The use of chest band to prevent CO₂ subcutaneous emphysema expansion
-Two case reports-

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CO₂ subcutaneous emphysema is one of the complications of laparoscopic surgery using CO₂ gas. During laparoscopic surgery, CO₂ gas can spread to the entire body surface through the subcutaneous tissue layer. Extensive CO₂ subcutaneous emphysema results in hypercarbia and acute respiratory acidosis. Hypercarbia and acidosis can lead to decreased cardiac contractility and arrhythmia. A cloth band, 5 cm in width and 120 cm in length, was made with Velcro tape at both tips, and placed on the patient's xyphoid process level and inframammary fold to prevent CO₂ subcutaneous emphysema. This report describes two successful cases using a chest band to prevent the expansion of CO₂ subcutaneous emphysema. (Korean J Anesthesiol 2010; 59: 425-428)

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specific underlying disease of the cardiopulmonary system. The pre-operative chest X-ray, electorocardiogram (ECG), complete blood count, blood chemistry, electrolyte were within the normal limits. The patient received premedication with midazolam 2 mg and glycopyrrolate 0.2 mg via an intramuscular injection 30 minutes before surgery.

Anesthesia and muscle relaxation was induced with propofol 100 mg and rocuronium 50 mg, respectively. After anesthesia induction, a chest band was applied to the patient at the level of the xiphoid process and inframammary fold. A cloth band, 5 cm in width and 120 cm in length, with Velcro tape at both tips was made by the authors (Fig. 1). Chest band compression was achieved by 5 cm reduction of the patient chest circumference (Fig. 2). Anesthesia was maintained with sevoflurane and 50% O₂ and N₂O. Intraoperative monitoring included ECG, noninvasive blood pressure (NIBP), pulse oxymetry, and capnogram.

The number of surgical ports was 3 and the CO₂ gas pressure was 15 mmHg. The duration of the operation and CO₂ insufflation was 145 minutes and 86 minutes, respectively. The intraoperative peak PₐaghettiCO₂ was 43 mmHg. There was no specific event during surgery. After surgery, crepitus was palpated over the surgical field to the level of the chest band. CO₂ subcutaneous emphysema was not observed beyond the chest band according to the post operative chest X-ray (Fig. 3). There were no complications related to the chest band, such as pressure sores and ventilatory difficulties. The patient had an uneventful recovery and was discharged 2 days later without complications.

Case 2

A 54-year-old female patient was scheduled to undergo a laparoscopic-assisted radical vaginal hysterectomy. She had no underlying disease. After anesthesia induction, a chest band was placed on the patient in a similar manner to case 1. Intraoperative monitoring included the ECG, arterial blood pressure, NIBP, central venous pressure, pulse oximetry and capnogram.

The number of surgical ports and CO₂ gas pressure was 4 and 15 mmHg respectively. The duration of surgery and CO₂ insufflation was 450 minutes and 405 minutes, respectively. The intraoperative peak PₐaghettiCO₂ was 43 mmHg. Hypercarbia and respiratory acidosis were not observed by intermittent
arterial blood gas analysis. No specific events were encountered during the surgical procedure. After surgery, palpation revealed crepitus over the surgical field to the level of the chest band. CO₂ subcutaneous emphysema beyond the chest band was not observed by postoperative chest X-ray (Fig. 4). No chest band related complications were observed. The patient had an uneventful recovery and was discharged 9 days later.

Discussion

Pneumoperitoneum with CO₂ can cause anatomic and physiological changes. It includes the following: reduced venous return from the lower extremities, reduced cardiac output and index, marked reduction in functional residual capacity, increased peak airway pressure, ventilation perfusion mismatch and increased alveolar/arterial O₂ gradient. A patient undergoing laparoscopic surgery with CO₂ pneumoperitoneum is at risk of arrhythmia, hypercarbia, atelectasis, pneumothorax, pneumomediastinum and subcutaneous emphysema [5,6].

CO₂ subcutaneous emphysema has been noted in 0.3–3.0% of patients undergoing laparoscopic surgery [1]. Significant insufflation of CO₂ into the injured subcutaneous tissues can cause extensive CO₂ subcutaneous emphysema and substantial CO₂ absorption. Extensive CO₂ subcutaneous emphysema causes hypercarbia, an increase in arterial CO₂ pressure, and an increase in the plasma catecholamine level. An increased plasma catecholamine level can lead to hypertension, tachycardia and arrhythmia [2]. If the hypercarbia is not corrected, it can lead to severe respiratory acidosis and cardiovascular suppression [1,3].

If extraperitoneal CO₂ insufflation occurs, CO₂ spreads to the subcutaneous tissue layer of entire body because there is no limitation in the expansion of the gas within the subcutaneous layer. However, in the case of intraperitoneal CO₂ insufflation, limited space can cause an increase in abdominal pressure, which can compress the capillary vessels. Suppression of capillary circulation causes a decrease in CO₂ diffusion. Diffusion due to intraperitoneal CO₂ insufflation causes an increase in CO₂ uptake until 15–20 minutes and becomes steady, whereas extraperitoneal CO₂ insufflation causes an increase in CO₂ uptake for the entire insufflation time [7,8]. Wolf et al. [9] reported that if CO₂ subcutaneous emphysema is present, CO₂ uptake can increase to 113%, compared to the 26% increase in subcutaneous emphysema absence. More rapid CO₂ absorption occurs if there is an increase in the CO₂ subcutaneous emphysema field [8]. The risk factors for CO₂ subcutaneous emphysema during laparoscopy include a maximum P_{ET}CO₂ of 50 mmHg or greater, the use of six or more surgical ports, surgery time more than 200 minutes and patient’s age over 65 years [5].

Most reports of extensive CO₂ subcutaneous emphysema describe the treatments of emphysema, not prevention. Based on the idea that CO₂ subcutaneous emphysema spreads through subcutaneous tissue layer, the authors made a cloth band, 5 cm in width and 120 cm in length, with Velcro tape to create continuous pressure on the subcutaneous tissue layer to prevent the expansion of CO₂ subcutaneous emphysema. The chest band was applied to the xiphoid process and inframammary fold level by 5 cm to reduce the length from the patient’s band level circumference. There were no complications with the application of a chest band, such as skin necrosis or ventilation problems.

From these two case reports, it is presumed that a chest band has a protective effect from CO₂ subcutaneous emphysema expansion. The restriction of CO₂ subcutaneous emphysema expansion may reduce the CO₂ absorption rate and delay hypercarbia and respiratory acidosis. However, more study will be needed to determine the proper chest band pressure and complications.

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