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Severe subcutaneous emphysema caused by small injury to the abdominal wall during robot-assisted laparoscopic radical prostatectomy

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ABSTRACT

A 67-year-old man underwent RARP in the Trendelenburg position with pneumoperitoneum at 12 mmHg. Gradual elevation of End-tidal CO2(EtCO2) began, and extensive subcutaneous emphysema was recognized when EtCO2 reached 58 mmHg. After interruption of pneumoperitoneum, careful observation of the surgical field led to detect an injury of the abdominal wall of 1 cm in length, suggesting the cause of severe subcutaneous emphysema. The injury was repaired and RARP was terminated without any cardiovascular problems. Attention should be paid that even minor abdominal wall injury could lead to severe subcutaneous emphysema which may cause respiratory or cardiovascular problems during laparoscopic surgeries.

1. Introduction

Laparoscopic urologic surgeries have increased, especially, robot-assisted laparoscopic radical prostatectomy (RARP) has become the main surgical treatments for prostate cancer.

Subcutaneous emphysema is a frequent perioperative complication in laparoscopic surgery, although most cases are not severe. We encountered a case of severe subcutaneous emphysema with hypercarbia caused by a small injury to the abdominal wall during RARP.

1.1. Case presentation

A 67-year-old man without any marked complication was referred to us for the further evaluation of serum PSA elevation (9.0 ng/mL). The patient was finally diagnosed with T2aN0M0 prostate cancer after systematic prostate biopsy, and chose RARP as a definitive treatment. His height was 171 cm, body weight was 59 kg, and BMI was 20.1. RARP was performed using the da Vinci Si system (Intuitive Surgical Japan, Tokyo, Japan) with a transperitoneal approach using a standard 4-armed configuration with 2 additional assistant ports under intubated general anesthesia and the 25-dgree Trendelenburg position. The open laparotomy technique was used when inserting a camera port, and the other robotic and assistant ports were placed laparoscopically. The intra-abdominal pressure for pneumoperitoneum was maintained at 12 mmHg during RARP. End-tidal CO2 (EtCO2) began to gradually rise after initiation of pneumoperitoneum and reached 58 mmHg (Fig. 1). The increased ventilation frequency failed to improve the elevated EtCO2 level, and a blood gas test showed hypercarbia (PaCO2: 63.5 mmHg). Severe subcutaneous emphysema extending from the trunk to chest and neck was recognized simultaneously. Pneumoperitoneum was immediately ceased, and we carefully observed the surgical field before to decide to open conversion. We found a small injury of the abdominal wall reaching the rectus abdominis muscle, 1 cm in length, caused during the approach to the Retzius space in the initial phase of RARP (Fig. 2a). The injured site was considered to be a possible cause of severe subcutaneous emphysema, and was sutured tightly without pneumoperitoneum under console surgery (Fig. 2b). After repairing the injury site, pneumoperitoneum was resumed at 8 mmHg. Further elevation of EtCO2 did not occur until the scheduled RARP was finished without any respiratory or cardiovascular problems. The operative time was 229 minutes with a console time of 185 minutes including the interrupted time. Chest X-ray immediately after RARP showed severe subcutaneous emphysema extending from the trunk to neck (Fig. 3a). Vertical emphysema was not observed. The patient was extubated with careful attention to avoid tracheal stenosis caused by subcutaneous emphysema, and he was returned to the general ward after careful confirmation of consciousness level and respiratory status. Although subcutaneous emphysema still remained in the neck on the following day, the disappearance of subcutaneous emphysema was confirmed on chest X-ray on the 5th postoperative day (Fig. 3b). The patient was

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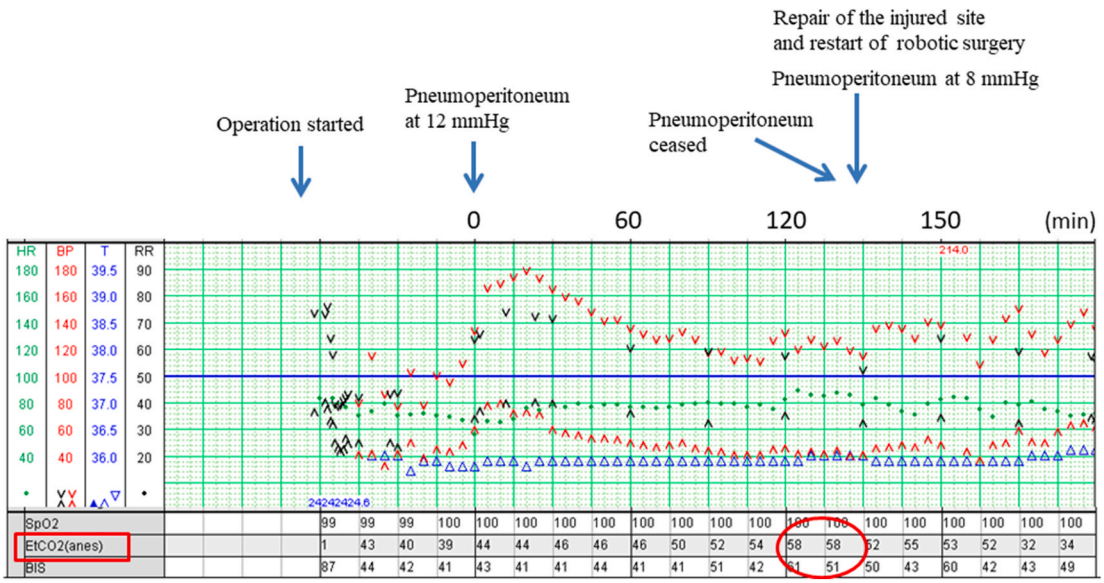

Fig. 1. Anesthetic chart of RARP. The gradual elevation of EtCO2 was observed. EtCO2 reached 58 mmHg 120 minutes later when pneumoperitoneum was maintained at 12 mmHg.

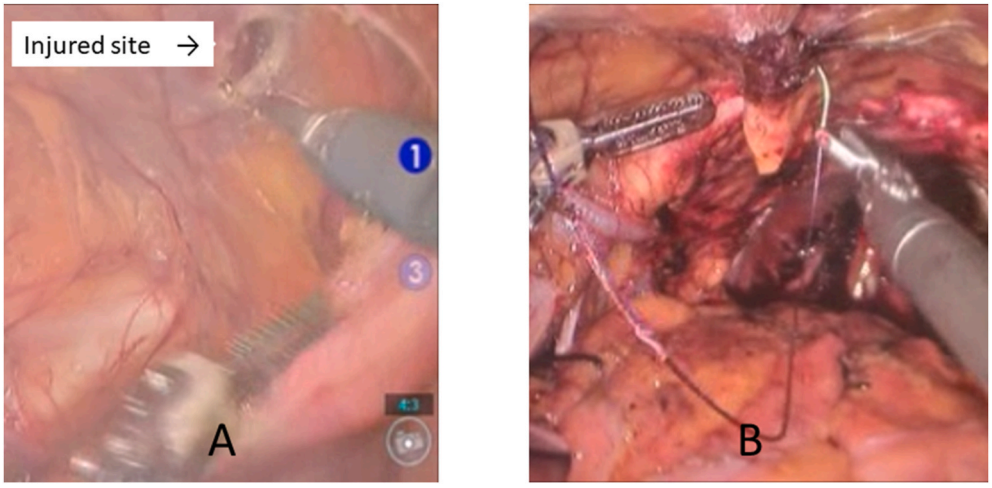

Fig. 2. Abdominal wall injury. The injury reaching the muscle layer (A) was repaired by a robotic procedure without pneumoperitoneum (B).

discharged on the 9th postoperative day without any respiratory or cardiovascular problems.

2. Discussion

Although laparoscopic surgeries have brought many advantages, they cause some specific complications in association with pneumoperitoneum with CO2 gas, such as subcutaneous and/or mediastinal emphysema, ventilatory failure arrhythmia, and gas embolism.

Subcutaneous emphysema is one of the most common complications in laparoscopic surgeries, but most of them are minor degrees.[1] Only 0.23–4.3% of laparoscopic surgeries showed macroscopically identifiable subcutaneous emphysema,[2] but the incidence of these subcutaneous emphysema increases up to 16.4% when using AIRSEAL® device.[2]

CO2 gas is absorbed from the peritoneum into the blood circulation during laparoscopic surgeries. The blood CO2 concentration may subsequently increase in patient with subcutaneous emphysema, leading to hypercarbia. Hypercarbia stimulates the sympathetic nervous system, which causes hypertension, tachycardia, and arrhythmia.[3] Extended subcutaneous emphysema in the thoraco-abdominal region, as in our case, causes reduced mediastinal compliance or lower tracheal occlusion, possibly leading to respiratory failure subsequently. Hypercarbia causes severe acidosis, arrhythmia, hypertension, CO2 gas embolism, cardiac arrest, and myocardial ischemia, which could be fatal.

The reported risk factors for severe subcutaneous emphysema in laparoscopic surgeries are: 1) long operative time (>200 minutes), 2) high pneumoperitoneum pressure (>15 mmHg), 3) number of ports (more than 6 ports), 4) incorrect angle or position of port insertion, and looseness around a port-inserted site, 5) wide range of tissue dissection port, and 6) high EtCO2 level (>50 mmHg).[2,4] The reported risk factors on the patient side are: 1) female sex, 2) low BMI, 3) friable subcutaneous tissues, e.g., long-term steroid intake, 4) older age (>65 years), 5) existence of chronic obstructive pulmonary disease, 6) operative technique, and 7) patients' positioning during surgery.[2] In our case, the pneumoperitoneum pressure was maintained at 12 mmHg, and the number of ports was 6. In addition, the patient was thin (BMI: 20.1) with little subcutaneous fat and of an older age (67 years). These were considered to be factors leading to severe subcutaneous emphysema. In addition to these factors, there was little doubt that the injured site reaching the rectus abdominis muscle was the direct cause of extensive

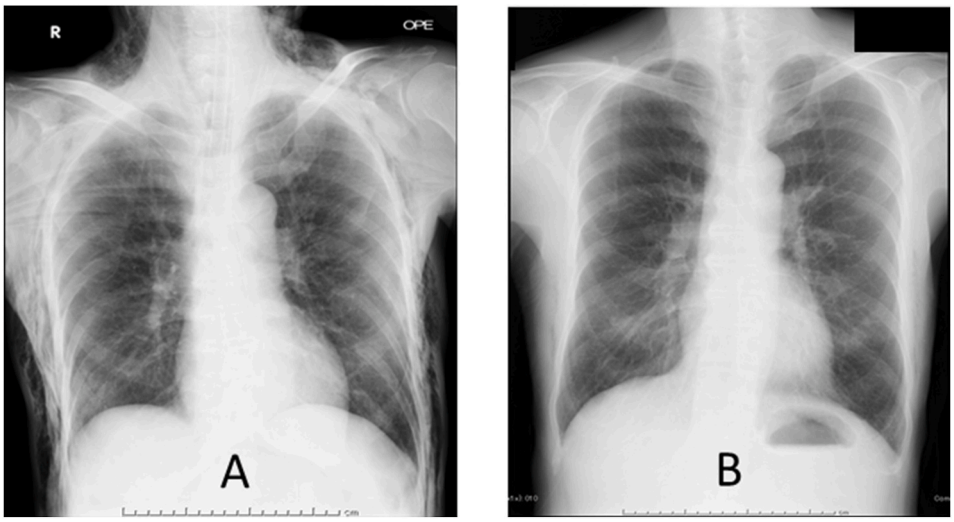

Fig. 3. Chest X-ray. Extended subcutaneous emphysema was noted immediately after RARP (A), and disappeared 5 days after RARP (B).

subcutaneous emphysema. The leakage of CO2 gas from the injured site through the subcutaneous tissue led to subsequent high levels of EtCO2 and hypercarbia as a result. More attention to intraoperative manipulation must be paid to avoid severe complications.

When severe subcutaneous emphysema is identified, it is necessary to decrease the pneumoperitoneum pressure promptly, or cease supplying CO2 gas. Conversion to open surgery should be considered without hesitation. In our case, we first discontinued the supply of CO2 gas, and repaired the injured site without pneumoperitoneum. After repairing the injured site, there was no elevation of EtCO2 on restarting pneumoperitoneum at 8 mmHg, confirming the injured site as the cause of the subcutaneous emphysema.

Extubation in patients with severe subcutaneous emphysema should be comprehensively determined according to their conditions, such as consciousness level, degree of spontaneous breathing, presence or absence of tracheal occlusion, and results of blood gas analysis.

3. Conclusion

We encountered a patient with severe subcutaneous emphysema with hypercarbia during RARP as a result of a small but deep abdominal wall injury. Attention should be paid to the fact that even minor abdominal wall injury can lead to severe subcutaneous emphysema during laparoscopic surgeries, which could be fatal.

Authors' contribution

Fukui: conception and design of the study, analysis and interpretation of data, manuscript writing, Kagebayashi: drafting the article, final approval. Iemura: data analysis, drafting the article. Matsumura: drafting the article.

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Informed consent

We have obtained informed consent.

Declaration of competing interest

The authors declare that they have no conflict of interest.

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