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Research Article

Post-Surgical Atelectasis: A Preventable Cause of Respiratory Failure

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Abstract

Respiratory failure is a clinical entity that substantially increases the possibility of tracheal intubation, implementation of invasive mechanical ventilation and life threatening. There are different types of respiratory failure, including a particular category: post-surgical respiratory failure. This clinical picture is usually a consequence of atelectasis secondary to the surgical procedures, the position during surgery, surfactant deterioration, pre-existing pathologies or age, among other causes. Its appearance has been associated with post-surgical complications, mainly pulmonary.

Keywords: acute coronary syndrome; three vessel disease

Introduction

Respiratory failure is a clinical entity, defined by the presence of a partial pressure of oxygen in arterial blood <60mmHg or carbon dioxide >45mmHg, while breathing room air. Both clinical situations determine what we call hypoxemic respiratory failure and hypercapnic respiratory failure, respectively. The possibility of suffering both pathologies, simultaneously, determines a mixed respiratory failure, as can be seen in COPD patients. The causes that can trigger these entities can be varied but, generally, they are related to gas exchange disorders, reduced inspired oxygen pressure, hypoventilation or ventilation-perfusion disorders in the first case; while in the second, the disorder is directly related to alterations in alveolar ventilation. All these particularities can be observed in the immediate post-surgical period, determining an increase in mechanical ventilation days, weaning delay, increase in post-surgical complications and mortality. This entity, known as post-surgical respiratory failure, is directly associated with the presence of atelectasis (ATL) as a consequence of the type of anesthesia used, fraction of inspired oxygen (FiO_2), age, mechanical ventilation modality, sedation, analgesia, neuromuscular blockeades and supine position (1) (Figure 1).

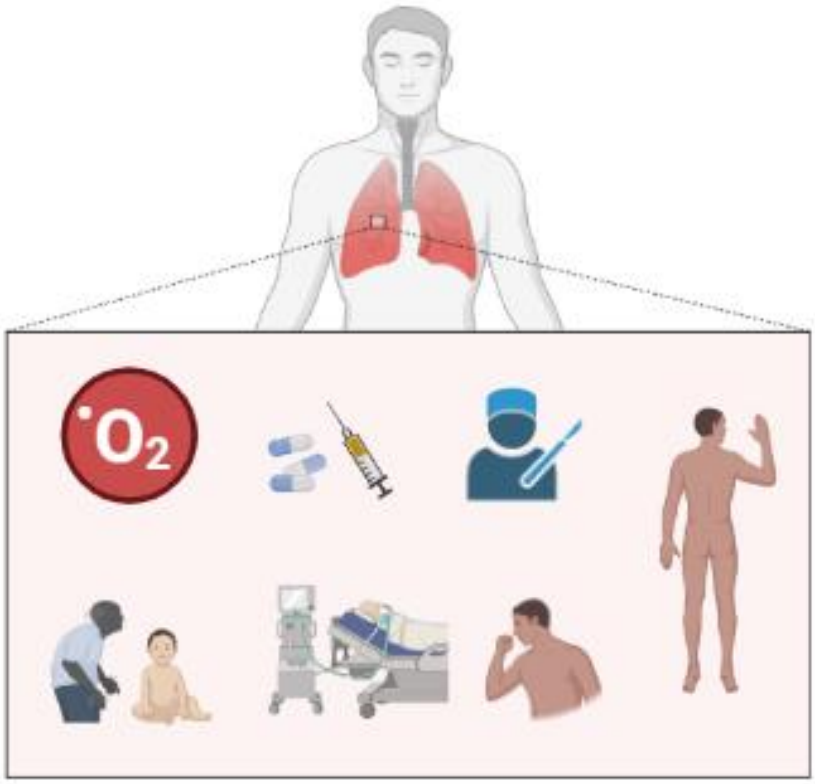

Figure 1. Factors related to the appearance of post-surgical atelectasis: fraction of inspired oxygen, sedative, analgesic and blocking drugs, type of surgery, age of the patient, type of mechanical ventilation, pre-existing pathologies and position (supine or prone) during the surgical act.

It is noteworthy that the consequences of the presence of ATL will not only be observed as respiratory failure. A reduction in compliance secondary to a reduction in functional residual capacity (FRC) and impaired oxygenation has been reported [2], while it was observed that approximately 90% of anesthetized patients suffered ATL and that they were associated with acute lung injury [3]. Additionally, increased pulmonary vascular resistance has been reported, possibly as a consequence of the hypoxic vasoconstriction reflex, and worsening of pre-existing lung injury due to changes in end-expiratory lung volume [4-6]. It has also been mentioned that ATL may be associated with surfactant deterioration as a consequence of anesthesia [7], gas reabsorption due to airway collapse or denitrogenation (8), and passive compression of the lung parenchyma due to the presence of pleural effusion [1].

Nowadays, within technological advances, there are imaging methods that allow, at the patient's bedside, to identify the cause of lung deterioration. Although it is possible to use laboratory tests and the evaluation of respiratory mechanics to infer the pulmonary insult consequent to the surgical act, the identification with images of the pulmonary collapse is crucial because the ATL is an eminently morphological alteration and, therefore, it is possible to quantify the amount of collapsed parenchyma using different imaging modalities (9). Rx and computed tomography (CT scan) are among the most used methods, which allow, directly, visualize and quantify the amount of collapsed tissue. Rx equipment can be transferred to the operating room or ICU, however, despite this advantage, like CT scan it has the disadvantage of irradiation and a static evaluation. In addition, CT scan, requires to transfer the patient out of the unit. On the other hand, recently, pulmonary ultrasonography has gained interest, showing correlation with CT scan as the gold standard [10]. Ultrasonography has an advantage over the previously mentioned imaging methods related to availability, practicality, non-invasive, bedside, without irradiating the patient and allowing to visualize pulmonary disorders in real time and corroborate the resolution of the ATL [11].

Once ATL has been corroborated as the cause of postoperative respiratory failure, the approach proposed for these patients includes an "open lung" ventilatory approach during the perioperative period. This concept was proposed in the early 90's [9] and was a pillar of treatment in the postoperative period. More recently, an alternative option has been shown, based on experimental studies, with good outcomes [10]. Likewise, a protective ventilation strategy, with reduction of tidal volume, maintenance of plateau pressure $<30cmH_2O$ and personalized positive end-expiratory pressure (PEEP) according to a PEEP/FiO_2 ratio has shown good results in patients with acute respiratory distress syndrome [11] and patients with healthy lungs. Other options to achieve individualization of PEEP values include estimates of esophageal pressure, using a catheter located in the distal third of the esophagus, to estimate pleural pressure and to determine transpulmonary pressure and the stress index applied to the lung parenchyma. In this sense, it has been reported that, through its use, optimal and personalized PEEP values were obtained [12].

Early mobilization and postural changes have also been shown to be effective in preventing ATL and ventilator-associated pneumonia in the postoperative period [13]. It has been reported that the reduction in FRC, secondary to the supine position, is close to 0.5-1lts; this volume loss increases by 0.5-0.7lts after anesthesia [14,15]. At the same time, a 27% decrease in FRC (facilitates cephalic displacement of the diaphragm induced by compression of intra-abdominal organs) has been reported [16], while the prone position was shown to reduce FRC by 53% [17]. Finally, another proposal to prevent this clinical situation is the use of non-invasive ventilation (NIV), in order to maintain PEEP and a sustained positive transpulmonary pressure that allows reducing the work of breathing and expanding the collapsed alveoli. Thus, the use of

continuous positive airway pressure (CPAP) reduces the risk of atelectasis, reintubation rate and prevents the appearance of pneumonia and sepsis [18]. In addition, NIV can be used as a therapeutic tool to improve gas exchange in the post-surgical period, optimize airway opening pressure and improve gas exchange and a reduction in cardiac preload [19,20].

As shown, there are numerous risk factors that can cause respiratory failure secondary to the appearance of post-surgical atelectasis, even in patients with healthy lungs, regardless of the type of surgery or anesthesia. Early detection, prevention, and treatment is of paramount importance to improve outcomes. This approach includes a mechanical ventilation strategy aimed at individualizing end-expiratory lung volume, optimizing PEEP values, adjusting tidal volume and plateau pressure, and improving respiratory minute volume to prevent lung injury and ensure a proper gas exchange. Options such as CPAP or NIV can be considered as prevention and rescue tools. Its use has been associated with a lower rate of pulmonary complications, reintubation and/or mortality and, consequently, an improvement in outcomes.

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