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Postobstructive pulmonary edema complicated by transient cardiac dysfunction in a young woman

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A 17-year-old woman who had been healthy since birth, developed postobstructive pulmonary edema (POPE) after maxillofacial surgery. She was extubated in a semiconscious state after general anesthesia, and subsequently developed severe airway obstruction due to glossoptosis, and blood and secretions in the oral cavity. When the obstruction was released, approximately 10 minutes later, the chest radiograph showed an increased cardiothoracic ratio, and cardiac ultrasonography showed a low value in the left ventricular ejection fraction when compared to the normal values for the same age. A diagnosis of type-I POPE with associated left ventricular dysfunction was made, and oxygen and diuretic administration were initiated. When continued hypoxemia is found, even after the elimination of any airway obstruction, it is important to evaluate left cardiac function, with due consideration to the possibility of POPE.

Key words: pulmonary edema, postobstructive pulmonary edema, hypoxemia, left ventricular dysfunction

Introduction

Postobstructive pulmonary edema (POPE) has been defined as noncardiogenic pulmonary edema that follows upper airway obstruction. It is classified as either type-I POPE, which is primarily negative-pressure pulmonary edema, or type-II POPE, in which venous perfusion is increased by the elimination of expiratory disorders, leading to an increase in hydrostatic pressure in the pulmonary capillaries.[1]

In patients developing acute upper airway obstruction, the incidence of POPE has been estimated to be up to 12%.[2] Laryngospasm during intubation or after anesthesia is reported to be the most common cause of upper airway obstruction leading to POPE in adults, and it has been reported to account for as much as 50% of the cases.[3]

This report presents the case of a young woman who had been healthy since birth. She underwent maxillofacial surgery under general anesthesia with endotracheal intubation, and following extubation developed a type-I POPE associated reduction of cardiac function.

Case Presentation

A 17-year-old woman (height, 154 cm; body weight, 48 kg), presented with no previous medical history, and American Statistical Association category I.

Maxillary and mandibular osteoplasties were performed for cleft lip, alveolus, and palate. General anesthesia was rapidly initiated using propofol and remifentanil, followed by the administration of vecuronium. Transnasal intubation was carried out with a nasotracheal tube (internal diameter of 6.5 mm). Intubation was achieved without complications, and anesthesia was maintained during surgery using sevoflurane and remifentanil. No intraoperative abnormalities associated with breathing or circulatory dynamics were observed, and the operation was completed in 5 hours and 40 minutes. The estimated blood loss was 440 ml, and the total infusion volume was 3,030 ml; hence, the intraoperative balance which includes the total urine volume (128 ml) and insensible perspiration (1,086 ml, approximately 4 ml/kg/hr) was plus 1,376 ml. Perioperative blood pressure remained constant.

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After the operation, the patient was semiconscious and able to follow commands to a limited degree. Spontaneous respirations with associated sufficient tidal volumes were present; therefore, the patient was extubated. However, immediately after extubation, she developed stridor accompanied by seesaw breathing involving marked inspiratory efforts. The patient's lower jaw was raised manually, and her progress was closely monitored. However, hypoxemia gradually worsened, and her level of consciousness waned. Her oxygen saturation decreased from 99% to 70%, even with the supplemental administration of 100% oxygen at 10 l/min using a facemask. The buccal cavity contained a large volume of blood and saliva, which were removed by suction. The airway obstruction symptoms were gradually alleviated, and her oxygen saturation returned to 98% after 5 minutes. Her consciousness also gradually improved, whereupon she complained of breathing difficulties. Her airway was checked using a fiberscope. The bilateral vocal cords were open, and although mild swelling of the arytenoid region was found, the larynx did not appear to have any functional or organic abnormalities. Arterial blood gas results after alleviation of the upper airway obstruction symptoms were low for PaO_2 at 97 mmHg, respectively, despite having 100% oxygen supplied at 10 l/min by facemask. The patient continued to complain of shortness of breath. Therefore, chest radiography was performed which showed evidence of transmission decrease in the bilateral lung fields, dilation of the pulmonary artery, increased opacity in the pulmonary hilum, cardiothoracic ratio (CTR) increased to 44%, and expansion of the right second arc (Figure 1). Transthoracic echocardiography revealed cardiac dysfunction, involving an expansion of the left ventricular lumen, and a reduction of the left ventricular ejection fraction (LVEF) to 50% or less. No marked changes were found by 12-lead electrocardiography. When diuretics were administered, her symptoms were alleviated somewhat, so the patient was transferred to the general hospital ward approximately 3 hours after extubation.

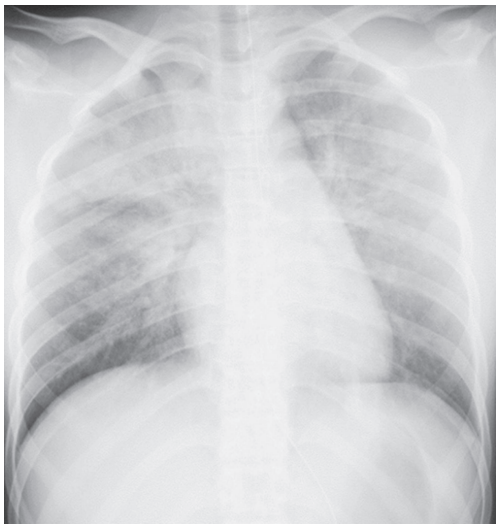

Figure 1. Chest radiograph immediately after release of airway obstruction. Showing a transmission decrease in the bilateral lung fields, dilation of the pulmonary artery, increased pulmonary opacity, increase in the cardiothoracic ratio to 44%, and expansion of the right second arc.

She had no subsequent return of the previous

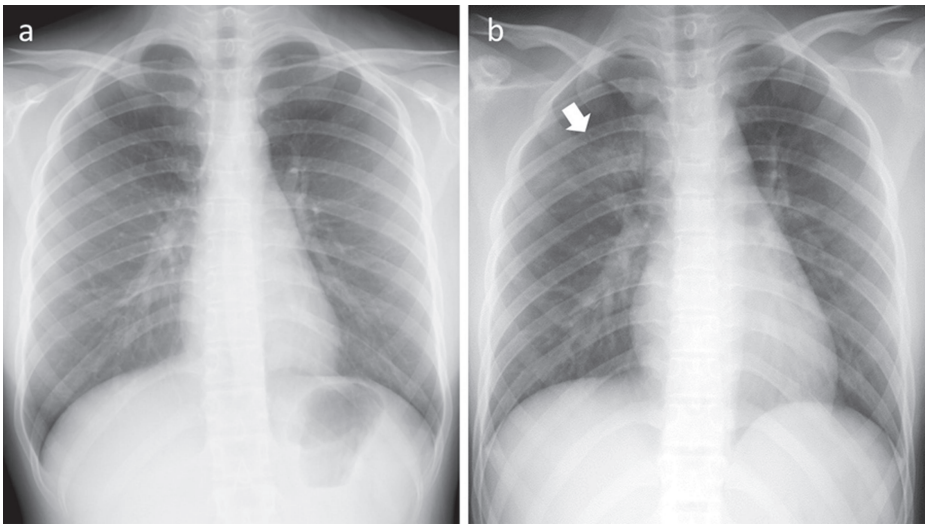

Figure 2. (**a**) Preoperative and (**b**) 24 hours after tracheal extubation chest radiographs. Showing (**b**) expansion of the cardiothoracic ratio and pulmonary opacity over the right upper lobe (white arrow).

respiratory symptoms and her progress was closely followed. She was managed with oxygen administration alone, and without treatments such as positive end-expiratory pressure (PEEP). Chest radiography showed a protrusion of the right and left second arcs, that had not recovered to preoperative levels, a persistent dilation of the pulmonary arteries, and an unchanged CTR (Figure 2). Cardiac function recovered to the normal state by 3 days after surgery, and the patient was discharged from the hospital 10 days after surgery.

Discussion

Various causes for this patient's upper airway obstruction can be suggested, including insufficient recovery from anesthesia at the time of extubation, reduced gag reflex and cough strength, and an accumulation of blood, phlegm, and saliva in the oropharynx. The simultaneous occurrence of laryngeal spasms stimulated by one or more of these processes cannot be ruled out. The mechanism of development of pulmonary edema in connection with this type of upper airway obstruction begins with an increase in the left ventricular pre-load due to excessive inspiratory efforts. Increased venous perfusion associated with excessive decreases in pulmonary internal pressure, and increased ventricular post-load due to stress causing sympathetic nerve tension, results in increased pulmonary blood flow, pulmonary venous pressure, and capillary hydrostatic pressure, ultimately leading to the development of pulmonary edema. In addition, strong negative pulmonary pressures cause the leakage of fluid from the pulmonary capillaries into the interstitium, resulting in edema. Pulmonary edema resulting from both of these mechanisms is classed as type-I POPE.[4,5]

In the case of the present patient, her inspiratory effort was not great, and stridor began at the time of extubation, which makes her condition consistent with type-I POPE. The pulmonary edema in type-I POPE consists primarily of negative-pressure pulmonary edema, but it also includes hydrostatic pulmonary edema.[6] After elimination of the patient's airway obstruction, chest radiography showed an increased CTR, and transthoracic echocardiography showed a low value LVEF. The patient's symptoms were followed for more than 12 hours after elimination of the airway obstruction. Chest radiography the following day indicated that the protrusion of the right and left second arcs had not yet recovered to their preoperative levels, and the pulmonary arterial diameters were still increased. Because this patient was a young adult, her intraoperative water balance would have been within the acceptable range, and it is uncertain whether or not the above changes can be explained solely on the basis of the mechanism of pulmonary edema in type-I POPE. Stress cardiomyopathy has been reported previously to occur after upper airway obstruction.[7] However, for this patient, the 12-lead electrocardiography showed no changes;therefore, no attempts were made to detect troponin T or B-type natriuretic peptide (BNP) or anyother myocardial biomarkers. However, the patient's increased CTR and low-value LVEF suggested heart failure with cardiac dysfunction; therefore, it is possible that pulmonary edema might be affected by the cardiac dysfunction. After upper airway obstruction, it is important to consider obtaining myocardial deviant enzyme measurements, and biomarkers in heart failure, electrocardiography, echocardiography, and if necessary, a consultation with a cardiovascular specialist.

The recommended treatment for POPE is airway management, oxygen administration, and the application of PEEP.[3] It can be suggested that for this patient the application of PEEP would have resulted in a more rapid alleviation of POPE, but because of her recent facial osteoplasty, the use of a non-invasive positive pressure ventilation (NPPV) facemask, which would be needed to apply PEEP, could lead to increased postoperative pain, swelling and/or bleeding. Additionally, it would be difficult to drain her sputum and secretions because of the nasal blockage that occurs after a facial osteoplasty. For these reasons, NPPV and PEEP were not good options for this patient. Fortunately, her symptoms were alleviated rapidly by oxygen and diuretic administration, therefore, the administration of positive airway pressure was not required.

General anesthesia for the maxillofacial surgery performed on this young woman, was achieved with endotracheal intubation, and type-I POPE developed at extubation. When continued hypoxemia is observed even after the elimination of an airway obstruction, it is important to evaluate the left-sided cardiac function, and to check BNP, at the same time as taking appropriate prophylactic measures considering the possibility of POPE.

Conflicts of Interest

None.

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