

Acute Respiratory Distress Syndrome (ARDS) Perioperative Considerations for the Anesthesiologist

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Abstract

Patients with Acute Respiratory Distress Syndrome (ARDS) that require some surgical intervention are prone to worsening of the pulmonary condition due to multiple factors during the surgical time, the role of the anesthesiologist is fundamental to detect early factors that may influence the deterioration respiratory and alveolar protection measures that must be granted during the trans-surgical period. The surgical interventions most associated with ARDS are cardiac, pulmonary, spinal and abdominal. The management by the anesthesiologist during the immediate postoperative and postoperative period includes the following: non-ventilatory measures and ventilatory measures. In ARDS, performing adequate ventilatory management while the patient is under mechanical ventilation, even while undergoing a surgical procedure, will improve the results.

Keywords: Acute Respiratory Distress Syndrome (ARDS); Anesthesiologist

Introduction

Acute Respiratory Distress Syndrome (ARDS), also called Adult Progressive Respiratory Distress Syndrome (SIRPA), is a serious clinical entity associated with high mortality. Corresponds to a systemic or local inflammatory response, with repercussion at the level of the pulmonary capillary, alveolar-capillary membrane and alveolus, altering the gas exchange, decreasing the arterial oxygen pressure in a significant way and being able to increase the levels of carbon dioxide later [1]. Patients with ARDS who require some surgical intervention are prone to worsening of the pulmonary condition due to multiple factors during the surgical time, the role of the anesthesiologist is fundamental to detect early factors that may influence respiratory deterioration and the measures of alveolar protection that must be granted during the trans-surgical period.

Epidemiology

The incidence varies between 5 and 33 cases per 100,000 hospitalized patients and between 11 and 21 cases per year hospital, taking into account multicenter studies between 1988 and 2010 in countries such as the United States, Spain, Iceland, and Finland [2-5]. initial description given by Ashbaugh in 1967, the initial mortality was reported in 70%, currently has decreased between 40 and 50% in the majority of large population series studied, although some randomized controlled studies have reported greater improvement in survival in selected groups of patients, this due to the new therapeutic strategies given by the adequate management of sepsis, measures of protective ventilation, use of adequate PEEP, limitation in blood transfusion, among others [1,6].

Etiology

Among the causes of ARDS, which concern the pre-surgical, trans-surgical and post-surgical territory, the following are frequently found [7,8].

Direct Causes

- Bronchoaspiration
- Embolism fat
- Pulmonary contusion
- Pneumonia
- Pulmonary injury associated with the ventilator

Indirect Causes

- Septic shock of potentially surgical infectious focus (abscesses, complicated appendicitis, cholangitis, etc.)
- Polytrauma
- Cardiopulmonary surgeries
- Transfusion of blood products
- Severe pancreatitis

The surgical interventions most associated with ARDS are cardiac, pulmonary, spinal and abdominal [9]. Other risk factors include multiple organ failure, alcohol and tobacco consumption, and the coding of 25 genes involved in coagulation, release of free radicals, and production of apoptosis [7].

Pathogeny

ARDS occurs due to an inflammatory response triggered by an initial lesion, which generates activation of macrophages, which, in turn, generate pro-inflammatory cytokines such as metabolites derived from arachidonic acid, Alpha Tumor Necrosis Factor, interleukins and procoagulant factors, among others, etc. that generate activation of the coagulation cascade and thrombosis, on the other hand complement is activated and there is migration of polymorphonuclear neutrophils from the capillaries to the interstitium and the alveolus, damaging the tissues through reactive oxygen species and proteases; This generates edema composed of water and proteinaceous material within the pulmonary interstitium and later located in the alveolus, hindering the exchange of oxygen and carbon dioxide [10-12].

Diagnosis

The diagnosis is based on the Berlin criteria, proposed in 2012, includes a clinical-gasometric criterion of respiratory failure, which is the decrease in PaO₂/FiO₂, a criterion of pulmonary imaging, a criterion for ruling out heart failure as a cause of pulmonary edema and positive pressure of at least 5 cmH₂O.

Berlin Criteria for SDRA [13-15]:

- 1) Start or worsening of clinical symptoms within 7 days.
- 2) Bilateral opacities in thoracic image (not well explained by effusions, atelectasis or nodules) in radiography or computed tomography.
- 3) Respiratory failure not completely explained by heart failure or water overload (in need of an objective study such as echocardiography) to exclude hydrostatic edema.
- 4) Use of PEEP or CPAP > 5 cmH₂O, with a decrease in PaO₂/FiO₂ < 300 mmHg and up to 200 mmHg (SIRA Leve), < 200 mmHg and up to 100 mmHg (Moderate SIRA), and < 100 mmHg (SIRA Severo).



Figure 1: Simple posteroanterior chest radiograph showing bilateral opacity corresponding to SARD.

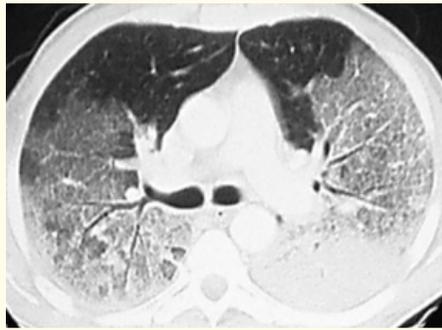


Figure 2: Computed tomography of the thorax in the pulmonary window showing bilateral ground-glass opacity with air bronchogram and left pleural effusion, corresponding to ARDS.

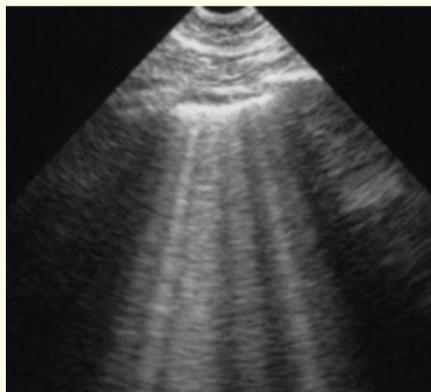


Figure 3: Lung ultrasound showing confluent B lines that occupy more than 75% of the intercostal field, corresponding to pulmonary edema due to ARDS.

Clinical Course [1,16]

The characteristic signs and symptoms are caused by hypoxemic respiratory insufficiency, presenting progressive dyspnea, nasal flutter, tiraje, thoracic-abdominal dissociation, alterations in the state of consciousness such as agitation and later stupor.

Hypoxemia is difficult to manage in most cases, and can be managed with non-invasive mechanical ventilation in case of mild SIRA, however, the vast majority of patients will require orotracheal intubation to maintain optimal levels of oxygenation.

During mechanical ventilation, the respiratory pattern will show a progressive increase in plateau pressure and increase in insufflation pressure (in volume control), decrease in tidal volume (in pressure control), with decreased pulmonary compliance.

In the pressure-volume loop, a tendency towards horizontalization will be observed, with increases in pressure without proportional volume gain (Figure 4).

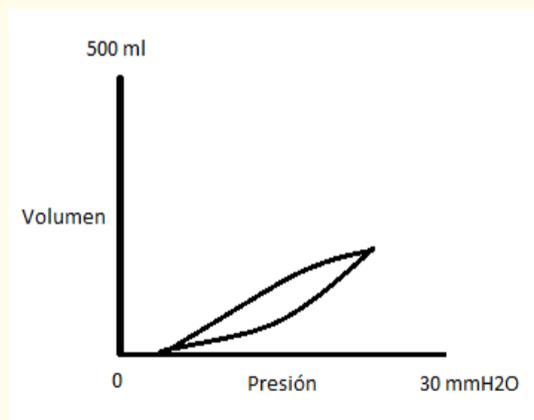


Figure 4: Pressure-volume loop, in which a pulmonary pattern of restrictive type is observed, with a tendency toward horizontalization of the loop, which shows a considerable increase in pressure without proportional increase in volume.

Treatment

The management of ARDS is complex, and requires resolution of the triggering cause [1,16], it is recommended that it be treated by an expert in mechanical ventilator management and consists of two types of therapy, ventilatory and non-ventilatory. Management by the anesthesiologist is essential to avoid a worsening of respiratory function during the immediate postoperative and postoperative period and includes the following:

Non-ventilatory measures

- Water restriction, given that the positive water balance is associated with higher mortality, and the extravascular lung water level will increase [16-18]. If the patient is in a state of shock, the use of vasopressors in the first instance should be considered. Instead of using intravenous solutions, except for hypovolemic shock.
- The use of neuromuscular blockers such as Cisatracurium in the case of severe ARDS [19] can increase survival in these patients, given that some patients require muscle paralysis during the trans-operative period, it is recommended that this drug be the one of choice.
- The use of intravenous albumin is recommended to reduce fluid leakage from the capillary into the alveolus, mediated by increased intravascular colloid osmotic pressure, as it is associated with an increase in arterial oxygenation and decreased mortality [20].
- A position of the patient in the supine position with a semi-recumbent head at 30° above the horizontal is recommended if the patient's conditions during the surgical procedure allow it.
- Orotracheal intubation should be with a cannula of the largest possible diameter according to the gender and size of the patient, which will decrease the resistance of the airway and favor the management of secretions.
- The prone position in the case of moderate to severe ARDS has shown improvement in survival in patients with PaO₂/FiO₂ less than 150, it is recommended when the patient does not improve with the application of an optimal PEEP and with an FiO₂ requirement greater than 60% [21] to maintain a SaO₂ > 88%, the patient can be placed in a prone position at the end of the surgical procedure, in the immediate postoperative period with few contraindications, such as not having invasive monitoring of intracranial pressure in the case of neurocritical or neurosurgical patients or a unstable spinal cord injury, medical personnel, nurses and stretchers should be trained to perform at a lower risk of complications.
- Maintaining a TAM greater than 65 mmHg is essential in patients in shock, given the hemodynamic repercussion related to the increase in pulmonary vascular resistance due to the pathology itself, in addition to the hemodynamic effect of mechanical ventilation [22].

Ventilatory measures

- It is recommended to use the ventilatory mode used with greater familiarity to the doctor, but currently the early use of APRV ventilation has been shown to increase oxygenation and decrease the days of mechanical ventilation in patients with ARDS [23].
- It is recommended to use the lowest inspired fraction of oxygen (FiO₂) necessary to maintain an arterial oxygen saturation (SaO₂) between 88 and 98%, using a mixture of air and oxygen in the anesthesia machine.
- A tidal volume objective of 4 to 8 ml/kg is recommended, it is recommended to start at 6 ml/kg and modify according to the volume required for the control of arterial pCO₂ [24].

- It is recommended to apply PEEP from 5 to 8 initially, and can be titrated looking for the level of PEEP that offers the best compliance without significant hemodynamic repercussion, by measurement of functional residual capacity, dead space or by quasi-static pressure curve volume [24].
- It is recommended to maintain the pressure of distension (DP for its acronym in English, driving pressure), resulting from the formula expressed by the plateau pressure minus the PEEP, below 16 cm H₂O, even a driving pressure is preferred (differential between peak pressure and plateau pressure) lower than 13 [25] since it is associated with greater survival, currently there are mechanical ventilators with dynamic monitoring of the PD.
- It is recommended to maintain the plateau pressure below 30 cm H₂O [23] to reduce the risk of hemodynamic repercussion mediated by right ventricular dysfunction.
- It is recommended to maintain the maximum pressure below 35 cm of H₂O [24] to minimize the risk of barotrauma and generation of pneumothorax.
- A SaO₂ objective is recommended by pulse oximetry or gasometry between 88 and 98%.
- A target arterial blood oxygen partial pressure between 60 and 100 mmHg is recommended to avoid consequences of hypoxemia or hyperoxemia as a decrease in DO₂ that can cause hypoxia or damage induced by free oxygen radicals.
- An objective of arterial pCO₂ less than 48 mmHg is recommended, which is associated with lower mortality [22].

Perioperative ventilatory goals in the patient with ARDS	
Running volume	4 to 8 ml/kg of weight predicted (Size in cm - 152.4) x 0.91 Add 45 (woman) or 50 (man)
PEEP	5 a 8 cmH ₂ O*
FiO ₂	21 a 60%
SaO ₂	88 a 98%
paO ₂	60 a 100 mmHg
paCO ₂	35 - 48 mmHg
Distension pressure (Driving pressure)	< 13 cmH ₂ O
Plateau pressure	< 30 cmH ₂ O
Maximum airway pressure	< 35 cmH ₂ O

Table 1: Goals of the ventilatory parameters in patients with ARDS during the perioperative period.
**In case of not reaching the goals of paO₂ and SaO₂ with 8 of PEEP, it is recommended to carry out a PEEP titration to determine the optimal PEEP level, carefully evaluating the patient's hemodynamic status.*

Conclusion

The ARDS is a common entity in the critically ill surgical patient, with high mortality to this day, an early recognition of the disease must be done to optimize the treatment of the underlying disease and, on the other hand, to carry out an adequate management ventilatory while the patient is under mechanical ventilation, even while undergoing a surgical procedure, to meet the goals of alveolar protection and avoid further lung damage.

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