Case report
Blunt tracheal transection and long tear in posterior membranous trachea

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Abstract
Blunt tracheobronchial injuries are rare, but can be life-threatening. A precise preoperative diagnosis and a well-recognised plan of surgical treatment, which may be unique for each patient, are needed to restore the continuity of tracheobronchial tree in a one-stage intervention. We encountered a patient with complete tracheal transection and 15 cm tear in the posterior membranous trachea and right bronchus, and whose tracheal injury was difficult to repair using direct intubation of distal airway by bronchoscopy. We achieved a good result of one-stage repair using a percutaneous cardiopulmonary support (PCPS).

1. Introduction
Tracheal injuries are uncommon but potentially fatal, and the incidence of tracheobronchial injury is reported to comprise 4% of all the chest trauma cases [1]. The postoperative mortality rate was reported to be 59% after tracheobronchial rupture in motor vehicle accidents [2,3]. Despite its rarity, tracheobronchial injury should always be considered after blunt chest trauma and should be recognized and treated early. We report the pre- and intraoperative management of a case of complete tracheal transection accompanied by a long tear of posterior membranous trachea and right bronchus.

2. Case report
At 08:00 a.m., a 23-year-old man was caught between rolls of paper measuring 2 m in diameter. He was transported to the nearest hospital with a Glasgow coma score of 15/15 at 08:30 a.m. and could walk and speak with slight dyspnea. After 10 min, he became drowsy, developed respiratory distress with labored breath and lost consciousness. He was immediately incubated orally without difficulty. Bronchoscopic examination confirmed that the trachea was disrupted and the tip of the tube was displaced instead of being inserted completely into the distal segment of the disrupted trachea. However, he could be effectively ventilated. X-ray of the chest showed pneumomediastinum and subcutaneous emphysema. Chest computed tomography (CT) scan demonstrated complete tracheal transection and subcutaneous emphysema (Fig. 1). He was diagnosed as having tracheobronchial injury and was transported to our hospital by ambulance under assisted positive ventilation at 13:30 p.m.

On arrival of the patient at our hospital, subcutaneous emphysema was noted around his neck and anterior chest wall. CT scan at our hospital showed mediastinal bleeding, pneumomediastinum, subcutaneous emphysema, bilateral lung contusion, and tracheal separation. The distal segment of trachea and bilateral bronchus were identified deep in the mediastinum. He was taken to the intensive care unit. It was becoming difficult to effectively ventilate the patient, and we applied percutaneous cardiopulmonary support (PCPS) (CAPIOX sp-101, Terumo, Tokyo, Japan) to secure expeditious establishment of ventilation. Then, he was taken to the operating room to repair a suspected tracheobronchial injury.

After median sternotomy, thymic vein was bleeding and ligated. The innominate vein and right brachiocephalic artery were abrupted and isolated. Trachea, posterior to the innominate vein, was completely avulsed in a length of 5 cm, and the membranous portion was split from 2 cm proximal to the transection site of the intermediate bronchus (Fig. 2). As
oxygenation was insufficient due to bilateral lung contusion, a high-pressure oxygen jet ventilator via an intratracheal catheter was applied. The membranous portion of the proximal trachea and that of distal trachea from 2 cm proximal of carina were closed primarily with a continuous suture (Fig. 2a and b). The cartilaginous portion of the trachea was sutured in a reverse telescope fashion with interrupted sutures (Fig. 2c). After the repair, the patient could be ventilated with acceptable inspiratory pressures and oxygenation, but continuous air leak appeared from the right bronchus. After closing the median sternotomy, the patient was easily weaned from PCPS and right fifth intercostal posterolateral thoracotomy was performed. The membranous portion was split from 2 cm proximal to the carina of the intermediate bronchus and was closed primarily with a continuous suture (Fig. 2d). The patient was weaned from mechanical ventilation on the second postoperative day and was discharged on the 61st postoperative day.

3. Comment

There are variety of signs and symptoms of tracheobronchial injury, dyspnea, cyanosis, haemoptysis, pneumomediastinum, and subcutaneous, mediastinal or deep cervical emphysema. These depend on whether there is free communication between the site of injury and pleura. Davies and Hopkins [4] reported two groups of patients. In the first group, there is immediate communication between the airway and pleural space. In the second group, there is no communication between the airway and pleural space, and the injury is sealed off by mediastinal tissue. An intact sheath of peritracheal fascia may allow a patient to breath, and continuity of the fascial sheath may enable ventilation even if the endotracheal tube has not reached the distal trachea. In this case, the patient was stable with positive pressure ventilation for 4 h until PCPS was instituted, and the airway might have been barely kept continuity by the mediastinal and peribronchial connective tissue.

Primary repair is the gold standard for tracheobronchial injuries, and the key to successful treatment is airway management before and during surgery. On arrival at hospital, most patients require prompt control of the airway because of respiratory compromise. In one large series of patients with blunt injuries to the cervical trachea, blind intubation failed to achieve an adequate airway in 76% [5], and the use of a bronchoscope to guide the endotracheal tube is recommended. However, this recommendation does not imply that every case can be secured by these methods. In our patient, we could not guide the dislocated endotracheal tube into the distal trachea despite bronchoscopy by three
Thoracic surgeons. Furthermore, emergent tracheostomy was considered risky because the distal trachea was located deeply in the mediastinum on CT. Although bronchoscopy is the essential method for diagnosing the site and form of tracheal injury, recently virtual bronchoscopy by 3-dimensional CT is reported as a useful method in haemodynamically stable patients [6]. But in this case, it was becoming difficult to effectively ventilate this patient, and we decided to apply PCPS as soon as possible rather than perform 3D-CT.

In every case of major airway injury, there must be extremely close cooperation between the surgeon and anaestheologist. In this case, the arterial blood gas level was not acceptable despite PCPS, and intrathoracic placement of an endobronchial tube and jet ventilation must be considered during suturing of the trachea.

References