CASE REPORT: OPTIMIZING POSITIVE END-EXPIRATORY PRESSURE USING ESOPHAGEAL BALLOON CATHETER MONITORING IN ARDS

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Abstract

Background:

Mechanical ventilation in patients with Acute Respiratory Distress Syndrome (ARDS) presents significant challenges, particularly in those with altered respiratory mechanics due to conditions like obesity. This case report explores the use of an esophageal balloon catheter for optimizing Positive End-Expiratory Pressure (PEEP) in a critically ill patient with ARDS.

Case Presentation:

A 46-year-old male with morbid obesity (BMI of 62 kg/m²), hypertension, and chronic Helicobacter pylori infection presented with symptoms of abdominal distention, constipation, shortness of breath, and oliguria. The patient was diagnosed with acute and chronic respiratory acidosis, leading to respiratory failure. Despite initial management with BiPAP therapy and mechanical ventilation, the patient's oxygenation remained inadequate.

Keywords: Optimizing, Positive, End-Expiratory, Pressure Esophageal Balloon Catheter Monitoring ARDS.

Intervention:

An esophageal balloon catheter was used to monitor esophageal pressures and adjust PEEP more precisely. Initial ventilator settings were modified based on transpulmonary pressure measurements obtained from the catheter, resulting in an improvement in oxygenation as evidenced by an increase in PaO_2/FiO_2.

Outcomes:

The use of the esophageal balloon catheter facilitated better alveolar recruitment and reduced the risk of ventilator-induced lung injury. The patient's condition showed gradual improvement, with PEEP effectively decreased and FiO2 reduced. However, due to ongoing complications, including desaturation episodes, a tracheostomy was performed on day 27 for prolonged mechanical ventilation.

Conclusion:

The esophageal balloon catheter proved effective in optimizing ventilator settings in a patient with severe ARDS and morbid obesity. This case underscores the importance of individualized respiratory management and the role of advanced monitoring techniques in improving clinical outcomes. Proper training and adherence to protocols are essential for maximizing the benefits of esophageal pressure monitoring in critical care settings.

Case Report: Optimizing Positive End-Expiratory Pressure Using Esophageal Balloon Catheter Monitoring

Mechanical ventilation in critically ill patients with respiratory failure poses serious clinical challenges to healthcare providers. The case report explores how the clinical application of an esophageal balloon catheter enhances the adequate adjustment of PEEP level in a patient diagnosed with ARDS. The esophageal pressure measurements aid in determining transpulmonary pressure and enable a review of the ventilator settings in the patient's physiological context. The approach is instrumental in managing many respiratory diseases since ventilation is a critical respiratory system function.

Case Presentation

A 46-year-old male patient with hypertension, chronic Helicobacter pylori infection, and morbid obesity with a Body Mass Index (BMI) of 62kg /m2 was admitted to the emergency room with the complaint of abdominal distention with slight pain, constipation for about a week and exertion and shortness of breath. The patient also expressed concern associated with oliguria and swelling of the lower limbs and said that the above symptoms have had moderate improvement after administration of furosemide. The first examination indicated that the patient developed acute and chronic respiratory acidosis with a PH level of 7. 24 and PCO2 of 81. 8 mmHg and subsequent worsening of this patient's secondary respiratory failure and CO2 retention. First, the patient's management consisted of BiPAP therapy and the intravenous bolus of furosemide. However, more importantly, there was continued respiratory acidosis and hemodynamic instability, so the patient was intubated and placed on mechanical ventilation.

CXR after intubation

Respiratory Management and Esophageal Balloon Catheter Application

After intubation, the patient was ventilated using PCV mode of ventilation with the starting parameters of pressure control 20 cmH2O, rate 20, PEEP 10 cmH2O, FiO2 70 %. However, the implemented strategies were still inadequate as the patient displayed poor oxygenation and ventilation. An esophageal balloon catheter was then used to facilitate the proper ventilator settings. This decision complied with the current evidence on the application of esophageal pressure monitoring in ARDS patients (Dostal & Dostalova, 2023). Hence, placing the catheter made it easy to monitor the transpulmonary pressures, facilitating accurate adjustments of PEEP and other variables on the ventilator.

Post catheterization, the ventilator settings were set at PC 20 cm H2O, RR 26, and PEEP 20 cm H2O, giving a minute volume of 12. 4 L/min mean peak inspiratory flow rate and tidal volume of 475 ml. Such changes enhanced oxygenation that was reflected by raised PaO2/FiO2 from < 95 to 210 after several days. Regarding respiratory mechanics, the esophageal balloon catheter gave us helpful information about the patient. The catheter enabled the determination of transpulmonary pressures to help adjust the PEEP to enhance alveolar recruitment while avoiding the development of barotrauma (Baedorf Kassis & Talmor, 2021). As demonstrated in this case, the approach is most advantageous in high BMI patients because chest wall compliance could be diminished.

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X-ray done, after applying Esophageal Balloon Catheter

Criteria for Esophageal Balloon Catheter Application

Several factors formed the basis of the decision to use an esophageal balloon catheter as a critical clinical intervention. The first was the patient's ARDS, which was worse concerning P/F50 below 150, which required further respiratory monitoring (Shimatani et al., 2023). The patient's morbid obesity was another essential factor because physiologic changes in respiratory mechanics and conventional methods of ventilation management may be insufficient (Baedorf et al., 2021; Hamilton Medical, 2024). Concerning traditional settings used in ventilators, the hypoxic state of the patient depicts that a more effective approach is required to support respiratory needs (Cammarota et al., 2020). Moreover, the patients required proper adjustment of PEEP. Compared to the other pre-study tools, the esophageal balloon catheter meant considerable manipulations in terms of PEEP through analysis of transpulmonary pressures, so it can be stated that it was routinized but not arbitrary (Jonkman et al., 2023; Xia et al., 2024). The method allowed the clinicians to set sufficient mean oxygen concentration to prevent system-induced lung damage, which is crucial in this case, as the patient has altered respiratory physiology due to obesity and severe ARDS.

Importance of Esophageal Balloon Catheter Use

The esophageal balloon catheter intervened in this case in several ways. First, it was possible to apply PEEP titration based on the patient's respiratory mechanics and achieve better oxygenation (Cammarota et al., 2021). The patient-centered approach is useful when the patient presents with multiple complaints. Additionally, the noninvasive feature of the catheter to track transpulmonary pressures also entailed reducing the incidence of ventilator-associated lung injury, which forms a significant part when operating on ARDS (Jonkman et al., 2023; Hamilton Medical, 2024). The device also provided adequate patient-ventilator synchrony by offering accurate estimations of the workload of the patient's respiration (Shimatani et al., 2023; Pasticci et al., 2020). The approach probably enhanced breathing and reduced the patient's discomfort.

Furthermore, continuous assessment of esophageal pressure yields valuable data concerning decisions made in the patient's weaning process. Although the patient required subsequent intubation and tracheostomy since he needed to be artificially ventilated for a longer period, these measurements provided a more objective idea about the plan for the management of the aspect of the ventilator as well as the efforts that can be made for the graduated discontinuation of the use of the ventilator (Hamilton Medical, 2024; Massion et al., 2021) The utilization of the esophageal balloon catheter, therefore, acted as another process of improving the respiratory treatment and the mechanical ventilation concerning the physiological orientation of the patient in this crucial situation.

Clinical Course and Outcomes

The patient's clinical course illustrated the slow progress under the use of an esophageal balloon catheter. PEEP was effectively decreased to 15 cmH2O, while FiO2 was gradually reduced to 30% during the critical period of the client's hospitalization (Jiang et al., 2022; Rudolph et al., 2024). Nevertheless, such essential developments as desaturation episodes and troubles with ventilator weaning still appeared in the patient's care. On day 27, a tracheostomy was done for the patient because of the necessity of continuing mechanical ventilation (Sy et al., 2021). Ventilatory management was maintained with the pressure control and pressure support modes adjusted by the patient's relevant clinical condition (Akoumianaki & Vaporidi, 2022). The Therefore, the complexity of the clinical scenario explains why the severe form of ARDS is challenging to treat. Therefore, it demonstrates that there is always a need to be vigilant and respond to the changing conditions of respiratory aids despite the utilization of sophisticated measures such as esophageal pressure monitoring.

Discussion

The above case highlights the usefulness of an esophageal balloon catheter in managing patients who have respiratory failure, especially if they are obese and thus have different mechanics of ventilation. Catheter data helped adjust the ventilator settings, which resonates with the current literature on protective lung ventilation. Jiang and colleagues (2022) also showed that the methods to calibrate the esophageal balloon are crucial when measuring the pressures, while Mireles-Cabodevila et al. (2023) emphasized the significance of esophageal pressure measurement while ventilating patients with ARDS. Implementation of the latter is addressed in this case using the approach that supports these findings, revealing the potential for enhancing the patients' respiratory status. Esophageal pressure measurement is useful in determining transpulmonary pressure and enabling the identification of optimal ventilator settings according to the patient's specific physiology.

However, it is important to realize that using esophageal balloon catheters may only be helpful if the correct protocols to insert the catheter and correct data identification processes are employed. In their paper, Piquilloud et al. (2024) pointed out that clinicians must adhere to outlined protocols, and the training should be comprehensive and specific to achieve the desired outcome. Besides, Jonkman et al. (2023) recommended that clinicians learn the advantages and limitations of using esophageal pressure in ventilated patients. This case describes the value of esophageal pressure monitoring and the necessity for modernizing the protocol in the ICU. As Mireles-Cabodevila et al. (2023) highlighted, accurate measurement is a critical factor in amplifying the technological advancement of respiratory monitors. The approach improves the use of the relevant technology and the quality of care given to respiratory patients.

Conclusion

In the above severe case of respiratory failure, using the esophageal balloon catheter exemplified the need to fine-tune the ventilator to the specific condition of a certain patient. The catheter also helped set the patient's PEEP to the desired level and evaluated the respiratory mechanics, thus improving tissue and cell oxygenation and further preventing ventilator-induced lung injury. The presented case also supports the need for current clinicians to consider high-end respiratory monitoring when dealing with patients presenting with moderate to severe ARDS, especially when morbidly obese.

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