Tension Pneumothorax After Percutaneous Tracheostomy

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A 76-year-old woman with right mandibular gingival cancer was scheduled for surgery. A percutaneous tracheostomy kit was used for tracheostomy under intravenous sedation. After puncturing the cricothyroid membrane, a dilator was inserted along a guidewire. Bucking was observed at the time of insertion of the dilator, despite intratracheal lidocaine spray applied before insertion. After that, the tracheostomy tube was inserted, but no capnographic waveforms appeared when the tube was connected to the anesthesia circuit. Direct macroscopic observation revealed a perforation extending from the posterior wall of the trachea to the anterior wall of the esophagus, which prompted us to request assistance from a thoracic surgeon for treatment before reinserting the tracheostomy tube. After verifying capnographic waveforms on the monitor, anesthesia was induced. Because arterial oxygen saturation was 96% under the administration of pure oxygen, chest radiography was conducted revealing a right pneumothorax. A chest tube was inserted and the patient transported to a nearby general hospital. We suspect that pneumothorax was induced when the integrity of the mediastinal pleura was compromised by mediastinal emphysema because of the injury to the posterior tracheal wall complicated by bucking at the time of insertion of the dilator.

Key Words: Percutaneous tracheostomy; Tension pneumothorax; Mediastinal emphysema; Subcutaneous emphysema.

Percutaneous tracheostomy, which generally involves a blind surgical procedure, carries a risk of causing damage to the trachea and surrounding tissue and can result in complications such as mediastinal emphysema and tension pneumothorax.^{1–6} Furthermore, the incidence of tracheal stenosis following percutaneous tracheostomy has also been reported.⁷ Here, we report a case of right tension pneumothorax as a result of injury to the posterior tracheal wall at the time of percutaneous tracheostomy, despite suturing.

CASE PRESENTATION

A 76-year-old woman (height, 146 cm; weight, 44 kg) was scheduled to undergo tracheostomy, segmental resection of the mandible, and reconstruction with myocutaneous flap of the greater pectoral muscle and a titanium plate as treatment for right mandibular gingival

cancer. Preoperative 12-lead electrocardiography showed a characteristic Brugada electrocardiography pattern, but the patient had no past history of syncope or cardiac arrest and no family history of sudden death.

After administration of 2.5 mg midazolam, an oral surgeon commenced percutaneous tracheostomy using a tracheostomy kit (Neo Perc™ Percutaneous Tracheostomy Kit, Covidien Japan). During tracheostomy, additional 0.5 mg boluses of midazolam were administered as needed, up to a total of 4 mg. After penetration of the cricothyroid membrane by a 22-gauge needle and 4% lidocaine spray inside the trachea, the primary dilator was inserted along a guidewire. However, because of bucking at the time of insertion of the secondary dilator, 4% lidocaine spray was re-applied, and a tracheostomy tube was inserted. Because no capnographic waveforms appeared when the tube was connected to the anesthesia circuit, we removed the tube and repeated the same procedure but still observed no capnographic waveforms. During this time, several buckings were observed. Macroscopic observation revealed a perforation extending from the posterior wall of the trachea to the anterior wall of the esophagus, which prompted us to administer 0.5 mg flumazenil and request help from the department of respiratory surgery

Received February 9, 2016; accepted for publication September 21, 2016.

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Anesth Prog 64:85–87 2017 | DOI 10.2344/anpr-64-02-07
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Figure 1. Chest radiographic findings of right pneumothorax. The right lung is severely collapsed. Air is observed in the subcutaneous layer and mediastinum (white dotted circles). The deep sulcus sign is observed in the right diaphragm (a black arrowhead).

in a nearby general hospital. Approximately 45 minutes after our request, suturing of the posterior wall of the trachea and the anterior wall of the esophagus was performed by a thoracic surgeon, enabling us to insert a tracheostomy tube. During this time, spontaneous ventilation was continued at a fraction of inspired oxygen of 1.0 and oxygen saturation of around 80 to 90%. After confirmation of capnographic waveforms on the monitor, anesthesia was induced by 50 mg propofol and 30 mg rocuronium and maintained by 1 to 1.5% sevoflurane and 0.2 $\mu\text{g}/\text{kg}/\text{min}$ remifentanyl. However, even after proper insertion of the tracheostomy tube, oxygen saturation remained low at 96% with fraction of inspired oxygen = 1.0. In addition, auscultation detected no respiratory sound in the right lung and bronchofiberscopy revealed no signs of blood and/or secretions in the airway or mainstem intubation. Chest radiography performed approximately 45 minutes after insertion of the tracheostomy tube revealed a severely collapsed right lung and dislocation of the right diaphragm, leading to a diagnosis of tension pneumothorax. In addition, subcutaneous and mediastinal emphysema were diagnosed because of the presence of air in the

Figure 2. Chest radiogram taken after insertion of a chest tube for drainage. Deep sulcus sign is absent.

neck region and the right mediastinum (Figure 1). We discontinued surgery and remifentanyl administration, and then administered 200 mg sugammadex sodium to restore spontaneous ventilation. We again requested help from the department of respiratory surgery, and approximately 40 minutes later, a thoracic surgeon “performed needle decompression,” placed a chest tube and connected it to a drain under spontaneous ventilation with 1 to 1.5% sevoflurane (Figure 2). Sevoflurane administration was discontinued, and the patient was urgently transported to a nearby general hospital. The total duration of surgery was 1 hour 47 minutes, and the duration of anesthesia was 4 hours 45 minutes.

The chest tube was removed 2 days after transfer, and the patient was readmitted to our dental hospital the following day. Thoracic computed tomography revealed a bulla at the apex of the right lung. Six days after readmission to our dental hospital, the tracheostomy tube was removed. Because of concerns regarding the possible recurrence of perioperative pneumothorax, the patient was scheduled to undergo surgery for gingival cancer under the supervision of thoracic surgeons at the general hospital.

DISCUSSION

Previous studies have reported a high incidence of complications such as mediastinal emphysema and

tension pneumothorax with percutaneous tracheostomy compared with surgical tracheostomy.^{7,8} Also, the incidence of tracheal stenosis following percutaneous tracheostomy has also been reported.⁷ In another study, however, the frequency of complications with percutaneous tracheostomy was similar to or even lower than that with surgical tracheostomy.⁹ Although the incidence of pneumothorax following percutaneous tracheostomy is reported to be 0.8%,¹ the rate may be higher when the procedure is performed blindly without bronchoscopy.

We think that tension pneumothorax was induced because of damage to the posterior tracheal wall at the time of inserting the dilators. However, the damage may have been caused by the trocar at initial placement rather than the insertion of the dilators themselves. The percutaneous tracheostomy kit used in this study enables the insertion of a primary dilator and a relatively bigger secondary dilator along the guidewire through a puncture site on the tracheal wall and also facilitates mechanical expansion of the trachea. The latter often deforms the wall and narrows the inner cavity,⁴ possibly causing damage to the posterior wall with or without direct needle puncture. In this case, bucking occurred several times during tracheal intubation. We think that because of bucking, expired air was pushed into the subcutaneous layer and mediastinum through the injury in the posterior tracheal wall, causing subcutaneous and mediastinal emphysema. Presumably by the same mechanism, the mediastinal pleura expanded and was damaged by the accumulation of air inside the mediastinum, causing tension pneumothorax.⁴

When inserting a tracheostomy tube in a percutaneous procedure, external force is exerted perpendicularly to the trachea, potentially triggering various complications. Therefore, to avoid complications, it is preferable to perform bronchoscopy-assisted surgery whenever possible (as recommended by the Neo PercTM package insert). The insertion of a bronchoscope through an endotracheal tube prior to percutaneous tracheostomy enables observation of the transtracheal puncture, and the insertion of dilators and tracheostomy tubes, thus guiding proper tracheal intubation and preventing damage to the posterior tracheal wall.⁷ In bronchoscopy-assisted surgery, even if damage to the posterior wall of the trachea and the anterior wall of the esophagus is inevitable, emergency treatment can be provided immediately, which would likely prevent the development of serious complications such as tension pneumothorax. Fortunately, the perioperative vital signs and blood pressure were stable in our patient, but any further delay in the diagnosis and treatment of this tension pneumo-

thorax could have triggered more serious complications such as circulatory collapse and cardiac arrest. We recommend that percutaneous tracheostomy and intubation be performed using bronchoscopy to aid visualization, enable accurate needle puncture and intubation, and avoid damage to tracheal tissue. Alternatively, formal surgical tracheostomy may be performed.

CONCLUSION

We have described a case of injury to the posterior tracheal wall during percutaneous tracheostomy, which led to a series of complications, namely mediastinal emphysema, compromised mediastinal pleura, and right tension pneumothorax. When performing percutaneous tracheostomy, it is advisable to utilize bronchoscopy to prevent the development of complications.

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