Clinical Reports

Intraoperative complications of laparoscopic cholecystectomy

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We report a series of intraoperative complications of laparoscopic cholecystectomy. Three cases are presented in which subcutaneous emphysema associated with pneumomediastinum, pneumoscrotum, and pneumothorax with pneumomediastinum and ocular emphysema, respectively, developed intraoperatively. These events resulted in no major morbidity to these patients. Use of N₂O and monitoring of airway and intra-abdominal pressures are discussed.

Nous rapportons une série de complications survenues pendant la cholécystectomie laparoscopique. Il s'agit de trois cas d'emphysème sous-cutané, tous survenus pendant l'intervention, dont le premier était associé à un pneumomédiastin; le deuxième à un pneumoscrotum; et le troisième à un pneumothorax accompagné d'un pneumomédiastin et d'un emphysème oculaire. Ces incidents n'ont pas causé de complications majeures. L'utilisation du N₂O et le monitoring des voies respiratoires et de la pression abdominale sont discutés.

Laparoscopic cholecystectomy has revolutionized the surgical management of patients with symptomatic cholelithiasis. Its advantages include diminished postoperative pain and wound infections, more rapid recovery of pulmonary function, shorter hospitalization and the associated reduced cost, more rapid return to full activity and superior cosmetic result.^{1,2} The first case report of the anaesthetic considerations for this procedure has been reported recently.³

Key words

COMPLICATIONS: pneumomediastinum, pneumoscrotum, pneumothorax, subcutaneous emphysema;
SURGERY: laparoscopy.

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Despite these favourable reports, there are no large-scale prospective comparative trials of this technique versus open cholecystectomy, and little literature on complication rates.⁴

We would like to report a series of three cases of intraoperative complications resulting from the pneumoperitoneum which is created surgically to facilitate laparoscopic cholecystectomy.

Case #1

A 28-yr-old woman suffering from chronic cholecystitis was admitted for laparoscopic cholecystectomy. There was a past medical history for asthma triggered by chemicals in the work environment, of angioedema, and migraine headaches. Her medications on admission were salbutamol, budesonide, loratadine, terfenadine, hydroxyzine, fiorinal-codeine, and domperidone. She had multiple drug allergies which included penicillin, sulphonamides, dextrometorphan, and diphenhydramine. She was a non-smoker, and had had an uneventful anaesthetic for cervical rib resections for thoracic outlet syndrome. Physical examination was unremarkable; weight was 70 kg, and her height 168 cm.

The patient was premedicated with lorazepam 2 mg sublingually and was given salbutamol aerosol one hour before surgery. Routine monitors (ECG, pulse oximetry, noninvasive blood pressure) were placed, and anaesthesia was induced with droperidol 1.25 mg, fentanyl 150 µg, midazolam 2 mg, d-tubocurarine 3 mg, and ketamine 200 mg iv. Ketamine was chosen for induction to prevent reflex bronchospasm. Succinylcholine 120 mg was given to facilitate tracheal intubation. Anaesthesia was maintained with 60% N₂O in oxygen and isoflurane 0.5–2% to maintain normotension. Pancuronium provided muscle relaxation. The initial ventilator settings using a Mapleson D circuit were tidal volume of 700 ml, frequency of 12 per minute, fresh gas flow (FGF) of 4.5 L · min⁻¹, and inspiratory pressure (IP) of 20/0 cm H₂O. Capnography was instituted with induction of anaesthesia. Hydrocortisone 100 mg was administered for perioperative steroid coverage. A Foley catheter was inserted, as well

FIGURE 1 Case #1: Lateral chest x-ray showing radiolucency with the consistency of air between the anterior chest wall and cardiac silhouette (solid arrow).

as an orogastric tube connected to low wall suction to decompress the stomach prior to inserting the trochar. The patient was prepared, draped, and placed in lithotomy and reverse Trendelenberg position with 10° left lateral tilt. The operation was commenced without difficulty. Inspiratory pressure (IP) increased to 28/0 cm H₂O with insufflation of CO₂. Approximately 50 min after the start of the procedure, the patient developed a sinus tachycardia and a slight increase in blood pressure. Although she became normotensive with deepening of the anaesthesia, the sinus tachycardia of approximately 100 · min⁻¹ persisted, and did not respond to a fluid bolus of approximately 500 ml. Other monitored functions were stable: SpO₂ = 98%, end tidal CO₂ (PETCO₂) 32 mmHg, IP = 28/0 cm H₂O. The FGF had been increased to 6 L · min⁻¹ to maintain a stable PETCO₂, and therefore, tachycardia was felt to be due to surgical stimulation. After approximately 85 min, the QRS voltages were noted to be diminished from the preoperative size. Breath

sounds were well heard bilaterally with no discernible wheezing. The patient was noticed to have palpable crepitus on the right and left lower neck, suprasternal, and supraclavicular areas. Monitored vital functions showed normotension, sinus tachycardia of 105 · min⁻¹, IP = 30/0 cm H₂O, SpO₂ = 98%, PETCO₂ = 34 mmHg. The diagnosis of pneumothorax or ruptured emphysematous bleb was entertained. The N₂O was discontinued, and the surgeon was notified. Within ten minutes the breath sounds were no longer audible on the left side and there was progression of subcutaneous emphysema towards the axillae. The CO₂ insufflation pressure was normal, and reduced from ~20 to 18 mmHg. Over the next 25 min the PETCO₂ peaked at 40 mmHg, and subsequently decreased to previous levels of 33 mmHg, and the IP decreased to 24/0 cm H₂O. The QRS voltages returned to normal, and breath sounds were equal over both hemithoraces. At the end of the procedure, neuromuscular blockade was reversed with neostigmine and glycopyrrolate, and the trachea was extubated awake in the operating room prior to transfer to the recovery room. The operative time was three hours. Chest x-rays (CXR) taken in the recovery room showed air anterior to the cardiac silhouette (Figure 1), and a continuous diaphragm (Figure 2), suggesting supradiaphragmatic air consistent with a pneumomediastinum. This CXR also showed evidence of subcutaneous air in the axillary regions (not shown). A repeat CXR done 24 hr postoperatively showed no evidence of residual pneumomediastinum.

This patient made an uneventful recovery.

Case #2

A healthy 32-yr-old man suffering from chronic cholecystitis presented for laparoscopic cholecystectomy. Sole medication was codeine *prn* for abdominal pain. Apart from a history of cocaine abuse six years previously, his past medical history was unremarkable. He had no history of drug allergies. He smoked one-half pack of cigarettes per day. Physical examination was unremarkable, weight 83 kg, height 178 cm. Preoperative laboratory tests were within normal limits. Premedication was with diazepam 10 mg *po* two hours before surgery. Upon arrival in the operating room, routine monitors were applied, and anaesthesia was induced with droperidol 1.25 mg, fentanyl 250 µg, d-tubocurarine 4.5 mg, and thiopentone 600 mg. Succinylcholine 140 mg was given to facilitate tracheal intubation. Anaesthesia was maintained with 60% N₂O in oxygen, isoflurane 0.8–2%, and supplemental fentanyl totalling 125 µg. Pancuronium was given for muscle relaxation. The patient was prepared as in Case #1, and was haemodynamically stable intraoperatively. The PETCO₂ was maintained at 35–40 mmHg by varying the FGF. The procedure lasted approximately four hours.

FIGURE 2 Case #2: Anteroposterior chest x-ray showing radiolucency consistent with air above the diaphragm, separating the cardiac silhouette from the diaphragm. This continuous diaphragm sign suggests air in the mediastinum.

Neuromuscular blockade was reversed and anaesthesia discontinued at the end of surgery. The drapes were removed and it was observed that the patient had developed a soft, markedly dilated scrotum and proximal penis, with crepitus extending over the abdomen to the lower thoraces. There was no crepitus over upper thoraces or axilla. The patient gave verbal consent to a photograph of the genital area (Figure 3) showing a markedly dilated scrotum and proximal penis, which was consistent with a pneumoscrotum. Written consent was obtained before publication. The patient had an uneventful recovery.

Case #3

A 46-yr-old man with chronic cholecystitis was scheduled for laparoscopic cholecystectomy. He had a medical history of inactive tuberculosis, and two episodes of infectious hepatitis. He was a non-smoker, non-drinker, had no known allergies, and had had no previous anaesthetics. Physical examination was unremarkable, weight 82 kg, height 178 cm. Preoperative laboratory tests were within normal limits.

Upon arrival in the operating room, routine monitors were applied and anaesthesia was induced with fentanyl 200 µg and thiopentone 375 mg. Pancuronium 8 mg was given to facilitate intubation which was unsuccessful on the first attempt with an 8.5 mm endotracheal tube as neither the vocal cords nor the arytenoids were seen on direct laryngoscopy. The lungs were ventilated and the trachea was intubated on the second attempt with a 7 mm endotracheal tube using a stylet via a blind insertion inferior to the epiglottis. Anaesthesia was main-

FIGURE 3 Case #2: Photograph of the scrotum of patient in Case #2 upon arrival in recovery room.

tained with 70% N₂O in oxygen, isoflurane, and intermittent fentanyl. Pancuronium was administered to maintain muscle relaxation. After verifying correct endotracheal tube position by inspection, auscultation, and capnography, the eyes were taped and the operative procedure commenced in the usual fashion. The intraoperative course was uneventful. When the procedure was terminated and the drapes removed, it was noticed that the patient had left periorbital swelling with palpable cutaneous crepitus extending from the superior thorax, neck, and left facial areas adjacent to the left periorbital area. This was consistent with subcutaneous emphysema. The trachea was extubated with the patient awake in the operating theatre and he was transported to the recovery room, where he consented to photography of his face (Figure 4). Written consent was obtained prior to publication. Operative time was 3 hr 45 min. A chest x-ray was taken to exclude a pneumothorax (Figure 5), and showed a right pneumothorax, gross pneumomediastinum, subsegmental atelectasis of right and left lower lobes, and bilateral lower lobe collapse. A chest tube was not inserted, and the patient made an uneventful recovery.

FIGURE 4 Case #3: Facial photograph of patient demonstrating left periorbital subcutaneous emphysema, extending from the adjacent left facial area.

Discussion

Improved laparoscopic techniques have revolutionized many surgical procedures. Although there is less pain, faster recovery and possibly less morbidity and mortality, laparoscopy is not a benign operation.^{1,2} Injury to the common bile duct or intestine may be more common⁴⁻⁶ than with an open cholecystectomy. Furthermore, this operation has different intraoperative anaesthetic considerations than a traditional open cholecystectomy.³ Anaesthetic considerations for laparoscopic cholecystectomy are similar to those for other laparoscopic procedures and result from the creation of a pneumoperitoneum by insufflation of CO₂ into the abdominal cavity. The resultant problems such as decreased functional residual capacity, increased airway pressure, hypercarbia and circulatory impairment are well known.^{7,8}

We have presented three cases which demonstrated some problems created by the extravasation of the insufflated CO₂. Case #1 presented with an intraoperative pneumomediastinum with subcutaneous emphysema and, initially, gave the clinical impression of an intraoperative pneumothorax. Upon discontinuing N₂O, all the clinical signs and changes in monitored vital functions resolved spontaneously within 30 min. Alternatively, this may have been due to diminishing CO₂ insufflation into the abdomen. Furthermore, within 24 hr, there was no radiological evidence of pneumomediastinum. The rapid disappearance clinically and radiologically of the subcutaneous emphysema and pneumomediastinum suggests that they were caused by CO₂, which has been previously reported⁹ during laparoscopy for gynaecological procedures and recently for cholecystectomy.¹⁰ The term

FIGURE 5 Case #3: Anteroposterior chest x-ray during expiration, showing small right pneumothorax (large, solid arrows), pneumomediastinum with air at the apex of the right lung extending into the neck (small, solid arrows), and subcutaneous emphysema of the soft tissues over the right axilla and supraclavicular area (large, empty arrows).

capnomediastinum and capnothorax may therefore be more appropriate.

It is assumed that intraperitoneal CO₂ traverses into the mediastinum via a defect in the diaphragm.¹⁰ What caused a "capnomediastinum" in this patient is unknown, but it seems unlikely to have been a classical "pneumothorax" from a ruptured airway or emphysematous bleb, as this resolved readily upon discontinuing CO₂ insufflation. It is unclear whether discontinuing N₂O had any role in resolving these complications. The tendency for N₂O to diffuse into air-filled cavities is well known¹¹ but whether it does so to the same degree in a CO₂-filled space is unclear. However, the routine use of N₂O in short uncomplicated laparoscopic cholecystectomy appears to have no effect on surgical conditions.¹²

The optimal intra-abdominal pressure (IAP) of insufflated CO₂ is not known although Kelman *et al.*⁸ sug-

gested an IAP ≤ 22 mmHg (30 cm H₂O) would give good surgical exposure, and is associated with an increase in cardiac output due to higher filling pressures. An IAP > 29 mmHg (40 cm H₂O) was associated with a decrease in cardiac output. Zucker *et al.* described a series of 100 patients who underwent laparoscopic cholecystectomy and stated that IAP was not allowed to exceed 15 mmHg, although he did not state why that value was chosen. They reported no complications due to insufflated CO₂. Perhaps our IAP of 20 mmHg was excessive.

Our recommendations are to monitor closely the intra-abdominal CO₂ pressure with the insufflator device if available, and to maintain a pressure sufficient for surgical vision, but to avoid over-expansion of the abdomen, and perhaps subsequently, the adjacent anatomical spaces. Finally N₂O should be discontinued in the event of a long complicated procedure or upon suspicion of CO₂ extravasation outside the abdominal cavity.

The second case report described a pneumoscrotum with subcutaneous emphysema and this has been reported previously.¹³ The pneumoscrotum created no problems and resolved within hours. The rapidity with which this resolved upon discontinuing CO₂ insufflation is further evidence of a pneumoscrotum or "capnoscrotum." The likely portal of CO₂ entry was by tracking along a normal spermatic cord through the inguinal canal to the scrotum.

In the third case, the patient had pneumomediastinum, pneumothorax, and bilateral partial collapse of the lower lobes, in addition to the "benign" subcutaneous emphysema. Airway inflation pressures are normally continually monitored throughout the course of anaesthesia whenever positive-pressure ventilation is instituted. It needs to be stressed that in all cases of laparoscopy excessive changes in airway pressure may represent an early sign of CO₂ extravasation. These respiratory stresses and complications in Case #3 were clinically inapparent intraoperatively, and posed no difficulties in the PARR. However, in the case reported by Gabbott *et al.*¹⁰ a symptomatic pneumothorax developed.

There are two possible causes for these complications in this patient. Direct tracheal injury during difficult intubation was unlikely, as this would have manifested itself shortly after tracheal intubation as subcutaneous emphysema and cardiorespiratory compromise upon instituting positive-pressure ventilation.¹⁴ Therefore, the most likely cause of the complications was CO₂ tracking cephalad after intra-abdominal insufflation.

Finally, we would like to discuss whether laparoscopy is indicated in the patient with cardiorespiratory compromise. Laparoscopic cholecystectomy does not require the deep Trendelenburg position used with gynaecological laparoscopies, but may require reverse Trendelenburg, thus diminishing the cephalad movement of the abdom-

inal contents and diaphragm. Furthermore, the respiratory stress imposed by CO₂ insufflation can be easily controlled by increasing the minute ventilation. Cardiac output may be increased provided excessive intra-abdominal pressure is avoided.⁸ Therefore, together with the better postoperative convalescence from laparoscopies versus laparotomies, and the probable lower morbidity and mortality, laparoscopic cholecystectomy may be preferable to laparotomy for the patient with cardiorespiratory compromise.

In conclusion, the necessity of creating a pneumoperitoneum by insufflation of CO₂ into the abdominal cavity during laparoscopic cholecystectomy has the potential for causing morbidity. Three cases were presented in which extravasation of CO₂ resulted in subcutaneous emphysema associated with pneumomediastinum, pneumoscrotum, and pneumothorax with pneumomediastinum and ocular emphysema, respectively. One needs to be aware of these possible complications and to consider carefully the use of N₂O. Intra-abdominal pressure should be closely monitored to avoid excessive pressures. The anaesthetist should carefully observe and document airway pressure changes during this procedure. An optimal intra-abdominal pressure may be 15 mmHg, although this remains to be confirmed.

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