Tension Pneumothorax Complicated by Double-Lumen Endotracheal Tube Intubation

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Tension pneumothorax is not a rare complication of mechanical ventilation, but its occurrence immediately after intubation with a double-lumen endotracheal tube (DLT) is very rare. Subsequent impairment of the respiratory and cardiovascular function can be life threatening if it is not detected early enough and managed properly. Most reported cases of tension pneumothorax during DLT intubation occurred when one-lung ventilation was applied. Herein we report a case of tension pneumothorax and pneumoperitoneum which occurred immediately after DLT intubation. It appeared before one-lung ventilation was applied because of an inappropriately small-sized and malpositioned DLT. *(Chang Gung Med J 2005;28:503-7)*

Key words: complication, tension pneumothorax, anesthesia, double lumen endotracheal tube intubation.

Double-lumen endotracheal tubes (DLTs) are used to isolate the lung being operated on from the other lung. The tube size and tube position affect the adequacy of ventilation and oxygenation during one-lung anesthesia. Choosing the correct size of a DLT for an individual patient is important. An inappropriately small DLT will either fail to provide lung isolation or will require endobronchial cuff volumes and pressures that could damage the bronchus. Too large of a DLT can rupture the trachea or bronchus. Herein we present a case of tension pneumothorax and pneumoperitoneum immediately after DLT intubation due to an inappropriately small-sized and malpositioned DLT.

CASE REPORT

A 34-year-old male patient was scheduled for an elective right thoracotomy due to right-side pneumothorax. He had a history of asthma since childhood and a history of right-side spontaneous pneumothorax which had occurred twice. He had undergone a right thoracotomy 3 years previous for that reason. Right-side chest tube insertion was performed during this hospitalization. Physical examination of the patient showed that he weighed 60 kg and was 170 cm tall. All laboratory data were normal. Preoperative chest radiography showed right lung collapse despite chest tube insertion. The left lung appeared normal. On arrival in the operating room, his vital signs were blood pressure of 135/80 mmHg, heart rate of 105 beats/min, and an SpO_2 of 90% at room air which rose to 98% with the O_2 mask. On auscultation, faint breath sounds over the right lung and prominent expiratory wheezing in the left lung were heard. After preoxygenation, we induced anesthesia with 150 μg of fentanyl, 5 mg/kg sodium thiopental, and 30 mg rocuronium intravenously. After deepening the anesthesia with sevoflurane and oxygen, the patient was intubated

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with a 35F left DLT under direct laryngoscopy. After the trachea was intubated, the stylet was removed and the tube was turned 90° counterclockwise and advanced until moderate resistance was felt. The depth of insertion was 31 cm on the tube at the level of the patient's incisors. After intubation, manual ventilation was instituted through the DLT, and we prepared to check the position of the DLT. During manual positive-pressure ventilation, increased airway pressure was noted through the endotracheal tube. No breathing sound was heard over either lung field. There was an absence of end-tidal CO_2 on the monitor. At that time, electrocardiography (EKG) showed a sinus rhythm of 80 beats/min and the SpO_2 was 98%. We prepared a fiberoptic bronchoscope to ensure the correct positioning of the DLT. Before evaluation with the fiberoptic bronchoscope, we noted that the patient's lips were cyanotic. The DLT was immediately replaced with a 7.5-mm single-lumen endotracheal tube without difficulty. We also made sure that the DLT tube was in the trachea, not in the esophagus by direct laryngoscopy. The peak inspiratory pressure felt high with manual ventilation after changing the tube. Because of the impression of an episode of severe bronchospasms, 1 mg epinephrine diluted with normal saline was injected through the endotracheal tube into the trachea, but in vain. No bloody discharge was seen during suctioning from the endotracheal tube. Meanwhile, the SpO_2 had disappeared, and the blood pressure could not be measured. No palpable carotid pulse with electrical activity on the EKG contributed to a diagnosis of pulseless electrical activity (PEA). Together with PEA and no breathing sound over the left lung, a tentative diagnosis of left tension pneumothorax was made. We called for help, began cardiopulmonary resuscitation (CPR), and immediately inserted a chest tube into the left lung. During the CPR, there were 2 episodes of pulseless ventricular tachycardia which were followed by defibrillation. After chest tube insertion, there was a dramatic restoration of spontaneous circulation. His blood pressure was 108/30 mmHg and heart rate was 125 beats/min. The SpO_2 returned to 88%, and the end tidal CO_2 was 37 mmHg. Marked pneumoperitoneum, and subcutaneous emphysema over the chest, neck, and scrotum were noted. When the patient's condition had stabilized, a portable chest radiograph was performed, and left tension pneumothorax with mediastinal shift towards the right lung was confirmed (Fig. 1). The surgery was cancelled, and he was transferred to the intensive care unit for further treatment. The patient never recovered consciousness because of hypoxic encephalopathy. He died due to sepsis on the 22nd postoperative day.

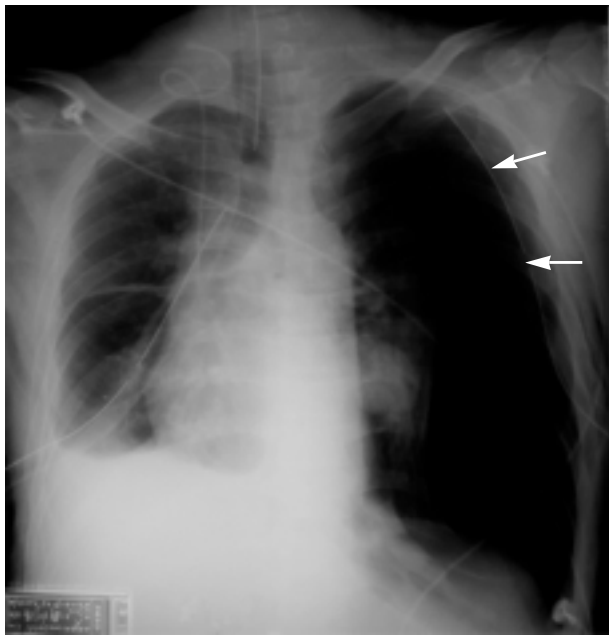

Fig. 1 Chest radiograph showing the right chest tube, rightward mediastinal shift, and left tension pneumothorax. Arrows indicate the left chest tube and left tension pneumothorax.

DISCUSSION

The chance for airway trauma anywhere in the respiratory tract is present during DLT intubation. The most-likely mechanism of airway trauma is due to an inappropriately sized DLT. Too large of a DLT can rupture the trachea and bronchus.[1] Too small of a DLT can be inserted too far, and the large tidal volume delivered to that lung can result in barotrauma.[2,3] A review of the literature showed that the majority of airway injuries with DLTs occurred with smaller-sized tubes.[4] They showed that in 5 of 14 cases (36%), a 35F tube was used, in 3 of 14 cases (21%), a 37F tube was used, and in 3 of 14 cases (21%), a 39F DLT was used.[4] No 41F DLT was associated with a major airway injury.[4] In our patient, the possible mechanism of the tension pneu-

mothorax was an inappropriately small left DLT which went in too far, and most of the tidal volume during manual positive-pressure ventilation was delivered to the left lung, resulting in barotrauma. The situation was even worse in our patient who had preexisting right-side pneumothorax. The additional left tension pneumothorax resulted in ventilatory failure, followed by cardiovascular collapse.

Choosing the correct size of the DLT is important for preventing barotrauma. The left main-stem bronchial diameter may provide a useful guide for choosing the appropriate DLT size for a patient.[5] The diameter of the left main-stem bronchus can be measured by posteroanterior chest radiography. The measured diameter is then reduced by 8% to 10% to compensate for the magnification of intrathoracic structures on PA films. Computed tomography of the thorax is better than a chest radiograph,[6] as it avoids the overlying soft tissue, which can make the bronchi difficult to identify on chest X-rays. It can accurately identify the bronchial wall, thus facilitating measurement of the bronchial diameter. Measurement of the tracheal width is also sufficient for predicting bronchial size.[7] The left bronchial diameter can accurately be determined using a ratio of the left bronchial diameter to tracheal diameter of 0.68.[7]

The optimal size of a DLT can easily be determined if the diameters of the patient's left main bronchus and left DLT bronchial tip are known.[1] A tube should be chosen with a bronchial end that is 1.0 to 2.0 mm smaller in diameter than the intubated bronchus. The bronchial tip diameter of different types of DLT is readily available in the literature.[1] The correct depth of DLT insertion is also very important to avoid major airway trauma. One study showed that the best method is to insert the DLT to a predetermined depth based on patient's height and check the position of the tube for correct depth of insertion using a fiberoptic bronchoscope before positive-pressure ventilation is initiated.[8] They showed that the average depth of insertion for both male and female patients 170 cm tall was 29 cm, and for each 10 cm increase or decrease in height, the average placement depth was increased or decreased 1 cm. As the depth of DLT insertion at any given height is normally distributed, a fiberoptic bronchoscopic examination to confirm correct DLT position should always be carried out after initial placement. The 35F size was too small for our 60-kg patient, and the 31-cm depth of the DLT was too far into the left lung for his height of 170 cm. According to the literature, we should have used a 39F DLT and a 29-cm depth of insertion to prevent barotrauma in this patient.

Intubation-induced bronchospasms, especially in asthma patients, can cause silent chest immediately after endotracheal intubation. But it rarely leads to cardiovascular collapse. Since the patient had a history of asthma and several episodes of spontaneous pneumothorax, it is probable that bullae or blebs in both lungs may have been present although the preoperative chest radiography appeared normal in the contralateral lung. When we ventilated the lungs, most of the tidal volume was delivered to the contralateral side resulting in tension pneumothorax because the DLT was too small and too far into the left lung. Although fiberoptic bronchoscopy can be ruled out in major airway trauma, air under pressure will dissect along the lung surface and travel toward the mediastinum where it can cause pneumomediastinum.[9] Pneumoperitoneum is due to an air leak through the diaphragmatic opening which reaches the peritoneal cavity.[9] This is the most-probable mechanism in this patient who developed pneumothorax, pneumoperitoneum, and subcutaneous emphysema over the chest, neck, and scrotum.

In conclusion, we report a case of tension pneumothorax noted immediately after DLT intubation. To prevent the occurrence of tension pneumothorax, the importance of choosing the correct size and proper placement of double lumen endotracheal tubes cannot be overlooked. Correct positioning should be ascertained with fiberoptic bronchoscopy immediately after DLT intubation in order to prevent barotrauma. Also, anesthesiologists should be aware that tension pneumothorax can occur throughout the procedure of DLT intubation and also before one-lung ventilation.

REFERENCES

1. Hannallah MS, Benumof JL, Ruttimann UE. The relationship between left mainstem bronchial diameter and patient size. J Cardiothoracic Vasc Anesth 1995;9:119-21.
2. Malik S, Shapiro WA, Jablons D, Katz JA. Contralateral tension pneumothorax during one-lung ventilation for lobectomy: diagnosis aided by fiberoptic bronchoscopy. Anesth Analg 2002;95:570-2.
3. Wagner DL, Gammage GW, Wong ML. Tracheal rupture following the insertion of a disposable double-lumen

endotracheal tube. Anesthesiology 1985;63:698-700.
4. Fitzmaurice BG, Brodsky BJ. Airway rupture from double-lumen tubes. J Cardiothoracic Vasc Anesth 1999;13:322-9.
5. Sivalingam P, Tio R. Tension pneumothorax, pneumomediastinum, pneumoperitoneum, and subcutaneous emphysema in a 15-year-old Chinese girl after a double-lumen tube intubation and one-lung ventilation. J Cardiothoracic Vasc Anesth 1999;13:312-5.
6. Hannallah M, Benumof JL, Silverman PM, Kelly LC, Lea D. Evaluation of an approach to choosing a left double-lumen tube size based on chest computed tomographic scan measurement of left mainstem bronchial diameter. J Cardiothoracic Vasc Anesth 1997;11:168-71.
7. Brodsky JB, Macario A, Mark JB. Tracheal diameter predicts double-lumen tube size: a method for selecting left double-lumen tubes. Anesth Analg 1996;82:861-4.
8. Brodsky JB, Benumof JL, Ehrenwerth J, Ozaki GT. Depth of placement of left double-lumen endotracheal tubes. Anesth Analg 1991;73:570-2.
9. Egan M, Boutros A. Pneumoperitoneum following pneumothorax. Report of two cases. Crit Care Med 1975;3:170-2.

插雙管氣管內管併發張力性氣胸

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機械性通氣造成張力性氣胸並非罕見，但插雙管氣管內管併發張力性氣胸是非常罕見的。一旦發生立即引起呼吸及心臟功能衰竭後病患會立刻死亡。文獻報告指出張力性氣胸幾乎只發生在單側肺通氣之後。我們報告一位病患麻醉誘導後插雙管氣管內管，單側肺通氣之前發生張力性氣胸。插雙管氣管內管後病患出現發紺,無脈搏電氣活動以及休克。實施高級心臟救命術並插左側胸管治療後心跳血壓恢復正常。文中我們分析插雙管氣管內管時發生張力性氣胸的可能原因，以供大家參考。(長庚醫誌 2005;28:503-7)

關鍵字：併發症，張力性氣胸，麻醉，雙管氣管內管插管。

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