

## Answer

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The most likely answer is: B. endotracheal tube (ETT) obstruction. A right mainstem intubation was ruled out radiographically. Cuff herniation is unlikely because the cuff was deflated and re-inflated to ensure it was not causing an obstruction. Severe bronchospasm would not have resolved simply by changing the ETT.

On examination of the first ETT used (see Fig. 1), the lumen was 60% to 70% occluded by a large blood clot, which was probably a result of the bleeding in the patient's mouth from the fractured jaw. Proper suctioning prior to intubation, as well as diligence in suctioning orally and down the ETT to ensure a patent airway, may have prevented this complication.



Fig. 1. Distal end of the first 8-mm endotracheal tube (subsequently replaced). Note the large blood clot partially occluding the distal lumen.

The dangers of high ventilating pressures are well documented. High airway pressures cause alveolar damage<sup>1</sup> as well as other pulmonary injuries such as pneumothorax, pneumomediastinum and subcutaneous emphysema.<sup>2</sup> It is therefore important to find the cause of the high inspiratory pressure.

Causes of high inspiratory pressure in trauma patients may be due to a number of factors. A systematic approach is needed in order to locate the source of the problem. This can be achieved by tracing the flow of gas, namely from the ventilator to the airway and finally, to the patient (VAP).

If the problem is not immediately apparent, an important first determination is to separate problems with the ventilator from those of the airway or patient. This is done simply by disconnecting the patient from the ventilator and using a resuscitation bag to ventilate the patient manually.<sup>3</sup> If the patient improves, the source of the problem lies with the ventilator. Mechanical problems that may cause elevated ventilating pressures include an excessive tidal volume or an inverse I:E (inspiratory time to expiratory time) ratio that causes air trapping. Otherwise, the problem resides further downstream with the airway or the patient.

Problems with the airway causing high ventilating pressures include displacement of the airway or obstruction of the airway by kinking, a foreign body, or cuff herniation. Passing a suction catheter down the ETT can help determine patency of the airway.

The "cuff deflation test" may also be used to see if there is an obstructed ETT.<sup>4</sup> If the cuff is deflated and there is no change in the gas leak around the ETT, it suggests ETT obstruction. If the gas leak increases with deflation it suggests obstruction distal to the ETT. Further, a gas leak with hyperinflation of the cuff suggests that the obstruction is

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distal to the ETT.<sup>4</sup> If the tube is kinked, a simple manual manipulation of the airway is needed.

ETT cuff herniation can cause obstruction of the distal end of the tube. If it is suspected, the cuff should be fully deflated and re-inflated. Displacement of the airway may be checked radiographically, but more immediate tests in-

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clude checking the centimetre markings on the ETT, using a CO<sub>2</sub> detector to rule out esophageal intubation, auscultating to ensure equal and bilateral air entry and performing direct visualization by laryngoscopy. Reducing the high airway pressure may simply be a matter of pulling the ETT back until it no longer impinges on the carina. If the ETT is deemed patent and in good position, and the problem

persists, the source of the elevated airway pressure is with the patient.

An important cause of elevated ventilating pressure can be patient dyssynchrony with the ventilator. If this is the case, sedation is not only warranted but necessary for patient comfort. If the airway pressure remains elevated, then further investigation is needed to determine its cause.

The cause of high airway pressures can be determined systematically by tracing the VAP flow. In this way, it becomes easier to isolate the source of the problem and treat it as expeditiously as possible.

For the Challenge, see page 255.

**Competing interests:** None declared.

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