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Surgical Repair of a Traumatic Tracheobronchial Injury in a Pediatric Patient Assisted with Venoarterial Extracorporeal Membrane Oxygenation

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Tracheobronchial rupture due to blunt chest trauma is a rare but life-threatening injury in the pediatric population. Computed tomography (CT) is not always reliable in the management of these patients. An additional concern is that ventilation may be disrupted during surgical repair of these injuries. This report presents the case of a 4-year-old boy with an injury to the lower trachea and carina due to blunt force trauma that was missed on the initial CT scan. During surgery, he was administered venoarterial extracorporeal membrane oxygenation (ECMO). Although ECMO is not generally used in children, this case demonstrated that the short-term use of ECMO during pediatric surgery is safe and can prevent intraoperative desaturation.

Key words: 1. Tracheobronchial injury
2. Pediatric
3. Blunt trauma
4. Extracorporeal membrane oxygenation

Case report

Tracheobronchial rupture due to blunt chest trauma is a rare but life-threatening injury in the pediatric population [1]. However, milder cases are not life-threatening and are very often missed at the initial presentation [2]. The role of computed tomography (CT) in the management of pediatric blunt tracheobronchial trauma is unclear [1]. This report presents the case of a child with an injury to the lower trachea and carina due to blunt trauma that was missed on the initial CT scan. During surgical repair, the patient was administered venoarterial extracorporeal membrane oxygenation (ECMO).

A 4-year-old boy was admitted to the emergency medical center with cervical discomfort. He had been squeezed under a table leg at his home. He presented with neck pain and discomfort, subcutaneous emphysema at the neck level, and bloody sputum. Initial oxygen saturation on pulse oximetry was 100% with room air. CT was performed, but there were no significant findings in the tracheobronchial tree, lung, or esophagus (Fig. 1A). He was initially diagnosed with uncomplicated pneumomediastinum with subcutaneous emphysema, for which he was prescribed antibiotic support and restriction of oral

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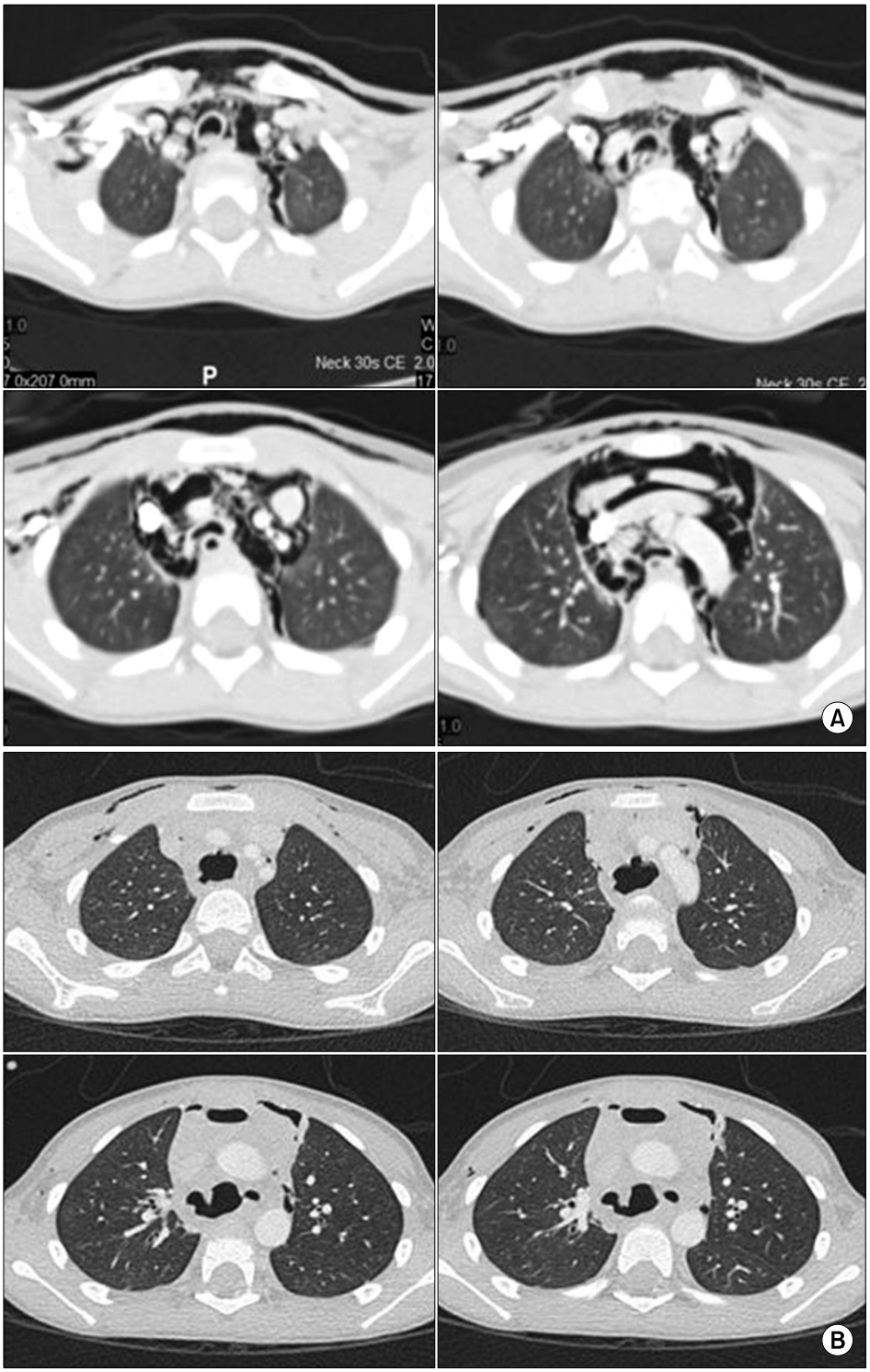

Fig. 1. (A) The initial CT scan shows no significant findings in the tracheobronchial tree, lung, or esophagus. (B) A CT scan performed on hospital day 2 shows a large common cavity from the proximal to the middle esophagus at the level of the T3–T5 vertebrae. CT, computed tomography.

foods and fluids. By day 2 of his hospitalization, a physical examination showed that his symptoms had improved. However, on chest radiography, a quadrate-shaped trapping of air in the mid-sternal area was seen (Fig. 2B) and a blood test showed leukocytosis. On a follow-up chest CT, the presence of a large common cavity, extending from the proximal to the middle esophagus at the level of the T3–T5 ver-

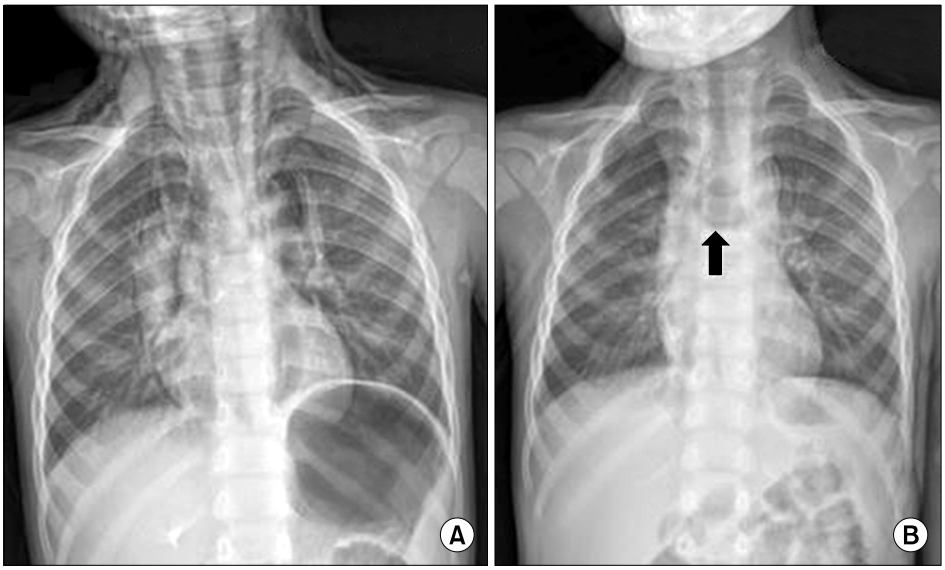

Fig. 2. (A) Plain chest radiography initially found no abnormalities, except a pneumomediastinum and subcutaneous emphysema. (B) A quadrate-shaped region of air trapping in the mid-sternal area was later detected (arrow).

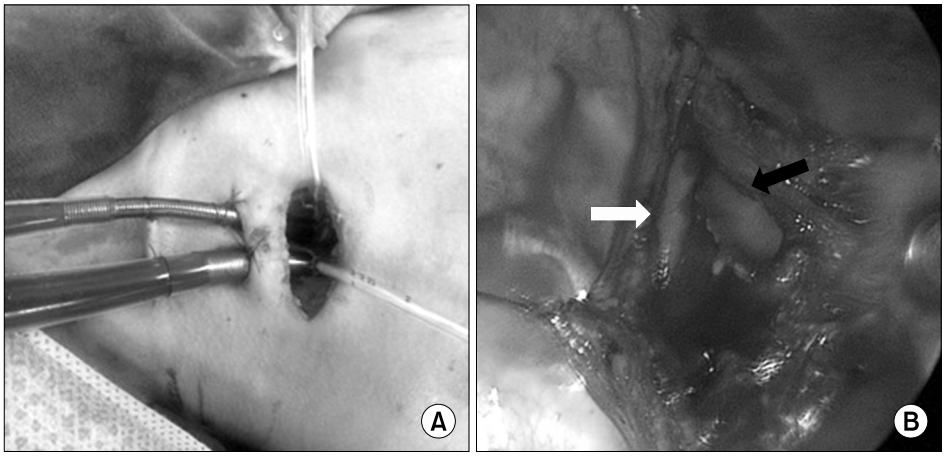

Fig. 3. (A) Venoarterial extracorporeal membrane oxygenation was established via the right jugular vein with a 14-Fr catheter and via the right common carotid artery with a 10-Fr catheter. (B) A bilateral linear disconnection of approximately 3 cm at the membranous and cartilage portions of the trachea and main bronchus. The white arrow shows the membranous portion detached from the tracheobronchial tree. The black arrow is the cartilage portion of the main bronchus.

tebrae, suggested a traumatic tracheobronchoesophageal fistula (Fig. 1B). The decision to surgically treat the tracheobronchial injury (TBI) was complicated by the difficulty in differentiating between the TBI and an esophageal fistula. Moreover, if the TBI was proximally located, ventilation would be disrupted during surgical repair. In the operating room, both a bronchoscopy and an esophagogastroduodenoscopy were performed, with the patient under general anesthesia. An extensive tracheal injury was identified, extending from the main carina to the main bronchus, as well as luminal disruption, which caused the membranous trachea to be detached with a quadriangular shape. Therefore, the bronchoscope could not enter the distal part of the injury, thorugh out to the mediastinum. There was no esophageal injury (perforation or laceration). Venoarterial ECMO via the right jugular vein was established with a 14-Fr catheter, and via the right common carotid artery with a 10-Fr catheter (Fig. 3A). The ECMO flow was 1,300 L/min, the gas flow was 0.8 L/min, and the fraction of inspired oxygen was 1.0. The TBI was explored surgically using a posterolateral thoracotomy approach at the fifth intercostal space, with the patient in the left lateral decubitus position. A small hematoma in the lower trachea and carina was removed and the lower trachea and carina were found to be covered with parietal pleura. Its removal revealed a bilateral linear disconnection of about 3 cm at the membranous tracheobronchial and carti-

lage portions (Fig. 3B). This tear was continuously sutured using polydioxanone 5-0 sutures. A hemovac drain and a chest tube drain were placed. After the repair operation, the venoarterial ECMO was decannulated. The total operation time was 317 minutes, including a tracheal operation time of 102 minutes; the total ECMO support time was 200 minutes. On postoperative day 1, the patient was transferred from intensive care to the general ward. On postoperative day 6, a chest CT scan was performed and the drainage tubes were removed. He was discharged in good condition and without other complications on postoperative day 8. He was found to be doing well, without any respiratory symptoms, 9 months postoperatively.

Discussion

TBIs in children are rare, occurring in $<0.05\%$ of chest traumas [3]. Moreover, the diagnosis of traumatic TBIs is often delayed, due to occult clinical findings [4]. Our patient had mild symptoms that resolved quickly, after 2 days. In addition, diagnosis of the TBI was difficult because the parietal pleura covered the injury, masking the symptoms and signs. Hwang et al. [4] reported that only 47.8% of patients with a TBI were diagnosed within 48 hours. Although plain chest radiography is the initial imaging modality, it can be misleading in cases of TBI due to blunt trauma, as it shows normal results in 1 in 5 cases [5]. Most authors agree that TBI is best diagnosed by a bronchoscopic examination [3]. Hwang et al. [4] reported that among TBI patients undergoing bronchoscopy, 100% of the cases were detected, compared to just 50% with CT. An initial suspicion of TBI greatly increases the likelihood of its diagnosis. The bronchoscopic criteria for surgery include tears involving the full thickness of the tracheal wall, tears >2 cm, and transluminal ruptures involving the parenchyma [1]. Our patient was first treated with conservative management for a misdiagnosed pneumomediastinum, but the follow-up CT scan showed an extended TBI. Compared with the initial CT scan, the TBI was clearer, so we thought that it had progressed despite the conservative treatment. The injury extended from the main trachea to main bronchus, about 3–4 cm longitudinally, and a transverse injury may induce interruption of airway continuity or stenosis after spontaneous healing. However, a bronchoscopic exam is often difficult to perform in children due to their small airways. Selective 1-lung intubation and double-lumen intubation are options for managing ventilation issues during tracheobronchial surgery. Furthermore, during surgical repair of a carinal injury or an injury to both sides of the main bronchus, ventilation may be disrupted. In these situations, ECMO should be considered, as its use can prevent catastrophic results. However, because children are cannulated in the carotid artery, ECMO is not generally preferred because it impedes surgery and increases the risk of neurological complications. ECMO support has been used in TBI patients with respiratory failure, but in our pediatric patient, ECMO support was implemented for 200 minutes during the surgical repair of the injury. Our case demonstrates the utility of ECMO in preventing desaturation during surgery and shows that its short-term use in children is associated with a minimal risk of complications.

In conclusion, this case highlights the importance of suspecting TBI in order to diagnose it correctly. During tracheal repair in pediatric TBI patients, the short-term use of venoarterial ECMO can prevent intraoperative respiratory problems.

Conflict of interest

No potential conflicts of interest relevant to this article are reported.

References

1. Ballouhey Q, Fesseau R, Benouaich V, et al. *Management of blunt tracheobronchial trauma in the pediatric age group*. Eur J Trauma Emerg Surg 2013;39:167-71.
2. Ballouhey Q, Fesseau R, Benouaich V, Leobon B. *Benefits of extracorporeal membrane oxygenation for major blunt tracheobronchial trauma in the paediatric age group*. Eur J Cardiothorac Surg 2013;43:864-5.
3. Dominguez E, De La Torre C, Sanchez AV, et al. *Severe tracheobronchial injuries: our experience*. Eur J Pediatr Surg 2015;25:71-6.
4. Hwang JJ, Kim YJ, Cho HM, Lee TY. *Traumatic tracheobronchial injury: delayed diagnosis and treatment outcome*. Korean J Thorac Cardiovasc Surg 2013;46:197-201.
5. Juvekar NM, Deshpande SS, Nadkarni A, Kanitkar S. *Perioperative management of tracheobronchial injury following blunt trauma*. Ann Card Anaesth 2013;16:140-3.