Case Report

Korean J Anesthesiol 2010 December 59(6): 425-428
DOI: 10.4097/kjae.2010.59.6.425

The use of chest band to prevent CO_2 subcutaneous emphysema expansion
-Two case reports-

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CO_2 subcutaneous emphysema is one of the complications of laparoscopic surgery using CO_2 gas. During laparoscopic surgery, CO_2 gas can spread to the entire body surface through the subcutaneous tissue layer. Extensive CO_2 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 CO_2 subcutaneous emphysema. This report describes two successful cases using a chest band to prevent the expansion of CO_2 subcutaneous emphysema. (Korean J Anesthesiol 2010; 59: 425-428)

Key Words: Emphysema, Hypercarbia, Laparoscopy.

The insertion of surgical instruments into the intra-abdominal space in laparoscopic surgery can cause subcutaneous tissue layer injury. The leakage of CO_2 gas into the subcutaneous layer during peritoneal CO_2 insufflation can cause the expansion of CO_2 subcutaneous emphysema to the upper trunk, neck, face, both arms, both legs beyond the surgical field. Extensive CO_2 subcutaneous emphysema can cause hypercarbia, respiratory acidosis related to CO_2 absorption. Severe respiratory acidosis can occur if hypercarbia and respiratory acidosis are not corrected, which can lead to hemodynamic changes, such as cardiac depression and arrhythmia, by direct or indirect action through sympathoadrenal stimulation [1-3].

Most case reports of CO_2 subcutaneous emphysema focused only on its treatment not prevention [4]. In this report, a cloth band, 5 cm in width and 120 cm in length, with Velcro tape at both tips was placed on the xyphoid process level and inframammary fold. Such simple effort can lead to a good result in preventing CO_2 subcutaneous emphysema expansion beyond the surgical field.

Case Reports

Case 1

A 50-year-old female patient was scheduled to undergo a laparoscopic-assisted vaginal hysterectomy. She had no

Received: December 24, 2009. Revised: 1st, January 4, 2010; 2nd, April 2, 2010. Accepted: April 5, 2010.
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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 xyphoid 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% O_2 and N_2O. Intraoperative monitoring included ECG, noninvasive blood pressure (NIBP), pulse oxymetry, and capnogram.

The number of surgical ports was 3 and the CO_2 gas pressure was 15 mmHg. The duration of the operation and CO_2 insufflation was 145 minutes and 86 minutes, respectively. The intraoperative peak $P_{ET}CO_2$ 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. CO_2 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 CO_2 gas pressure was 4 and 15 mmHg, respectively. The duration of surgery and CO_2 insufflation was 450 minutes and 405 minutes, respectively. The intraoperative peak $P_{ET}CO_2$ was 43 mmHg. Hypercarbia and respiratory acidosis were not observed by intermittent

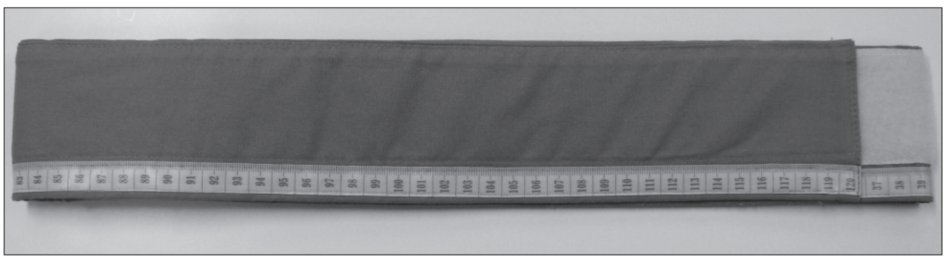

Fig. 1. Cloth band, 5 cm in width and 120 cm in length, with Velcro tape at both tips.

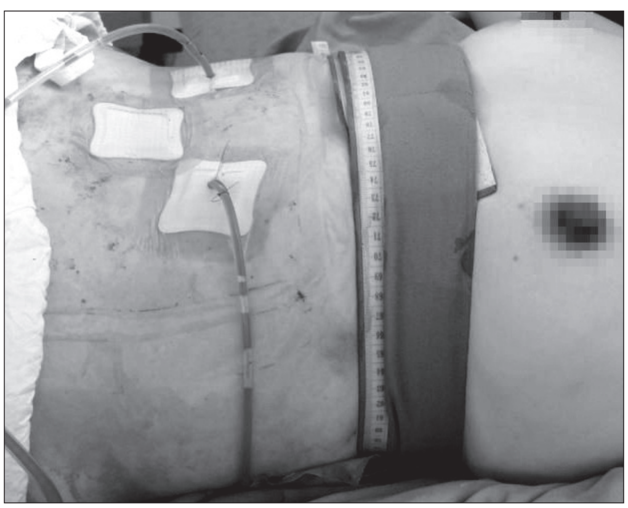

Fig. 2. Chest band applied to the xyphoid process level and inframammary fold.

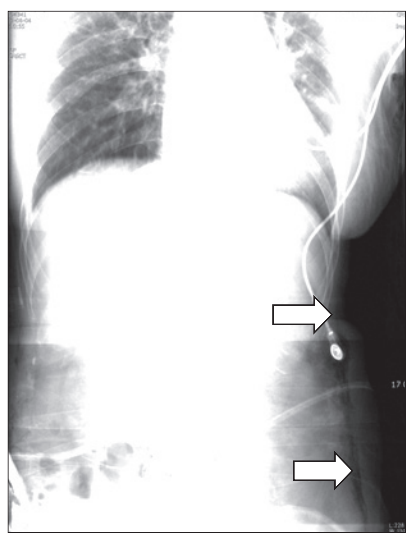

Fig. 3. Postoperative chest X-ray shows subcutaneous emphysema limited to the left lower abdomen below the chest band (arrow).

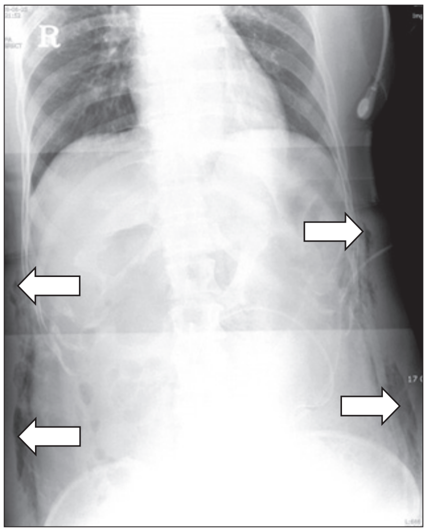

Fig. 4. Postoperative chest X-ray shows subcutaneous emphysema limited to the left lower abdomen below the chest band (arrow).

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. CO_2 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 CO_2 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 O_2 gradient. A patient undergoing laparoscopic surgery with CO_2 pneumoperitoneum is at risk of arrhythmia, hypercarbia, atelectasis, pneumothorax, pneumomediastinum and subcutaneous emphysema [5,6].

CO_2 subcutaneous emphysema has been noted in 0.3−3.0% of patients undergoing laparoscopic surgery [1]. Significant insufflation of CO_2 into the injured subcutaneous tissues can cause extensive CO_2 subcutaneous emphysema and substantial CO_2 absorption. Extensive CO_2 subcutaneous emphysema causes hypercarbia, an increase in arterial CO_2 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 CO_2 insufflation occurs, CO_2 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 CO_2 insufflation, limited space can cause an increase in abdominal pressure, which can compress the capillary vessels. Suppression of capillary circulation causes a decrease in CO_2 diffusion. Diffusion due to intraperitoneal CO_2 insufflation causes an increase in CO_2 uptake until 15−20 minutes and becomes steady, whereas extraperitoneal CO_2 insufflation causes an increase in CO_2 uptake for the entire insufflation time [7,8]. Wolf et al. [9] reported that if CO_2 subcutaneous emphysema is present, CO_2 uptake can increase to 113%, compared to the 26% increase in subcutaneous emphysema absence. More rapid CO_2 absorption occurs if there is an increase in the CO_2 subcutaneous emphysema field [8]. The risk factors for CO_2 subcutaneous emphysema during laparoscopy include a maximum $P_{ET}CO_2$ 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 CO_2 subcutaneous emphysema describe the treatments of emphysema, not prevention. Based on the idea that CO_2 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 CO_2 subcutaneous emphysema. The chest band was applied to the xyphoid 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 CO_2 subcutaneous emphysema expansion. The restriction of CO_2 subcutaneous emphysema expansion may reduce the CO_2 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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