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DEVELOPMENT OF BRONCHIAL MUCOUS PLUGS UNDER ANESTHESIA AND REMOVAL BY BRONCHOSCOPY DURING OPEN-HEART SURGERY*

A Case Report

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Imparied respiratory function resulting in hypoxemia is a common finding following major surgery and anesthesia. Overt pulmonary complications are not necessarily concomitant disorders of respiratory function, however the two are interrelated with each other. Pulmonary complications such as impaired ciliary function, decreased pulmonary compliance, increased pulmonary arteriovenous shunting due to micro-atelectasis and airway closure will exacerbate changes in respiratory function[1,2]. We recently observed a special case of hypoxia associated with bronchial mucous plugs.

Case Report

A seven-year-old girl was referred to our institute because of growth retardation, complaints of frequent blackouts, fatigue and syncope on exertion. Examinations and investigations revealed that the patient had an atrial septal defect (ASD) which was planned to be closed surgically. The patient was given ketamine intramuscularly and taken into the operating room. Arterial and venous lines were inserted. Gelatin (Hemacel) infusion was started. Sleep was induced by morphine and diazepam. Then pancuronium was administered to facilitate tracheal intubation. After the induction, few erythemas were seen on the upper chest and antihistamine and corticosteroids were given intravenously. The arterial blood gas values were recorded as pH 7.52, PaO_2 303 mmHg, $PaCO_2$ 20 mmHg, HCO_3^- 16.9 mEq/L, O_2 saturation 99.8% and the necessary ventilatory adjustment was performed. The next routine recorded the arterial blood gas values as pH 7.41, PaO_2 77.2 mmHg, $PaCO_2$ 22.9 mmHg, HCO_3^- 14.5 mEq/L, O_2 saturation 95.3%. The most likely causes of the hypoxia were investigated.

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Cardiopulmonary bypass (CPB) was used to close the ASD primarily and the heart started to beat again. Total left lung atelectasis was noticed when preparations were under way to discontinue the CPB procedure. The endotracheal tube was repositioned, suctioned, and then replaced with another endotracheal tube without a cuff. The patient was ventilated manually. All the measures taken failed and the atelectasis persisted. It was then decided that a bronchoscopy be performed. A rigid bronchoscope revealed that the left main bronchus was blocked with a mucous plug which was then suctioned. The patient's condition improved dramatically as the atelectasis disappeared. The CPB procedure was gradually discontinued and the surgery was completed sucessfully. The arterial blood gas values were pH 7.47, PaO_2 345.5 mmHg, $PaCO_2$ 25.6 mmHg, HCO_3^- 18.6 mEg/L, O_2 saturation 99.8%.

Discussion

Normally secretions move from the lower to the upper bronchial tree by ciliary activity, and at a higher level an active cough reflex leads to effective expulsive efforts. These defense mechanisms also protect the lung from inhaled foreign bodies and bacteria. Pre-existing pulmonary disease, smoking, surgery, anesthesia, obesity, aging, recent upper respiratory tract infections including many other factors can alter these mechanisms thus leading to inadequate clearance of mucus and particulate matter. General anesthesia may impair these processes in several ways. Mechanical stimuli such as an airway or endotracheal tube can provoke an increase in salivary and bronchial secretions as do ketamine and neostigmine. Agents such as atropine and hyoscine may cause sputum to become viscid and tenacious and mucus transport is impaired if dry gases are inhaled especially by a non-rebreathing valve system[3]. There is also evidence that some anesthetic agents depress ciliary activity[4]. The main pulmonary changes during general anesthesia, irrespective of the technique used, are an increase in the alveolar component of the respiratory dead space, an increase in the alveolar-arterial (A-a) oxygen tension difference, quantified as increased pulmonary venous admixture, and a decrease in functional residual capacity[5]. A decrease in cardiac output can lead to a large increase in the amount of unperfused and over-ventilated alveoli (increased physiological dead space). An increase in physiological dead space also occurs if micro-aggregates of white cells, platelets and fibrin accumulate in the pulmonary vascular bed as a result of CPB and large transfusions of unfiltered, stored blood. All these factors predispose to atelectasis. During general anesthesia inspired gases should be humidified in order to prevent drying of secretions and the mucosa of the tracheobronchial tree. Inspired oxygen concentrations should be kept below 100 percent, if possible, as this favors the production of absorption collapse and if

mechanical ventilation is used, ventilation should be adjusted to prevent pulmonary collapse.

In the case presented, one of the main bronchi was blocked, resulting in atelectasis of the related area which led to serious hypoxia and hypoxic pulmonary vasoconstriction in sequence[6-10]. Such a situation could create difficult problems during open-heart surgery. Since there is invariably a period of ischemic cardiac arrest during CPB, there will be some myocardial injury[11-13]. Atelectasis and hypoxia resulting from mucous plugs in the bronchi could induce malignant arrhythmias and myocardial depression after the CPB procedure is discontinued[14,15]. If such a complication occurs before the CPB procedure is terminated, the mucous plugs should be removed and the atelectasis has to be expanded. Bronchoscopy should be performed if the other measures taken fail to re-expand the atelectasis. Continued full-flow CBP was a valuable advantage which made performance of bronchoscopy easy and comfortable without inducing hypoxia. It should be recalled that a rigid bronchoscope could cause bronchial bleeding in fully heparinized patients. But we believe that carefully performed bronchoscopy entails the least risk of bronchial bleeding and this risk should be taken when occasion dictates.

Summary

A seven-year-old girl who developed total left pulmonary atelectasis as a result of left main bronchial obstruction by a mucous plug during repair of an atrial septal defect is presented. Before discontinuing the cardiopulmonary bypass (CPB) procedure, attempts were made to expand the left lung, but failed. Continued full-flow of CPB made it possible to perform a bronchoscopy. The airway was cleared, thereby completely re-expanding the left lung for adequate ventilation. Thereafter, the CPB procedure was gradually discontinued and the surgery was completed successfully. In conclusion, performing a bronchoscopy facilitated by continued full-flow of CPB should be considered an absolutely safe method in dealing with these kinds of complications which can occur during open-heart surgery.

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