Intraoperative Atelectasis Due to Endotracheal Tube Cuff Herniation: A Case Report

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Received: 8 Feb. 2012; Received in revised form: 1 Jul. 2012; Accepted: 19 Jul. 2012

Abstract- Endotracheal tube (ETT) cuff herniation is a rare, and often difficult to diagnose, cause of bronchial obstruction. We present a case of outside cuff herniation of an endotracheal tube that caused pulmonary right lung atelectasis. A 29-year-old man ,a case of car accident with multiple fractures, was admitted to the emergency ward and transferred to the operating room(OR) for open reduction and internal fixation (ORIF) of all fractures .The procedures were done under general anesthesia (G/A). The past medical history of the patient did not indicate any problem. Anesthesia was induced with thiopental, atracurium and then maintained by propofol and remifentanyl infusions and 100% O_2 via orally inserted ETT. The patient was positioned in left lateral decubitus position for operation. Two hours after induction of anesthesia, the oxygen saturation level dropped to 85 % and the breath sounds in the right side of the chest were weakened. The chest x–ray images showed right lung atelectasis especially in the upper lobe. The problem was disappeared after removal of the ETT. In this case, we observed that an ETT cuff herniation can be a cause of airway obstruction. If there is a decreased unilateral breath sounds, we recommend replacement or repositioning of ETT.

Acta Medica Iranica, 2012; 50(9): 652-654.

Keywords: Endotracheal tube defect; Intraoperative atelectasis; Intraoperative hypoxemia; Lung

Introduction

Intraoperative drop of O_2 saturation may be caused by a variety of factors, 1- Reduction of alveolar ventilation 2- Disturbance of gases diffusion 3- Pulmonary edema 4- Embolism of pulmonary arteries 5- Bronchospasm 6- Pneumothorax 7- Secretion accumulation in the trachea and 8-One-lung ventilation.

One of the causes of reduction of alveolar ventilation is intraoperative atelectasis. In definition, atelectasis is loss of volume of the lung; lobe or segment from any cause .It is a condition where the alveoli are deflated, as distinct from pulmonary consolidation (1). Intraoperative atelectasis may be caused by a variety of factors, which have been classified into three basic mechanisms. Compression atelectasis occurs when the transmural pressure distending the alveolus is reduced. Absorption atelectasis occurs when less gas enters the alveolus than is removed by uptake by the blood. Loss-of-surfactant atelectasis occurs when the surface tension of an alveolus increases because of reduced surfactant action. Any of these factors may contribute to atelectasis during anesthesia and the postoperative period. Absorption atelectasis can occur by two mechanisms. The first mechanism is complete airway occlusion .The second mechanism is when the inspired ventilation/perfusion (VA/Q) is less than a critical value (2).

Complete airway occlusion in the acute setting usually occur secondary to mucous plugging. Other causes are endobronchial tumor, malposition of ETT, foreign body endobrochial intubation, and so for (1). ETT Cuff herniation is a rare and often difficult to diagnose the cause of bronchial obstructions. We observed the right lung atelectasis due to ETT Cuff herniation.

Case Report

A 29-year-old man was admitted for fractures of both femoral shaft and left forearm due to car accident. In his past medical history, there was not any sign of

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cardiopulmonary diseases or smoking. His vital signs, chest and abdominal physical examination were normal. Electrocardiogram (ECG) and Chest x-Ray were taken two hours before operation and they were normal. Open reduction and internal fixation was planned and G/A was indicated.

Anesthesia was induced by 4 ml remifentanyl, 4mg ondansetron, 250mg Thiopental, and 40mg atracurium and maintained with infusion of 2µg/min remifentanyl, 600mg/h propofol.

After induction of anesthesia, an ETT was orally induced to the trachea and auscultation of both hemithoraces was checked. ETT was disposable and when its cuff was inflated with 5cc air it seemed to be normal before intubation. Integrity of the cuff was assessed preoperatively and no contact occurred between the cuff and teeth during intubation. The Patient was placed in the left lateral decubitus position and chest ventilation was checked and then the operation began.

Lung ventilation supported by FiO_2=100% positive end expiratory pressure (PEEP)=3cm H_2O ,Rate= 14/min, tidal volume=800 ml and mode of ventilation was continues mandatory ventilation (CMV). Patient was being monitored by using the ECG, capnography, pulse oximetry. Two hours after induction of anesthesia oxygen saturation dropped to 85%, chest auscultation showed decreased breath sounds in right hemithorax especially its upper part. Then tube obstruction was ruled out by successfully passing a suction catheter through the ETT. Therefore patient was changed to the supine position and ETT cuff deflated and repositioned but the problem did not resolve. Then, a portable chest x-ray was taken to rule out the possibility of pneumothorax. There was no sign of pneumothorax in CXR, but chest x–ray images showed right lung atelectasis especially its upper lob (Figure1).

After removal of ETT, an aneurysm of the cuff was evident (Figure 2).

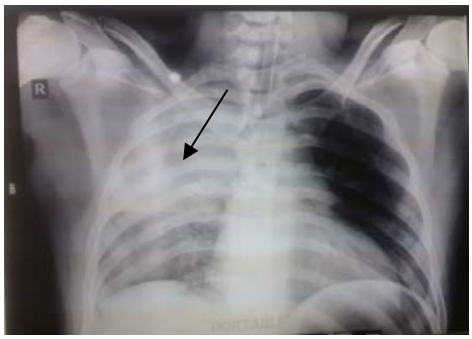

Figure 1. Pulmonary right upper lobe atelectasis after two hours induction of anesthesia

Figure 2. Endotracheal tube cuff herniated to outside

Rigid bronchoscopy illustrated normal tracheobrocheal anatomy, and the thin secretions lying distal to the right bronchus and especially right upper bronchus were suctioned out.

Ventilation and oxygen saturation showed improvement, therefore operation continued and chest x-ray became normal after 48 hours.

Discussion

We observed a right pulmonary atelectasis especially its upper lobe, following the endotracheal intubation. In this patient, based on the observations, atelectasis occurred during the operation. We didn't find thick sputum collection or right upper lobe tracheal bronchus and others causes of right upper lobe atelectasis during rigid bronchoscopy. Therefore we thought that when the patient was placed in the left lateral decubitus position, head fell into flexion and ETT advanced into a rare position in which the Morphy's eye was faced into the opening of right bronchus and the tip orifice was entered into the left one but the opening of right bronchus was partially obstructed by the herniated diverticulum like part of cuff in a manner that completely obstructed the right upper lobe entrance and partially right bronchus. The cuff herniation may develop at once or gradually. Since the respiration of the patient at first was good and then gradually worsened, the cuff appeared to slowly deformed and herniated in to the right bronchus and caused obstruction of this bronchus and consequently right pulmonary and especially upper lobe atelectasis. There is an expectation that modern low-pressure high volume endotracheal cuffs will not herniated and occlude inspiratory gas flow .5mL of air in the cuff could expand to between 35 and 40 mL in 1 h. There may have been a fault in the cuff wall, one part of which was thinner than the rest, possibly causing disproportionate swelling in one area of the cuff and

occluding the right upper lobe entrance and partially right bronchus (3).

Cuff herniation may have been caused by unsuitable material or its structural drawback, and malposition of ETT especially after left lateral decubitus position. Herniation may have been due to air-filled cuff over inflation; the deformed cuff may either block the lumen at the end of the tube, or push the tube against the tracheal wall. In the reported case, the deformed cuff pushes the tube in to the right bronchus and especially caused obstruction right upper bronchus. Decrease of O2 saturation was the cause of attention of anesthetist and so, pulse oximetry was helpful for early diagnosis. Missed cuff herniation despite fiberoptic bronchoscopy reported by Jariani and Orser (4). Performing the cuff deflation test is the simple way to diagnose cuff herniation. Awareness of this condition, especially when anesthesiologists lose direct control of the airway during such procedures is important because undesirable complications can be prevented through quick decision and action (5). Careful management of cuff pressures especially when nitrous oxide is used, awareness of the condition and monitoring of the patient can prevent fatal consequences. We reported this case to remind our colleagues that cuff herniation is still encountered even with modern-ETTs**.** In conclusion, we recommend re-evaluating ETT after any patient's change of position. In addition, since equipment failure can be a cause of desaturation, it is advised to carefully check equipment which is going to be used before anesthesia.

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