



A Case of Gastric Contents Reflux Aspiration during General Anesthesia Induction in A Patient with Femoral Vein Atrial Septal Defect Closure

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Abstract

Background: Aspiration of gastric contents during the induction of general anesthesia remains a significant cause of mortality and morbidity in anesthesia. We report an 18-year-old patient with a closed atrial septal defect who developed gastric content reflux aspiration and severe aspiration pneumonia despite abstaining from drinking and fasting for more than 12 hours.

Case Presentation: An 18-year-old female patient with congenital heart disease (atrial septal defect) had no previous history of gastroesophageal reflux. After fully abstaining from drinking and fasting (more than 12h), conventional anesthesia was induced, and after the patient's spontaneous breathing and consciousness disappeared, the patient was assisted with mandibular support with both hands and mask pressure. The induction process was smooth. When preparing for intubation, a large amount of yellow fluid was found in the patient's mouth. Intubation was performed immediately after suction. Aspiration pneumonia still occurs after the operation even if the patient is treated promptly.

Conclusions: As the incidence of perioperative pulmonary aspiration is relatively low, precautions to prevent aspiration tend to be overlooked. We should be alert to the complications of gastric contents regurgitation aspiration in patients with sufficient abstention and fasting during general anesthesia intubation.

Keywords

Respiratory Aspiration, Respiratory Aspiration of Gastric Contents, Intubation, Airway management, Atrial Septal Defect

Background

Pulmonary aspiration is the pathologic passage of fluid or substances below the level of the vocal cords into the lower airways. Typically, aspiration is considered an acute event that can result in infectious pneumonia, chemical pneumonitis, or even respiratory failure from acute respiratory distress syndrome (ARDS) [1]. Gastric contents reflux aspiration is one of

the dreaded complications of sedation or general anesthesia [2]. The incidence of aspiration during anesthesia is 1/6500, and emergency surgery is one of the main risk factors, but elective surgery may also result in aspiration, with varying severity [3]. As reflux aspiration in preparation for elective surgery is very rare, we share this case to remind anesthesiologists to be vigilant in this situation.

Case Report

Case Presentation

An 18-year-old female, weighing 44 kg and measuring 165 cm, diagnosed with congenital heart disease (atrial septal defect and mild tricuspid valve regurgitation), was admitted to our hospital for surgery on May 26, 2023. After completing the preoperative examination, the planned procedure of "atrial septal defect closure via femoral vein" was scheduled to be performed under general anesthesia on May 27, 2023. Preoperative chest CT, electrocardiogram (ECG), blood routine, and biochemical examinations revealed no specific findings. No premedication was administered, and the fasting period exceeded 12 hours. Upon entering the operating room, the patient underwent routine monitoring for ECG, blood pressure (BP), and SpO₂, revealing a BP of 135/82 mmHg, a heart rate (HR) of 80 beats/min with a sinus rhythm on ECG, and an SpO₂ of 98%.

Denitrogenation with 100% oxygen was performed for 3 minutes, followed by the intravenous injection of midazolam 2mg, sufentanil 20µg, cis-atracurium 8mg, and propofol 90mg for anesthesia induction. No hiccup or cough reflex took place during the administration of drugs, and mask-assisted ventilation persisted for about 2 minutes after the patient's consciousness subsided, with ventilation pressure less than 14 cmH₂O.

Upon exposing the vocal cords with a visual laryngoscope, a large amount of biliary yellow liquid was found near the vocal cords. The patient was quickly adjusted to the lateral position with a low head and high foot, and sufficient negative pressure was applied to aspirate gastric reflux. The visual laryngoscope fully exposed the glottis, and the enhanced tracheal catheter 7# was successfully inserted to a depth of 22 cm from the incisor. After intubation was performed, another 10 ml of yellow fluid was drawn from the tracheal tube (**Fig-1**). Machine-controlled assisted ventilation was conducted with an airway pressure of 30 cmH₂O. Both lungs exhibited wheezing during the expiratory phase, particularly in the lower lobe of both lungs. Unfortunately, a gastric contents reflux event occurred.

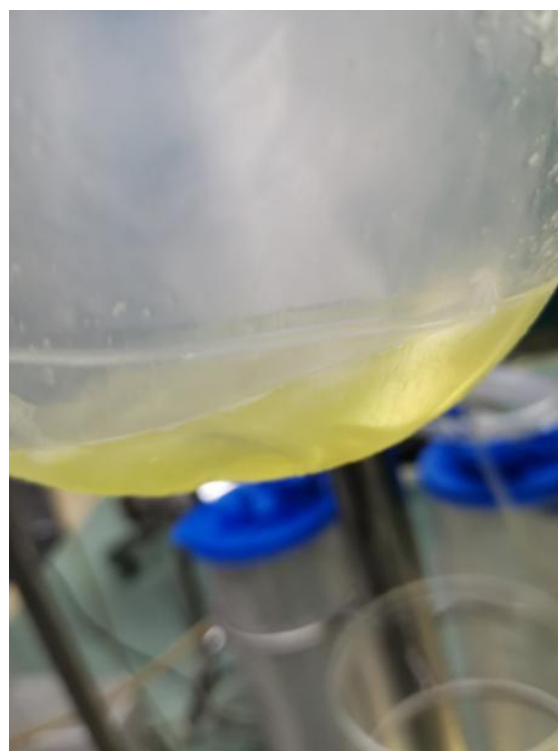


Fig-1:

Yellow liquid drawn to a negative pressure suction bottle in the tracheal tube

What do we do immediately when this happens? Intravenous administration of methylprednisolone 80mg and dexamethasone 10 mg. 10ml of 0.9% normal saline was injected into the tracheal catheter to flush the airway and lungs, and this procedure was repeated 3 times. Expiratory phase wheezing in the lower lobes of both lungs was significantly reduced. Airway pressure drops to 22cmH₂O.

We adopted volumetric controlled ventilation mode with parameters set at 8ml/kg and positive end-expiratory pressure (PEEP) set at 6 cmH₂O. Since the vital signs, including the peripheral capillary oxygen saturation (SpO₂), as measured by pulse oximetry were stable, the operation was performed as planned. Blood gas analysis showed pH of 7.48, PCO₂ of 32 mmHg, and PO₂ of 82 mmHg at FiO₂ 0.5. The patient successfully completed the atrial septal defect closure under the guidance of esophageal ultrasound, and the operation lasted for 14 minutes. During the operation, the fraction of inspired oxygen (FiO₂) was maintained at 0.5, and the SpO₂ was 100%.

After the operation, the patient was extubated and

Case Report

transferred to the post-anesthetic care unit. The patient complained of dyspnea and chest tightness. 40mg methylprednisolone and 10mg of dexamethasone were administered intravenously. The patient was asked to sit up, and manual back patting was performed to help expel phlegm, and the patient was asked to slowly and deeply breathe to promote lung regrowth for treatment. After 1.5h of observation, the patient's symptoms, such as chest distress, improved, and blood gas analysis showed pH of 7.41, PCO₂ of 41 mmHg, and PO₂ of 59 mmHg at FiO₂ 0.21.

Then the SpO₂ decreased to 88% in room air in the post-anesthetic care unit, so the patient was transferred to the ward with a simple mask delivering O₂ at 6 L/min, following which the SpO₂ was well maintained. CT examination of the chest on the first day after surgery showed diffuse patchy high-density shadows in both lungs, characterized by the lower lobes of both lungs (**Fig-2A** and **Fig-2B**). The patient received antibiotic piperacillin-tazobactam therapy and beclomethasone atomization inhalation for pulmonary

aspiration. The SpO₂ was maintained with a nasal catheter delivering O₂ at 3 L/min until the day before discharge. The patient was discharged on postoperative day 8 without complications related to pulmonary aspiration (**Fig-2c**).

Discussion and Conclusions

Transfemoral venipuncture for atrial septal defect closure requires the use of esophageal ultrasound for real-time closure umbrella guidance and usually adopts general anesthesia. The fasting period of this patient was over 13 hours, and general anesthesia with routine induction is considered safe and low risk for reflux aspiration occurring.

There are multiple factors that may lead to reflux and eventual aspiration of gastric fluid into the lower airways. Firstly, anesthetized patients are at high risk for gastric contents reflux aspiration due to sedation or loss of consciousness, reduced lower esophageal sphincter tone, and suppression of protective reflexes in the throat.



Fig-2A:

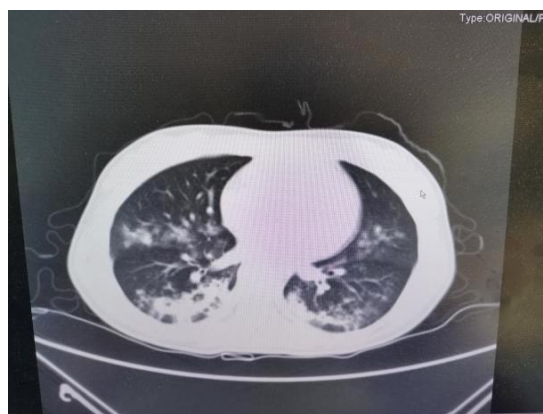


Fig-2B:

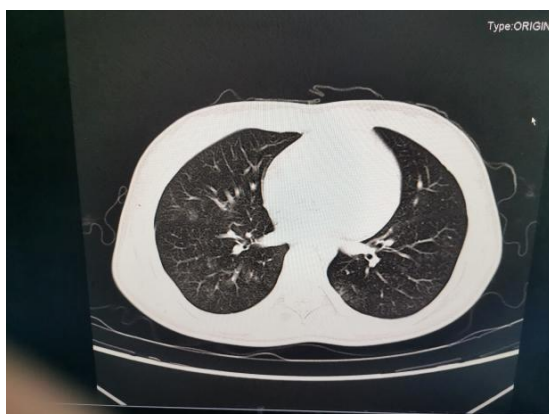


Fig-2C:

Case Report

Secondly, gastroesophageal reflux is the retrograde movement of gastric fluid into the esophagus and notably not a state of excess gastric acidity. Normal adults fasting gastric fluid secretion in 12h about 20-100mL, gastric fluid volume up to 1.5mL/kg (about 100mL) is common in fasting people, does not significantly increase the risk of aspiration [4].

Thirdly, the patient was thin and usually had stomach dyspepsia, but no gastroscopy was done to confirm reflux esophagitis. In principle, the pressure gradient between the stomach and the esophagus (i.e., the transdiaphragmatic pressure gradient (TDPG)) and the competency of the esophagogastric junction (EGJ) and lower esophageal sphincter (LES) are what define whether gastric fluid will abnormally enter into the esophagus [1]. Although this patient had no history of gastroesophageal reflux disease (GERD), it is certain that gastric fluid remained in the stomach at the time of induction of anesthesia.

The muscle relaxant (cis-atracurium) used for anesthesia induction has a relaxing effect on the esophageal sphincter, resulting in airway obstruction and a significant decrease in intrathoracic pressure and TDPG during hard inspirations. Fourthly, coupled with the influence of gravity at the head position, the use of volume-controlled ventilation with both hands on the mask increases the likelihood of gas entering the stomach. At the same time, anesthesia can weaken gastrointestinal peristalsis, resulting in a relatively large amount of air and gastric fluid in the stomach. Last but not least, during anesthetic transient LES relaxations, if gastric contents do reflux into the esophagus, it traverses the span of the esophagus up into the pharynx (i.e., laryngopharyngeal reflux) by bypassing the important barriers of not only the EGJ and LES but also esophageal peristalsis.

However, the esophageal defenses are breached and proximal refluxate enters the pharynx during anesthesia induction, when generated sufficient volume to allow passage beneath the vocal cords into the lower airways, aspiration has occurred.

Patients with aspiration pneumonitis usually occur during episodes of reduced consciousness or under general anesthesia and can develop symptoms that can

range from none at all to tachypnea, bronchospasm, and possibly respiratory distress after a few hours from the aspiration event [5].

What is different from the routine is that the girl underwent general anesthesia for less than an hour, and immediately after the tracheal catheter was removed, she felt dyspnea and chest tightness, although she did not reach respiratory distress, but the symptoms were still very serious. A cascade of inflammatory responses follows this initial injury and includes the recruitment of inflammatory cells and the release of various inflammatory mediators. The refluxed gastric acid and digestive enzymes into these structures cause direct tissue injury and interfere with the protective epithelial barrier of the airways. With massive gastric acid aspiration, acute lung injury occurs, with diffuse alveolar damage and progressive hypoxemia [6-8].

Since her sputum examination and sputum culture did not detect any bacteria, apparently the girl developed aseptic chemical pneumonia. Although we immediately flush the lungs with saline, it does not stop the attack of stomach acid on the lungs.

Aspiration of solid or semisolid material into the airways causes mechanical obstruction, resulting in acute respiratory distress or sometimes asphyxia, depending on the location of the obstruction and the size of the foreign body; gastric fluid does not cause mechanical obstruction. Bronchoscopic examination confirms the diagnosis of foreign body aspiration by visualizing the obstructing foreign body. There's no sign of mechanical obstruction in her airway, so we won't need it.

Atrial septal defect is a residual open defect between the left and right atria caused by abnormal embryonic development. Because the pressure of the left atrium is usually higher than that of the right atrium, when the atrial septal defect occurs, the blood of the left atrium is shunted into the right atrium. Consequently, the enlargement of the heart is mainly caused by the right ventricle and the right atrium. In this state, the right atrium and right ventricle not only accept the blood of the upper and lower vena cava but also accept the blood of the left atrium, greatly increasing the load on

Case Report

the right heart. This further leads to an increase in pulmonary circulation blood flow, resulting in intimal hyperplasia of pulmonary arterioles, lumen stenosis, and an increase in pulmonary artery resistance, ultimately resulting in significant pulmonary hypertension [9].

The typical clinical manifestations of aspiration are wheezing, hypoxemia, and decreased lung compliance [10]. These can cause severe pulmonary hypertension, which in turn increases lung damage, leading to a lack of oxygen in the heart muscle and, in severe cases, cardiac arrest. Fortunately, this patient's hypoxemia did not cause serious cardiac consequences due to immediate detection and treatment.

In terms of reflux aspiration, what can we do to reduce the incidence of such serious anesthesia-related adverse events? We propose the following ways to deal with it. Point-of-care ultrasound might be a potential solution to this conundrum. With gastric ultrasound (GUS), we can determine the patients' gastric content in at least 85% of obstetric, 90% pediatric, and 95% of other patients [11,12]. Next, the use of premedication such as pro-kinetics, proton pump inhibitors, and H₂-blockers might assist in preventing pulmonary aspiration [13].

In addition, pressure ventilation during induction of general anesthesia will increase the probability of gastric distension, and some may even affect the operation due to gastric distension [14]. The degree of gastric distension is directly related to the level of airway pressure during pressurized ventilation. If the airway pressure is higher than 2.0kPa in the recumbent position, the gas will overcome the gastroesophageal barrier pressure (BrP) and enter the stomach [15]. The peak airway pressure produced by different pressure oxygen delivery methods during the induction of general anesthesia was significantly lower in pressure-controlled ventilation (PCV) than in manual ventilation (MCV) and volume-controlled ventilation (VCV). In PCV, only 1.1% of patients' gas entered the stomach, while in MCV and VCV, it was 3.3% [16].

Lastly, at a 20° head height, the BrP is 2.08kPa, while in the supine position and at a 20° head height,

it is 2.58kPa and 2.61kPa, respectively. It is suggested that the gas is more likely to enter the stomach when the head is high, resulting in gastric distension, increasing the risk of gastric contents regurgitation aspiration [17]. When pressurized oxygen is induced by general anesthesia, lifting the jaw correctly to maintain airway patency, and if necessary, the oropharyngeal (nasopharyngeal) airway is used to reduce the airway pressure and to reduce causing reflux aspiration.

In conclusion, we describe a case of severe aspiration pneumonitis caused by gastric contents reflux aspiration in a patient undergoing femoral vein atrial septal defect closure during general anesthesia induction. This case suggests that there is still a risk of reflux aspiration during elective surgery for general anesthesia induction, emphasizing the importance of prevention.

Authors' Contributions

XB was a major contributor to writing the manuscript. WRR: Corresponding author, revising the article critically for important intellectual content, final approval of the version to be published, and agreement to be accountable for all aspects of the work thereby ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All authors have read and approved the final manuscript.

Consent for Publication

Written informed consent for publication of the clinical details and clinical images was obtained from the patient.

Conflict of Interest

The authors have read and approved the final version of the manuscript. The authors have no conflicts of interest to declare.

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Case Report

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