

中文題目：中央氣道阻塞導致低潮氣容積警示的經典影像

英文題目：Classic image of low tidal volume alarm due to central airway obstruction

作者：陳智選¹，陳昫元²，郭育筑²，陳韋成²

服務單位：¹中國醫藥大學附設醫院內科部，²中國醫藥大學附設醫院胸腔內科

Introduction

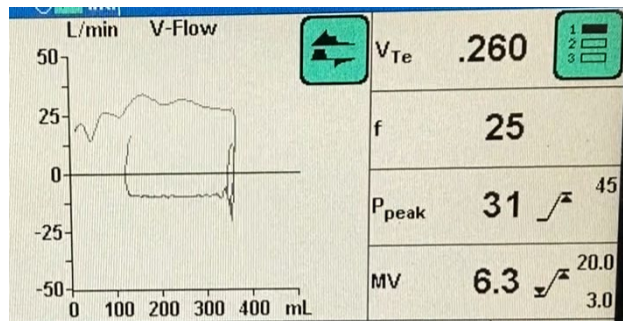
Low tidal volume alarm commonly happened in intensive care unit. It is important for young resident to immediately find out the reason and solve the crisis of low tidal volume before the complication of hypoxemia. Here we presented a case of sudden decrease in tidal volume in a patient with tracheostomy.

Case presentation

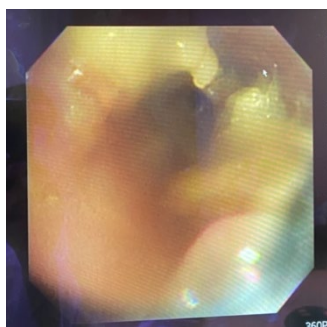
An 88-years-old man with a history of traumatic subdural hemorrhage status post craniectomy with tracheostomy tube placement and coronary artery disease presented in the emergency department with shortness of breath for one day. Much sticky sputum was told by caregiver. The vital signs at initial triage were body temperature of 37.2°C, blood pressure of 165/81 mmHg, pulse rate of 129 beats per minute, respiratory rate of 30 breaths per minute, and oxygen saturation level of 90% at room air. The physical examination showed wheezed breathing sound, regular heartbeat without audible murmur. Accessory muscle using and paroxysmal breathing pattern were noted. After connecting to the mechanical ventilation for effort breathing, the oxygen saturation returned to 100% and paradoxical breathing pattern was diminished under the setting of volume-controlled mode with fraction of inspired oxygen of 30%, positive end-expiratory pressure of 8 cm of water, tidal volume 454ml.

However, tachycardia and dyspnea occurred suddenly with ventilator alarming at 6 hours after admission. Physical examination revealed paradoxical breathing, wheezing especially on pre-sternal area, decreased breathing sound on bilateral peripheral chest. The panel of ventilator showed reduced tidal volume around 130ml and high peak inspiratory pressure up to 39cmH₂O. The bronchospasm was impressed by duty physician and salbutamol and ipratropium inhalation and hydrocortisone infusion were used twice. Limited tidal volume persisted with decline of saturation to 92% even after fentanyl and midazolam infusion. The Rectangular shape with flattened top and bottom of the loop was noted on flow-volume loop of ventilator(Picture 1). Central airway obstruction was suspected, and the suction tube cannot fully be inserted for sputum suction. Near total occlusion of tracheostomy tube due to sticky mucus plugs was found under emergent bronchoscopy(Picture 2 and picture 3). The breathing pattern and desaturation were improved immediately after replacement of a new tracheostomy tube. On the next day, the patient tolerated well with pressure support ventilation and

weaning successfully with oxygen therapy from T-piece 0.3L/min. He was transferred to general ward for further care then.



Picture 1. Showed flow-volume loop of patient under ventilator.



Picture 2. Showed bronchoscope of patient with severe mucus plug obstruction.



Picture 3. Showed outer appearance of tracheostomy tube

Discussion

Low tidal volume alarm on mechanical ventilator is a common situation encountered and well-understanding of the background knowledge is important to solve the crisis.

The most common situation of decreased tidal volume is large leak in ventilator, including ventilator disconnection. Careful checking the ventilator circuit is needed.^{1,2} The second common cause is high airway pressure, such as ventilator circuit kinking, wet filters with increase resistance, bronchospasm (asthma or chronic obstructive pulmonary disease), reduced lung compliance (acute respiratory distress syndrome, and lung fibrosis etc.), chest wall restriction (abdominal distention, kyphoscoliosis, obesity etc.), and patient-ventilator asynchrony (coughing, double trigger, insufficient flow, etc.).^{3,4,5} The flow-volume loop could give some hints on airway problems. For example,

flatten on top and bottom of flow-volume loop with rectangular shaped may be showed when fixed obstruction.^{6,7,8} When large airway obstruction is highly suspected, bronchoscope is a direct way to check when there was suspicious on airways problem. The possible different diagnosis for central airway obstruction includes airway obstruction due to sputum, blood clot, foreign body, or tumor, airway stenosis, bronchopulmonary hemorrhage or inflammation.^{9,10}

Conclusion

Timely identification of the classic pattern of central airway obstruction on ventilator is crucial and educational for young resident training in intensive care unit.

References

1. Saudi J Anaesth. 2017 Oct-Dec; 11(4): 496–497.
2. Singh PM, Kaur M, Rewari V. An unusual site of leak in anaesthesia circuit. *Anesth Essays Res.* 2012;6:111.
3. Ann Transl Med. 2017 Jul; 5(14): 287.
4. Ther Adv Respir Dis. 2016 Feb; 10(1): 57–71.
5. J Appl Physiol (1985). 2018 May 1; 124(5): 1186–1193.
6. Respir Care. 2009 Apr;54(4):474-9.
7. Garcia-Pachon E. Tracheobronchomalacia: a cause of flow oscillations on the flow-volume loop. *Chest* 2000; 118:1519.
8. Harrison BD. Upper airway obstruction--a report on sixteen patients. *Q J Med* 1976; 45:625.
9. J Thorac Dis. 2016 Dec; 8(12): 3826–3837.
10. Antoni Rosell, Grigoris Stratakos. *European Respiratory Review* 2020 29: 190178.