Case Report

Tracheostomy Cuff Herniation Following Cardiac and Pulmonary Arrest

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Abstract

Tracheostomy is a common procedure performed on patients who require long-term airway maintenance and ventilation support. It is preferred over endotracheal intubation due to its reduced airway resistance, lower risk of displacement compared with the endotracheal tube, increased patient comfort, improved weaning from mechanical ventilation, and enhanced suction capabilities. According to the literature, patients needing airway support for fewer than 12 days can undergo translaryngeal intubation, while tracheostomy is indicated for patients requiring ventilatory support for more than 20 days. Although tracheostomy is frequently performed in ICUs and operating rooms, several complications can arise following the procedure. These complications include leakage, obstruction of the tracheal tube, minor or major bleeding or oozing, barotrauma, infections, tracheoesophageal fistula, stenosis, and injury to surrounding peripheral tissues such as arteries, veins, and nerves.1

While herniation of the endotracheal cuff is a more common cause of airway obstruction and hypoxia, tracheostomy tube cuff herniation is a rare complication of this procedure.1-7

In this report, we present a rare case of cardiopulmonary arrest following the implantation of a tracheostomy tube cuff in a female patient and its management.

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Keywords: *Tracheostomy; Cuff herniation; Cardiac arrest; Pulmonary arrest; Mechanical ventilation; Mediastinitis*

Introduction

Tracheostomy is a common procedure performed on patients who require long-term airway maintenance and ventilation support. It is preferred over endotracheal intubation due to its reduced airway resistance, lower risk of displacement compared with the endotracheal tube, increased patient comfort, improved weaning from mechanical ventilation, and enhanced suction capabilities. According to the literature, patients needing airway support for fewer than 12 days can undergo translaryngeal intubation, while tracheostomy is indicated for patients requiring ventilatory

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support for more than 20 days. Although tracheostomy is frequently performed in ICUs and operating rooms, several complications can arise following the procedure. These complications include leakage, obstruction of the tracheal tube, minor or major bleeding or oozing, barotrauma, infections, tracheoesophageal fistula, stenosis, and injury to surrounding peripheral tissues such as arteries, veins, and nerves.[1]

While herniation of the endotracheal cuff is a more common cause of airway obstruction and hypoxia, tracheostomy tube cuff herniation is a rare complication of this procedure.[1-7]

In this report, we present a rare case of cardiopulmonary arrest following the implantation of a tracheostomy tube cuff in a female patient and its management.

Case Report

A 64-year-old woman who underwent coronary artery bypass graft (CABG) surgery was hospitalized at Rajaei Cardiovascular Medical and Research Center in Tehran, Iran, for a week and discharged in good general condition. About 20 days after surgery, the patient was readmitted with symptoms of left-sided paresis and hypotension (systolic blood pressure =88/70 mm Hg and heart rate =80 bpm). She was diagnosed with a cerebrovascular accident. An echocardiography test revealed mild systolic dysfunction of the left ventricle (ejection fraction =50%), with no indications of pericardial effusion, clot, or pulmonary stenosis. The vital signs of the patient during 2 tracheostomy procedures are indicated in Table 1.

Table 1. Vital signs of the patient before percutaneous dilatational tracheostomy

Vital signs following percutaneous dilatational tracheostomy				
Signs	First		Second	
	Before surgery	After surgery	Before surgery	After surgery
PO_2	80%	85%	60%	70%
O_2 saturation	94%	95%	90%	93%
SBP	160 mm Hg	165 mm Hg	160 mm Hg	140 mm Hg
DBP	80 mm Hg	80 mm Hg	80 mm Hg	75 mm Hg
HR	80/ h	85/h	100/h	98/h

SBP, Systolic blood pressure; DBP, Diastolic blood pressure; HR, Heart rate

Upon rehospitalization due to purulent secretions from the operation site and a diagnosis of mediastinitis, the patient underwent multiple debridement surgeries and wound irrigations. Ultimately, following the healing of the patient's wound, a pectoralis major flap was performed.

During the hospitalization period, due to a lack of diuresis, increased creatinine levels, and acidosis resistant to treatment, the patient underwent dialysis and several rounds of hemodialysis. Additionally, as a consequence of the infection in the left limb graft, debridement of the wound site was performed during endocardial evaluation. The patient was a candidate for percutaneous dilatational tracheostomy as a result of long-term intubation. The tracheostomy procedure was performed uneventfully alongside simultaneous left leg graft surgery. After the implantation procedure, the patient was transferred to the ICU in stable hemodynamic condition. The cardiopulmonary resuscitation was shockable, and the patient was successfully resuscitated after defibrillation and chest compressions. Chest compression, along with an injection of 1 mg epinephrine, was prescribed. During ventilation with an Ambu bag, the lungs were stiff, and the chest could hardly be expanded. It was suspected that the tracheostomy tube was displaced; therefore, the tracheostomy was immediately removed, and the patient was intubated with a tracheal tube. The cuff of the tracheostomy tube was asymmetrically prominent and protruded at the back (Figure 1). During ventilation, the chest rose bilaterally. The rhythm of the patient's vital signs stabilized, and she was reconnected to the ventilator. After the stability of the patient's hemodynamic status was ensured, a bronchoscopy was performed, and the airways were opened. The echocardiographic findings of the patient after surgery are presented in Table 2.

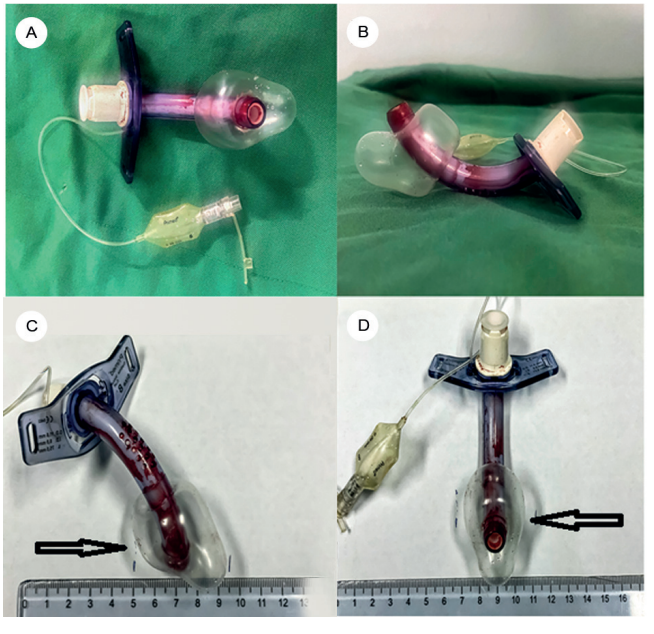

Figure 1. The images show the deformation of the tracheostomy tube cuff after inflation in the patient. The tracheostomy tube, removed from the patient's trachea, is shown from different angles. It indicates the abnormal inflation of the cuff of the tracheostomy tube, which led to airway obstruction in our patient.
A) Frontal view of the tracheostomy tube, B) lateral view of the tracheostomy tube, and C & D) inflated tracheostomy tube

After a week, a tracheostomy was successfully performed

again at the same site, and the patient was transferred to the ICU. A few days later, the ventilator was removed. T-pieces were attached to monitor the patient's tolerance and hemodynamic stability before she was moved to the surgical ward. Unfortunately, while in the surgical ward, the patient experienced complications from mediastinitis, leading to cardiopulmonary arrest. This time, the arrest was non-shockable, and tragically, she passed away.

Table 2. Echocardiography results of the patient after cuff herniation

Findings	Hemodynamic Measurements	Complications
LVEDVI	66 cc/m^2	Mild LV enlargement
LVEDD	4.7 m/s	
LVESD	3.8 c cm	
LVEF	40%	Moderate systolic dysfunction
IVS	11 mm	Mild concentric LV
MV E velocity	0.72 m/s	Mild LV diastolic dysfunction
Lateral vein	9.5 cm/s	
LAVi	25 mL/m^2	Normal bilateral size
RAVI	24 mL/m^2	

LV, Left ventricle; LVEDVI, Volume of blood in the left ventricle at end load filling indexed for body surface area (mL/m^2); LVEDD, Left ventricular end-diastolic diameter; LVESD, Left ventricular end-systolic diameter; LVEF, Left ventricular ejection fraction; IVS, Interventricular septum; MV E Velocity, Mitral valve E-wave velocity; LAVi, Left atrial volume index; RAVI, Right atrial volume index

Discussion

Tracheostomy is still the standard-of-care procedure for the prolonged management of patients who need mechanical ventilation. The benefits of tracheostomy compared with endotracheal intubation have been explained previously.[3, 8] However, the decision should be made after thoroughly weighing the complications and advantages before placement. Tracheostomy has been reported to be associated with several early and late complications that can be life-threatening if left untreated. There are inconsistencies in the literature regarding the prevalence of clinical complications following tracheostomy.[3, 5, 9, 10] Such inconsistencies can be due to unclear clinical presentations, the expiration of critically ill patients during the operation, or other factors such as transfer to another center or ward. Nonetheless, a prior study reported a rough estimate of over 60% for early, late, minor, and major complications of tracheostomy. Some recent studies have compared conventional tracheostomy with the percutaneous dilatational approach regarding the risk of complications. While some studies suggest that the percutaneous dilatational approach leads to lower complications such as oozing and infections, other studies using fiberoptic bronchoscopy for evaluating complications indicate an increased prevalence of stenosis among patients who underwent the percutaneous dilatational approach compared with those who underwent the conventional approach. The rule of thumb is that patients with obesity, and more importantly morbid obesity, suffer from higher rates of complications than those with normal weight.[5, 11, 12]

Few studies have reported fatal complications, such as in our case, from tracheostomy. Based on a cursory review of the literature, there is no consistent pattern regarding the age of the patients, with ages ranging from 32 to 73.[4-7, 10, 13-16] The first sign of tracheostomy balloon herniation is an abrupt and progressive fall in oxygen saturation. This phenomenon can be attributed to bronchospasm, pneumothorax, central nervous system suppression, disconnection of the circuit, aspiration of fluids such as blood or mucus into the tube, blockage by external objects, tube displacement, malposition, and rarely, cuff herniation. Since herniation is indeed a very rare event, the anesthesiologist and the surgical team may find the cause of the saturation drop with delay, which can compromise the patient's condition and potentially lead to ischemic cerebral or cardiac injury, ultimately resulting in death if untreated. One study that investigated tracheostomy cuff herniation based on different brands reported that herniation occurred more commonly when the size of the tube was disproportionately larger than the size of the trachea itself.[9] This may cause increased tension in the silicone material of the tube, which exacerbates when the anesthesiologist fills the cuff with air. The most common method for detecting cuff herniation, after ruling out the more prevalent causes of decreased oxygen saturation, is to remove the tube and examine it by filling it with air. The herniation will only reveal itself if it is filled with air; otherwise, the anesthesiologist may not detect the herniation and may reinsert it for the patient. After the detection of the herniation, the cuff should be removed and replaced with a new one, according to our previous cases and the current case. If the cause of oxygen desaturation is detected in time, the surgery or hospitalization can continue uneventfully.[3, 5, 12, 17]

There is limited information regarding cardiac herniation, but lung hernias are mostly diagnosed through physical examination, imaging, and bronchoscopy, with X-ray scanning and computed tomography scans shown to be superior tools for identifying the herniated area.[18]

It should be noted that although most manufacturers clearly state that the device should be carefully examined and tested before use, such complications and herniations cannot be detected at this stage. Herniation occurs after the insertion of the device. One recent study suggested the use of airway ultrasound in detecting cuff herniation; nevertheless, that study was performed on endotracheal tube herniation.[19]

Conclusion

If all the aforementioned causes of sudden falls in oxygen

saturation have been ruled out, cuff herniation should be included in the differential diagnosis, as it may lead to fatal and life-threatening consequences if not considered.

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