience concerning injection of quinidine during recovery from use of other muscle relaxants suggests that quinidine may delay recovery. This possibility must also be considered for ZEMURON (rocuronium bromide) injection.

ZEMURON-induced neuromuscular blockade was modified by alkalosis and acidosis in experimental pigs. The spontaneous recovery rate from neuromuscular block is observed, further recovery may be facilitated by administration of a peripheral nerve stimulator to monitor drug response need for additional relaxation and adequacy of spontaneous recovery or antagonism.

INDIVIDUALIZATION OF DOSAGE:

Drug/Laboratory Test Interactions: None known.

Carcinogenesis, Mutagenesis, Impairment of Fertility: Studies in animals have not been performed to evaluate potential carcinogenic, mutagenic, or fertility effects of ZEMURON (rocuronium bromide) injection. Since several drugs (e.g., phenytoin, carbamazepine or phenytoin) also exhibit these properties, some cross-reactivity of the mechanisms of these effects may be expected, clinically significant, or thought to be histamine related.

Digestive: nausea, vomiting

Respiratory: bronchospasm, respiratory depression, respiratory arrest

Cardiovascular: arrhythmia, abnormal electrocardiogram, tachycardia

None known.

None known.

There are studies (doses tested) involving intravenous administration with only a slight irritation of surrounding tissues observed and acid-base imbalance are usually mixed, either enhancement or inhibition may occur. Magnesium salts, administered for the management of tachyarrhythmia, may enhance neuromuscular block.

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Adverse experiences in less than 1% of patients:—NONE

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ADVERSE REACTIONS: Clinical studies in the U.S. (n=1,137) and Europe (n=1,394) totaled 2,531 patients. Prolonged neuromuscular blockade was associated with neuromuscular blocking agents as a class. Prolonged neuromuscular block (166 minutes) occurred after 0.6 mg/kg ZEMURON (rocuronium bromide) injection in a obese 67-year-old female with hepatic dysfunction who had undergone coronary bypass surgery. The patients explored in the U.S. clinical studies provide the basis for calculation of adverse reaction rates. The following adverse experiences were reported in patients administered ZEMURON (rocuronium) injection (all events listed by investigators during the clinical trials have to have a potential for the drug to achieve onset of effect.

Drug/Laboratory Test Interactions: None known.

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