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CASE REPORT

CO_2 Inducer, Indicator ($EtCO_2$) and venting it, is the Healer of Subcutaneous Emphysema

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ABSTRACT

Today, surgeons across the world have realized the benefits of laparoscopic approach, for short hospital stay, improved postoperative recovery times. Thus, laparoscopic surgeries are being used with greater frequency in health care system. However, laparoscopy is not without complications like, subcutaneous emphysema, pneumopericardium, pneumothorax, gas embolism, visceral injuries. Since, these complications remain a cause of concern, we need better trained anesthesiologist and laparoscopic surgeons. Regular assessment and monitoring should be done to recognize the complication as early as possible and prompt treatment for positive patient outcome.

Subcutaneous emphysema is defined as the presence of gas within the tissue, beneath the skin. Here, we describe a case report where the patient developed massive subcutaneous emphysema during laparoscopic ovarian cystectomy.

Keywords: Carbon dioxide, Hyperventilation, Laparoscopy, Subcutaneous emphysema, Ovarian cystectomy.

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INTRODUCTION

As budding surgeons are using laparoscopic approach for almost all surgeries with greater frequency, providing anesthesia for laparoscopic surgeries has become a new challenge for anesthesiologist. It has its own advantages and disadvantages. Laparoscopic surgery allows for smaller surgical incisions and minimal invasiveness, while still providing sufficient visualization of peritoneal cavity. Carbon dioxide (CO_2) has proven to be beneficial for insufflations because of its rapid diffusion ability, low cost and decrease flammability compared with alternative gases (air, helium, argon, and N_2O). However, insufflations can cause CO_2 diffusion into subcutaneous tissue to cause subcutaneous emphysema. The incidence of subcutaneous emphysema in laparoscopic surgery is 0.3 to 3%.[1] Various risk factors attributing to it are increased age, multiple surgical ports, high insufflations pressures and prolonged surgical time.[2] Recently, the influence of insufflations pressures and surgical duration has been demonstrated to have the most important impact on the rate of CO_2 absorption.[2]

Laparoscopic approaches in gynecologic procedure are being used since 1937.[3] Here, we report a case where massive subcutaneous emphysema developed in a patient undergoing laparoscopic ovarian cystectomy.

CASE REPORT

A 25-year-old 45 kg woman of American Society of Anesthesiologist (ASA) physical status II was scheduled to undergo a laparoscopic ovarian cystectomy. She had no previous illness. Preoperative laboratory investigations were within normal limits. She was shifted to the operation room (OR) and all standard monitor were applied [noninvasive blood pressure (NIBP), pulse oximetry, electrocardiogram]. Anesthesia was induced uneventfully with sodium thiopentone 5 mg/kg (2.5%), succinylcholine 1.5 mg/kg, fentanyl 2 μg/kg BW intravenously, O_2:N_2O 50% each and 0.5% halothane. Trachea was intubated with Portex 7.5 mm cuffed endotracheal tube and confirmed by bilateral equal breath sounds and capnography showing end tidal carbon dioxide ($EtCO_2$). Neuromuscular blockade was achieved by nondepolarizing muscle relaxant injection atracurium. Adequate minute ventilation was delivered with tidal volume of 8 ml/kg BW and respiratory rate of 14/min. A nasogastric tube was placed after induction of general anesthesia. The Veress needle and trocar were inserted into the peritoneal cavity without difficulty. Patient's hemodynamics was stable initially during the procedure with an $EtCO_2$ of 30 mm Hg. After 15 minutes of CO_2 insufflation there was a steady rise of $EtCO_2$ from 30 to 78 mm Hg, with peak airway pressure rising to 40 mm Hg. The insufflation pressure was reduced from 23 to 12 mm Hg. Hyperventilation was instituted, even then there was no fall in $EtCO_2$. We took the patient on manual ventilation and noticed resistance in the bag and were unable to ventilate the patient despite adequate depth of anesthesia. Patient heart rate rose to 130/min and NIBP to 160/100 mm Hg. While auscultating for the air entry we undraped the patient, which unveiled swelling of face, edematous eyes and crepitus all over the chest, both arms and abdomen as the patient had developed subcutaneous emphysema. Complication was notified to the surgeon and laparoscopic check was made for any rent in

diaphragm which was found intact, the laparoscopic approach was abandoned and converted to conventional incision, which vented out the accumulated CO_2 rapidly. N_2O was stopped and was ventilated with 100% O_2. Arterial blood gas analysis showed pH: 7.26, PCO_2: 90 mm Hg, PO_2: 80 mm Hg, HCO_3: 18 mmol/l. Vitals were monitored. Injection mannitol 0.5 gm/kg IV was given in view of suspecting raised intracranial pressure (ICP) because of hypercarbia. After 15 to 20 minutes the subcutaneous emphysema started subsiding with $EtCO_2$ approaching to near normal level. At the end of surgery, patient was reversed for the residual neuromuscular blockade with injection neostigmine 0.05 mg/kg and glycopyrrolate injection 0.01 mg/kg. Trachea was extubated after the patient was fully awake and maintaining 100% saturation. Patient was shifted to postoperative ward and the postoperative stay of the patient was uneventful.

DISCUSSION

With developing technology, laparoscopic procedures are being frequently used worldwide, because of its minimal invasive nature of surgery, cosmetically better scar, early postoperative recovery. Laparoscopic procedures have a positive overall economic benefit due to the shorter hospital stays necessary for patients, compared with those undergoing open procedures.[4] In spite of all advantages laparoscopic procedures are not without complications. The potential complications include subcutaneous emphysema, pneumopericardium, pneumothorax, gas embolism, visceral injuries.[2] Most commonly used among the gases for insufflation is CO_2, as it is readily available, low cost, a high Ostwald's B/G partition coefficient (0.48), and odourless, inert, nonflammable, rapidly buffered in the body by bicarbonate and excreted via lungs. But this aberrant diffusible property of CO_2 is responsible for various complications. At rest, body cells consume 200 ml/min of O_2 and produce same amount of CO_2.[5] During insufflations as much as 120 L can accumulate in the body during pneumoperitoneum.[1]

Subcutaneous emphysema is an uncommon complication during laparoscopic procedure. It occurs when the insufflations pressure is greater than 12 mm Hg or because of leakage of CO_2 through the trocar site as they pass through the skin and muscle. In our case, the insufflation pressure was found to be 23 mm Hg at the time of diagnosing subcutaneous emphysema. Singh et al demonstrated subcutaneous emphysema to be more common during extraperitoneal *vs* intraperitoneal laparoscopic procedure due to the large CO_2 absorption surface area provided by the large extraperitoneal space.[2]

Reference is made to 4-point scale comparing varying degrees of subcutaneous emphysema.[6]

- 0 = no subcutaneous emphysema
- 1 = mild emphysema with crepitus at trocar insertion sites or in the groin
- 2 = marked emphysema with crepitus extending to the abdomen and thighs
- 3 = massive emphysema extending to the chest or neck and face.

Our patient developed massive subcutaneous emphysema extending to chest, neck and face, resulting in difficulty in ventilating the patient.

Acute rise in $EtCO_2$ and peak airway pressure was the first indicator which signalled the occurrence of subcutaneous emphysema. The resulting hypercarbia increases the cardiac output, arterial blood pressure, ICP and respiratory acidosis.

The management of subcutaneous emphysema during laparoscopic procedure include hyperventilation, abandoning the laparoscopic procedure, discontinuation of N_2O, monitoring the vitals. Certain anesthetic recommendation for the management of patient undergoing laparoscopic procedure has been described.[7]

1. Monitoring of CO_2 insufflation pressure (<12 mm Hg).
2. Routine and frequent examination and palpation of abdominal and chest wall to detect subcutaneous gas accumulation.
3. Use of N_2O with caution.
4. Adjusting the ventilation to an acceptable $EtCO_2$.
5. Ruling out all other causes of subcutaneous emphysema and acute hypercarbia.

CONCLUSION

Laparoscopic surgery represents a new challenge to the anesthesiologist. A thorough concept of pathophysiological changes during laparoscopy, strict monitoring and prompt diagnosis and treatment of complications can result in positive patient outcome.

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