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Case Report

Perianesthesia negative pressure pulmonary edema in edentulous patient: a case report

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Abstract: A 66-year-old female patient underwent an elective uncomplicated hysterectomy under general anesthesia. Following tracheal extubation, the patient developed hypoxemia, tachypnea, shortness of breath, pulmonary rales, decreased oxygen saturation, and evidence of upper airway obstruction. A chest X-ray showed pulmonary edema. According to the clinical features, residual curarization and edentulism in both jaws are most likely related to the upper airway obstruction in this case. The patient was diagnosed with negative pressure pulmonary edema (NPPE), which always occurs secondary to an acute upper airway obstruction. The patient recovered remarkably within a few hours after a treatment with supplemental oxygen and intravenous furosemide and amiodaronum, and was discharged on POD 7 without any complications. NPPE is more prevalent in young healthy patients. NPPE in edentulous patients has not been previously described in the literature. Herein, we describe a case of NPPE following tracheal extubation in an edentulous patient.

Keywords: NPPE, upper respiratory obstruction, general anesthesia

Introduction

With an aging population and an estimated 60% prevalence of edentulism among that population [1], an increasing proportion of patients presenting for general anesthesia in China suffer edentulism. Studies have shown that mask ventilation is very difficult in edentulous patients [2]. Once edentulous patients develop hypoxemia after general anesthesia, mask ventilation is not very effective. The unique anatomical structure of edentulous patients may pose an increased risk of the obstruction of the upper airway leading to negative pressure pulmonary edema (NPPE). NPPE is reported to be prevalent in <0.1% of patients undergoing general anesthesia [3], and is more often related to anesthesia-related laryngospasm [4]. NPPE is a noncardiogenic pathological process in which the obstructed upper airway leads to a high negative intrathoracic pressure resulting in transudation of fluid into pulmonary interstitium and causing pulmonary edema [5]. Here we report a case of NPPE in an edentulous patient after tracheal extubation following general anesthesia.

Case report

A 66-year-old female patient, 149 cm in height and 46 kg in weight, was scheduled for hysterectomy under general anesthesia. She was edentulous in both jaws. Chest auscultation revealed rough breath sounds but no rales. Her other physical examinations and laboratory studies were unremarkable. Preoperative chest radiograph showed increased bronchovascular shadows, scattered and streak- or spindle-shaped in appearance, hyperdense and spot-like calcifications in the bilateral upper lobes with pleural thickening on the right side (**Figure 1A**). Echocardiography demonstrated trivial regurgitation in the tricuspid and pulmonic valves and left ventricular diastolic dysfunction. Pulmonary function tests revealed restrictive ventilatory disturbance. All other tests revealed no abnormalities.

The patient's upper limb vein was cannulated for fluid replacement. Noninvasive blood pressure (NIBP), pulse oxymetry (SpO_2), heart rate (HR), and electrocardiogram (ECG) were monitored as is routine during an operation. Before anesthesia induction, the patient's NIBP was

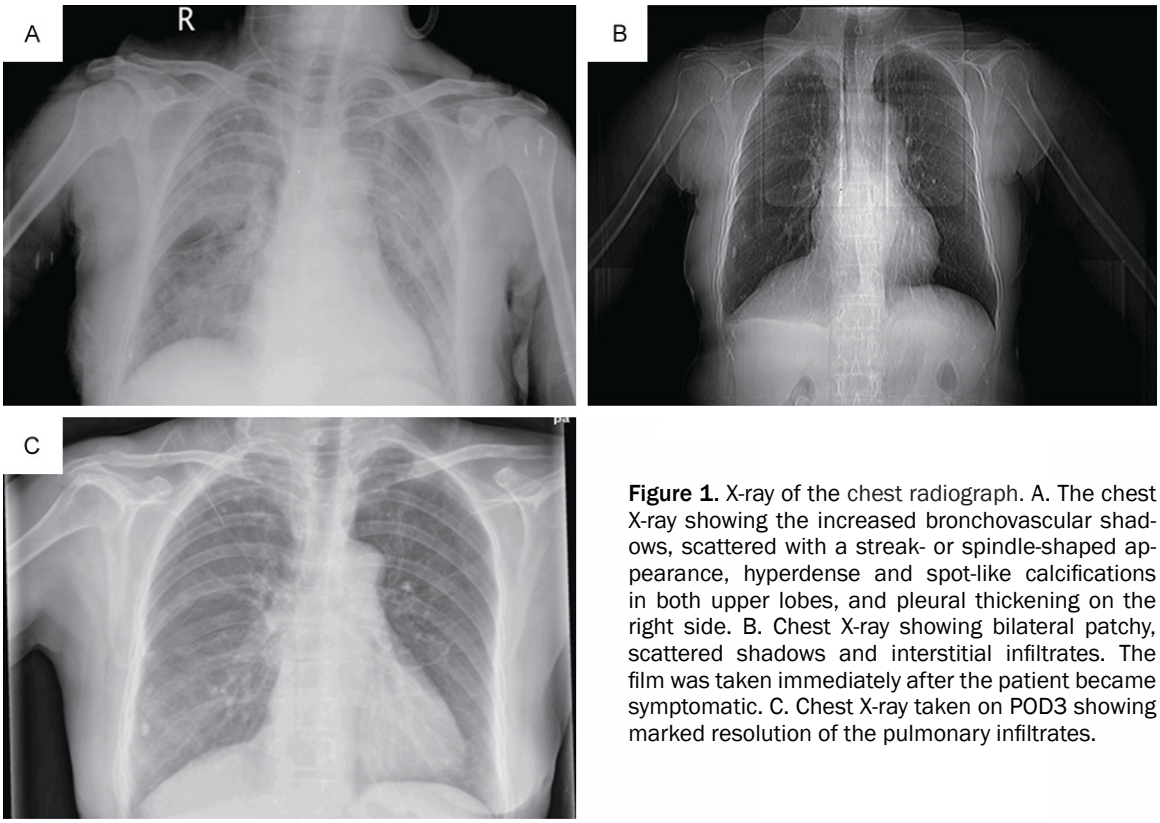

Figure 1. X-ray of the chest radiograph. A. The chest X-ray showing the increased bronchovascular shadows, scattered with a streak- or spindle-shaped appearance, hyperdense and spot-like calcifications in both upper lobes, and pleural thickening on the right side. B. Chest X-ray showing bilateral patchy, scattered shadows and interstitial infiltrates. The film was taken immediately after the patient became symptomatic. C. Chest X-ray taken on POD3 showing marked resolution of the pulmonary infiltrates.

137/80 mmHg, HR was 64 beats/min and SpO_2 was 97%. After premedication with 2 mg midazolam, anesthesia was induced with 20 mg etomidate and 25 mcg sufentanil. The trachea was intubated with a 7.0 mm inner diameter endotracheal tube atraumatically after a neuromuscular blockade was achieved with 8 mg vecuronium. Anesthesia was maintained with intravenous infusion of propofol 2~4 mg/(kg·h), remifentanil 2~4 μg/(kg·h), and sevoflurane in 60% oxygen with air. The vital signs remained stable during the operation. $PETCO_2$ was maintained at between 36 and 40 mmHg and SpO_2 were maintained at 100%. The surgery lasted 1.5 h. She received 0.5 L of crystalloids and 0.5 L of hetastarch. Estimated blood loss was 100 mL and urine output was 400 mL.

The residual neuromuscular blockade was reversed with a combination of neostigmine 0.04 mg/kg and atropine 0.02 mg/kg. The trachea was extubated after the patient could obey verbal commands such as opening her eyes. The patient became agitated and had difficulty breathing while on a patient trolley as she was being transferred to the postoperative anesthesia care unit (PACU), and her SpO_2 dropped to less than 80%. Continuous positive airway pressure with 8 L/m of oxygen was applied immediately using a face mask and the SpO_2 climbed above 90% after manual ventilation but was down to 85% when left on spontaneous breathing. The patient was conscious and stated she had chest tightness. Chest auscultation revealed coarse inspiratory rhonchi over the bilateral lung bases. On admission to the PACU, arterial blood gas analysis (ABGA) revealed a pH of 7.27, a PaO_2 of 50 mmHg, and a $PaCO_2$ of 51 mmHg on 8 L/min of oxygen through manual ventilation with a face mask. On the basis of such clinical considerations, the clinical suspicion of pulmonary edema was high. Thus, 20 mg furosemide (lasix) and 40 mg methylprednisolone (Solu Medrol) were given intravenously. After 30 minutes, the anteroposterior chest radiograph at bedside showed bilateral patchy, scattered shadows and interstitial infiltrates (**Figure 1B**). Although the plasma D-dimer was 500, there was no clear evidence to support the diagnosis of pulmonary embolism, so the patient was diagnosed with post-extubation pulmonary edema and remained on supplemental oxygen therapy. The patient recovered gradually within the next two hours

Figure 2. Compared with the operating table, the patient transport trolley does not provide a good environment for the relief of breathing obstructions.

and the SpO_2 reached between 95% and 99% on supplemental oxygen via nasal cannula. Blood gas analysis revealed pH 7.36, PaO_2 62 mmHg, and $PaCO_2$ 42 mmHg, and then the patient was transferred to the gynecological ward and remained on oxygen therapy. On postoperative day (POD) 3, chest radiograph showed marked resolution of the pulmonary infiltrates (**Figure 1C**). The patient was discharged on POD 7 without any complications.

Discussion

We present here the case of a 66-year-old female patient who underwent a hysterectomy complicated by NPPE, first described by Moore in 1927 [6], and always secondary to an acute upper airway obstruction. The prevalence of NPPE is reported to be <0.1% [3]. Following extubation, the patient developed hypoxemia, tachypnea, shortness of breath, pulmonary rales, and decreased oxygen saturation. A chest radiograph showed pulmonary edema. However, the diagnosis of NPPE is often confused with cardiogenic pulmonary edema, so we took into account the pulmonary edema preceded by upper airway obstruction (NPPE), acute lung injury, fluid maldistribution, anaphylaxis, or neurogenic pulmonary edema. The clinical features of this case were most consistent with NPPE, with upper airway obstruction as the most likely cause. Upper airway obstruction leading to NPPE increases the risk of airway complications upon extubation after general anesthesia. The risk factors include obesity, laryngospasm, obstructive sleep apnea syndrome, foreign body aspiration, or oropharyngeal surgery [7]. This patient did not have any of the above-mentioned risk factors. According to the clinical features, residual curarization and edentulism in two jaws are most likely related to the upper airway obstruction in this case, and extubation was performed without confirmation of recovery of neuromuscular function.

It has been reported that complete tooth loss among the domestic elderly ranges from 3.5% to 10.2%, and the ratio of tooth loss is as high as 78.8% to 88.4% in China. Edentulism may be one of the major factors causing hypoventilation for the geriatric population. These people usually have a series of morphology changes to their faces [8]. After tooth loss, the gum line may recede, and the oral-maxillofacial region may fall in from loss of support. Facial wrinkles increase, as well as mouth subsidence, and vertical dimension in the basifacial 1/3 is reduced [9]. All of these will prevent a medical mask from sealing tightly to the face, and serious leakage or mask ventilation difficulties arise during assisted ventilation [10]. In our hospital, dentures are routinely removed before surgery, but Conlon et al. [1] conclude that bag-mask ventilation is easier in edentulous patients when their dentures are left in situ, because the presence of dentures helps maintain the shape of the facial soft tissues. Studies have confirmed that the mask ventilation success rate was 17.9% in domestic edentulous patients. If ventilation problems are not solved in these patients, anesthesia becomes risky [11]. In this case, continuous positive airway pressure with 100% oxygen was applied using a face mask when the patient became agitated and developed marked shortness of breath on the patient transport trolley, but mask ventilation was not very effective.

Negative-pressure pulmonary edema (NPPE) is an uncommon complication following general anesthesia. The main mechanism proposed is the use of inspiratory efforts to overcome the

obstructed upper airway that, secondary to glottis closure following extubation, leads to marked increase in negative intrathoracic pressure. The high-negative intrathoracic pressures cause increased venous return to the right side of the heart and increased hydrostatic pulmonary capillary pressure, and will favor the shift of fluid into the pulmonary interstitium causing pulmonary edema [12]. The most important method of treating the NPPE is early relief of the obstruction of the upper airway, preventing the pulmonary edema from deteriorating even further. 100% oxygen administered via a face mask during spontaneous assisted ventilation is an effective and efficient method [13]. However, in this case, the patient's edentulous anatomy increased the difficulty of relieving the obstruction, and we continued to assist breathing using the positive pressure ventilation, while at the same time administering intravenous furosemide and methylprednisolone. The patient's oxygen saturation gradually improved. If you cannot quickly relieve the symptoms and airway obstruction has become further aggravated, in order to ensure effective circulation and improve heart and lung function, reintubation should be performed as soon as possible after neuromuscular block has been achieved. While taking some of the symptomatic treatment measures, including cardiac, vasodilator, diuretic, water and electrolyte balance should be maintained along with the proper application of hormones [13]. In our case, the patient was not transferred to the intensive care unit (ICU), because we achieved rapid and complete resolution of both clinical and radiological features within 24 hours. As long as the measures taken are timely, reasonable, and effective, most patients of NPPE usually recover fully without complications [14].

In general, the edentulous anatomical structure of the patient was the main cause of the obstruction of upper airway leading to NPPE. In addition, the patient transport trolley cannot provide a good environment for the relief of breathing obstructions when compared with the operating table (**Figure 2**). This case demonstrates that we should make full preparations before anesthesia for patients who are missing all of their teeth. These patients should be treated as having difficult airways. In fact, having at the ready a conventional oral airway or a nasopharyngeal airway is necessary [15]. We recommend that all edentulous patients with dentures should routinely come to the operating room with their dentures left in place. If the patient has difficulty in breathing while on a patient transport trolley, they should be transferred to the operating table immediately and fully prepared for relieving the obstruction of the upper airway.

Disclosure of conflict of interest

None.

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