

CARDIAC ARREST AS A RESULT OF ONE-WAY VALVE TYPE OBSTRUCTION OF THE ENDOTRACHEAL TUBE

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ABSTRACT:

In cases of sudden hypercapnia developing in a mechanically ventilated patient, obstruction of the endotracheal tube (ETT) should be suspected first at the outset. Herein we aimed to show that one-way valve type ETT obstruction is a major clinical event that can lead to patient morbidity and mortality in mechanically ventilated intensive care unit (ICU) patients. Case Report: A 74-year-old male who had coronary artery disease and diabetes mellitus and developed pneumonia after coronary by-pass surgery could not be extubated in the cardiovascular surgery unit and was sent to our ICU on the 35th day of the postoperative period. After 12 hours, the patient had developed bradycardia and cardiac arrest. The patient underwent approximately 40 minutes of cardiopulmonary resuscitation (CPR) prior to recovery. However, PaCO₂ and PaO₂ were 116 and 83 mmHg respectively. Lung sounds were not heard on auscultation bilaterally. With these findings, pneumothorax was suspected due to rib fractures that developed after CPR and anterior midclavicular thoracostomy was performed with 2nd intercostal access bilaterally. Three milliliters of hemorrhagic material containing air was aspirated totally. Thirty minutes after thoracostomy, a chest X-ray showed pneumothorax bilaterally; thus a bilateral chest tube was placed. In the 90th minute, ventilation could not be achieved either by respirator or bag-valve device and then the ETT was changed and a large plug was detected. After reintubation vital signs and blood gases returned to normal limits. Conclusion: In this case we thought that the suctioning tubes had pushed the plug into the trachea and caused diagnostic difficulties. For patients who are on long-term ventilatory support, humidification systems must be used. If the patients develop sudden ventilation difficulties, the ETT must be changed before the other procedures.

Key Words: Intubation, Complication, Obstruction, Hypoxia

ENDOTRAKEAL TÜPÜN TEK YÖNLÜ VALV TİPİ OBSTRÜKSİYONU SONUCU GELİŞEN KARDİYAK ARREST ÖZ:

Mekanik ventile edilen bir hastada ani hiperkarbi gelişmesi durumunda ilk şüphe edilmesi gereken endotrakeal tüpün obstrüksiyonu olmalıdır. Biz burada; tek yönlü valv tipi endotrakeal tüp obstrüksiyonunun, mekanik ventile edilen yoğun bakım ünitesi (YBÜ) hastasında mortalite ve morbiditeye neden olabileceğini vurgulamak istedik. Olgu Sunumu: 74 yaşında özgeçmişinde koroner arter hastalığı, hipertansiyon ve diyabeti olan erkek hasta, koroner bypass operasyonundan sonra pnömoni ve postoperatif ensefalopati gelişmesi üzerine kardiyovasküler cerrahi ünitesinde extübe edilemeyip, postoperatif 35.gün YBÜ'mize devredildi. On iki saat sonra bradikardi ve kardiyak arrest gelişti, yapılan kardiyopulmoner resusitasyona (KPR) 40.dakikada cevap alındı. Bununla birlikte PaCO₂ ve PaO₂ sırasıyla 116 ve 83 mmHg idi. Oskültasyonda bilateral olarak akciğer sesleri duyulmuyordu. Bu bulgularla, KPR sırasında oluşan kırıklarının pnömotoraksa yol açtığı düşünülmüş, bilateral olarak anterior mid-klavikular yaklaşımla 2. interkostal aralıktan torasentez yapıldı. Hava ile karışık 3 ml hemorajik materyal aspire edildi. Torasentezden 30 dakika sonra, akciğer grafisinde bilateral pnömotoraks gözlemlendi ve bilateral göğüs tüpü yerleştirildi. Doksanmıncı dakikada ventilasyon ne mekanik ventilatör ne deambu ile sağlanamadı ve endotrakeal tüp değiştirildi, büyük bir tıkaç olduğu görüldü. Reentübasyondan sonra vital bulgular ve kan gazı değerleri normal limitlere geri döndü. Sonuç: Bu olguda; aspirasyon sondalarının, tıkaçı trakeada ileri ittiğini ve tanıyı güçleştirdiğini düşünüyoruz. Özellikle uzun dönem mekanik olarak ventile edilen hastalarda humidifikasyon sistemleri kullanılmalıdır. Bu olguda olduğu gibi, aniden ventilasyonda güçlükle gelişirse, diğer işlemlerden önce endotrakeal tüp değiştirilmelidir.

Anahtar Kelimeler: Entübasyon, Komplikasyon, Obstrüksiyon, Hipoksi

INTRODUCTION

Partial obstruction of the endotracheal tube (ETT) is a notorious problem for ventilator dependent patients, and detecting narrowing of the ETT or the circuit is essential with respect to patient safety and prevention of prolonged mechanical ventilation resulting from ETT induced increased work of breathing. Pneumomediastinum, pneumothorax, subcutaneous emphysema, and interstitial emphysema are well-known complications of mechanical ventilation, thought to be associated with regional or localized alveolar hyperinflation.

In cases of sudden hypercapnia developing in a mechanically ventilated patient, obstruction of the ETT should be suspected first. In this paper we aimed to show that one-way valve type partial ETT obstruction is a major clinical event that can lead to patient morbidity and mortality in mechanically ventilated intensive care unit (ICU) patients.

CASE REPORT

A 74-year-old male who had coronary artery disease and diabetes mellitus and developed pneumonia after coronary by-pass surgery could not be extubated in the cardiovascular surgery unit and was sent to the ICU on the 35th postoperative day. The patient developed bradycardia and cardiac arrest in the 12 hours after admittance to the ICU. He responded well to CPR after 40 minutes. Catheter suctioning of the ETT using a small amount of saline lavage yielded moderate amounts of tenacious secretions and some improvement in respiratory status. Peak inspiratory pressure (PIP) remained between 15 and 25 cm H₂O. Arterial blood gas values revealed a pH of 7.19, PCO₂ of 116 mmHg, and PO₂ of 83 mmHg. Bilateral breath sounds were absent in auscultation. With these signs, pneumothorax due to rib fractures was suspected and bilateral anterior mid-clavicular thoracostomy was performed with second intercostal access. Three milliliters of hemorrhagic material containing air was aspirated in total. Arterial blood gas values revealed a pH of 7.03, PCO₂ of 101 mmHg, and PO₂ of 133 mmHg at this time. A chest X-ray taken 30 min after the thoracostomy demonstrated bilateral pneumothorax and a chest tube was inserted bilaterally. Ninety minutes after the insertion of the chest tube, ventilation became difficult and there was a sudden increase in PIP to 40-45 cm H₂O. Manual ventilation with the patient disconnected from the ventilator circuit was again difficult even after deflating the ETT cuff. The patient was emergently extubated and reintubated. Hypotension improved with administration of epinephri-

ne and dopamine after further volume repletion. Examination of the removed ETT figure revealed a mass of dried secretions and coagulated blood adherent to the internal wall of the ETT, adjacent to and occluding the Murphy eye. The mass extended beyond the end of the tube in a mobile fashion capable of intermittently occluding the distal ETT port in a one-way valve manner. The patient responded with a prompt return to baseline vital signs and PIP.

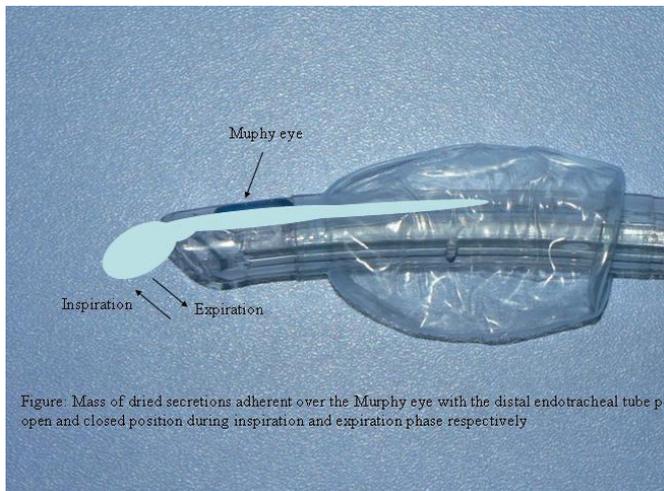


Figure: Mass of dried secretions adherent over the Murphy eye with the distal endotracheal tube port open and closed position during inspiration and expiration phase respectively

DISCUSSION

Endotracheal tube narrowing and obstruction can be important causes of morbidity among mechanically ventilated patients. More gradual narrowing of the ETT lumen can be insidious and clinically unrecognized.

Endotracheal tube obstruction can be caused by a wide variety of mechanisms. These include tube kinking, cuff herniation, and tube delamination, especially with the use of nitrous oxide in laminated, wire-reinforced endotracheal tubes. A wide variety of foreign bodies have also been reported to cause ETT obstruction, including nasal turbinates avulsed during nasotracheal intubation, surgical tape, dried lubricant, a broken endotracheal tube stylet sheath and retained plastic debris from the manufacturing of the Murphy eye. Other conditions, such as formation of endobronchial mucous plugs or blood clots, tension pneumothorax, massive aspiration, or acute bronchospasm, may be included in the differential diagnosis of a ventilated patient who suddenly becomes difficult to ventilate and has high PIP. An attempt to pass a suction catheter down the ETT to clear an obstruction and other causes of increased PIP are reported.

Higher degrees of sudden ETT obstruction represent a medical emergency and should be treated immediately. These situations are almost always detected by the traditional warning signs of ETT obstruction. In contrast, lower grades of obstruction caused by formation of biofilm or adherence of secretions to the inner surface of the tube may go unrecognized. It is important that simple tools be developed to identify these situations at the bedside so that patients can be treated promptly, thus reducing morbidity.

Kinking of tubing or blocking of the ETT by thick secretions

or similar emergencies would certainly not go undetected with peak monitoring. The mucous inside the ETT can dry out and reduce its inner diameter dramatically without causing the typical sound that might help to identify partial obstruction by auscultation. Not until narrowing is extreme will PIP increase with volume-controlled ventilation, while with pressure-controlled ventilation inspiratory volume will eventually decrease.

One-way valve type ETT obstruction by a mucous plug may not cause a problem on inspiration but may cause expiratory difficulties. On inspiration, the plug moved away from the ETT, allowing gas passage into the lung. On expiration, the plug moved back to the end of the tube, blocking the tube lumen and preventing passage of expired gas out of the lungs. The repeated one-way valve action of this mass resulted in pulmonary hyperinflation and consequent barotrauma, as manifested by a tension pneumothorax and subcutaneous emphysema.

In our case, a mass of dried secretions and clotted blood was adherent inside the tube, completely occluding the Murphy eye. The remainder of the dried secretions and clot extended beyond the tip of the ETT. The large diameter and mobility of this mass allowed it to open and close over the distal ETT port. PIP would move the mass away from the distal port, allowing inspiratory flow to occur and then expiratory pressure distal to the ETT would push the mass into the distal port, occluding expiratory flow.

Normally this type of obstruction causes sudden increases in PIP and leads to increased positive end-expiratory pressure (PEEP) and progressively more difficult ventilation. Eventually venous return is compromised and blood pressure can decrease. These complications were seen in our patient because the obstruction was not quickly removed. Whenever airway obstruction is suspected in an intubated patient, prompt, thoughtful intervention is necessary to locate and relieve the obstruction. Appropriate actions will depend on factors including the degree of obstruction (complete versus partial), anticipated difficulty of ventilation and reintubation, and availability of equipment. By utilizing physical examination findings, manual ventilation, a suction catheter, and by deflating the endotracheal cuff the problem should be localizable to the patient, the ETT, the cuff, or the ventilator circuit.

Due to the lack of an appropriate and dedicated monitoring and alarm system, partial obstruction of the ETT is a frequently overlooked and underestimated phenomenon in patients on respiratory support although it may become significant as early as within the first 24 h after intubation.

CONCLUSION

We thought that in our case the rigid suctioning tubes had pushed the plug into the trachea and caused diagnostic difficulties. In patients who are on long-term ventilatory support, humidification systems must be used. The most straightforward action would be to remove the occluded ETT, manually ventilate the patient with a bag-valve-mask device, and reattempt intubation before the other invasive procedures in patients who develop sudden ETT obstruction.

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