Esophageal balloon catheter Guided PEEP Titration in Severe ARDS Following Bariatric Surgery in a Morbidly Obese Patient

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Abstract

Background: Morbid obesity profoundly alters respiratory mechanics by elevating pleural and chest wall pressure, rendering standard airway-pressure-based ventilation unreliable in patients with acute respiratory distress syndrome (ARDS). Esophageal balloon catheter enables estimation of pleural pressure and calculation of transpulmonary pressure, allowing individualized PEEP titration beyond what airway pressure alone can provide.

Case Summary: A 50-year-old morbidly obese woman (BMI 43.15 kg/m^2) developed severe ARDS (PaO_2/FiO_2 ratio ~84) following laparoscopic revisional bariatric surgery. Despite pressure-regulated volume control with a set tidal volume of 500 mL, only 132 mL was delivered, indicating markedly compromised respiratory compliance unexplained by airway pressure alone. An esophageal balloon catheter was inserted and used to guide PEEP titration based on transpulmonary pressure. PEEP was escalated to 25 cmH_2O guided by esophageal balloon catheter and subsequently weaned in a stepwise manner over Four days. The patient was successfully extubated on day four of ICU admission, with marked improvement in arterial blood gas parameters.

Conclusion: This case highlights the critical role of esophageal balloon catheter guided ventilation in obese ARDS patients where airway pressure is a misleading surrogate for lung mechanics. Transpulmonary pressure-guided PEEP titration enabled safe use of high PEEP levels that facilitated alveolar recruitment and ultimately successful extubation.

Keywords: Esophageal manometry; transpulmonary pressure; PEEP titration; acute respiratory distress syndrome; morbid obesity; mechanical ventilation; bariatric surgery

INTRODUCTION

Patients with acute respiratory distress syndrome (ARDS) are a particularly challenging population due to obesity, which changes the normal respiratory mechanics, and it also causes respiratory complications in the lungs because the intra-abdominal pressure increases and chest wall elastance increases, leading to an increase in pleural pressure and lung collapse (Jonkman et al., 2023; Shimatani et al., 2023; Tolone et al., 2025). The airway pressure may be an inaccurate indicator of the overall lung distending pressure, since much of the airway pressure is released in the chest wall and not via the alveoli (Ball et al., 2024; Dostal & Dostalova, 2023; Mireles-Cabodevila et al., 2023). Therefore, in standard ventilator settings, lung collapse is not always detected. And, due to the fear of barotrauma and low recruitment for the patient and low recruitment of the PEEP, it may lead to a high PEEP and the patient to be underweight or underweight through a higher PEEP (Dostal & Dostalova, 2023).

The existing approaches to ARDS management (e.g., ARDSNet PEEP/FiO_2) were developed in heterogeneous populations and may not cope with the very abrupt changes to chest wall mechanics in morbidly obese patients (Battaglini et al., 2025; Jonkman et al., 2023). Esophageal pressure (Pes) provides an approximation to pleural pressure, and with esophageal manometry, it is possible to calculate transpulmonary pressure as the difference between airway pressure and esophageal pressure (Dostal & Dostalova, 2023), and the physiologic approach allows for tailored PEEP titration for each individual patient to target positive end-expiratory transpulmonary pressure and minimize excess end-inspiratory overdistention (Baedorf Kassis & Talmor, 2021). The EPVent and EPVent-2 trials/analysis have already demonstrated that guided PEEP can be determined by transpulmonary pressure and not airway pressure alone in ARDS by showing guided PEEP guided ventilation with esophageal pressure guided ventilation of the tissue of the lungs (Beitler et al., 2019; Fish et al., 2014; Sarge et al., 2021; Turbil et al., 2019).

Case Presentation

A morbidly obese woman (BMI 43.15 kg/m²) underwent laparoscopic revisional bariatric surgery. During surgery, she had a sleeve gastrectomy 7 years ago, and intraoperatively was found to have previously undiagnosed vertical banded gastroplasty with mesh placement. She remained intubated and transferred to the intensive care unit due to hypoxemia despite maximal noninvasive ventilatory support requiring mechanical assistance.

Signs of progressive respiratory failure with marked hypercapnia and respiratory acidosis were evident on the first postoperative day, even with vigorous ventilation. The patient was under pressure-regulated volume control with a tidal volume of 500 mL, respiratory rate of 25 bpm, FiO_2 of 100%, and PEEP of 8 cm H_2O, but the actual tidal volume was only 132 mL, which shows the respiratory system was not in good order, and perfusion was more than alveolar ventilation. The abnormal airway pressure and dynamic compliance showed that standard methods have not been able to capture the magnitude of respiratory mechanics arising from an underlying pathology. The arterial blood gas analysis revealed severe combined respiratory and metabolic derangement (pH 7.00, $PaCO_2$ 94 mmHg, PaO_2 84 mmHg, SaO_2 92%, bicarbonate 23 mmol/L, lactate 4.0 mmol/L). At FiO_2 of 1.0, the PaO_2/FiO_2 ratio was approximately equal to or less than ~84, which is the Berlin criteria for severe ARDS (Matthay et al., 2019). Diffuse bilateral airspace opacities were noted in acute lung injury on chest radiography due to severe hypoxemia, high load on the obesity-related chest wall, and poor tidal ventilation even with maximum ventilator adjustments. Esophageal balloon-guided ventilation was performed.

Intervention: Esophageal Balloon-Guided PEEP Titration

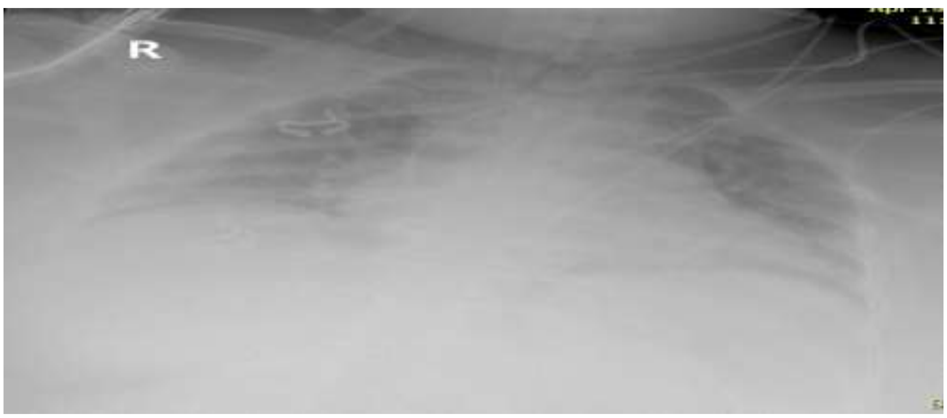
The main reason for the insertion of esophageal balloons was severe acute respiratory distress (ARDS) in morbidly obese patients who were observed to have unexpectedly low pulmonary component compliance; this could not be appropriately accounted for simply with respect to airway pressure measurements. Here, the study used esophageal pressure monitoring to separate lung and chest wall mechanics, and for guided PEEP titration according to transpulmonary, rather than airway pressure (Jonkman et al., 2023). We inserted an esophageal balloon catheter in line with the current practice in critical care. Positioning was verified by waveform characteristics assessment and ventilator-occlusion testing according to the current understanding of the monitoring of esophageal pressure (Jiang et al., 2022; Piquilloud et al., 2024). Transpulmonary pressure and ventilator adjustments were estimated by end-expiratory and end-inspiratory esophageal pressures.

Maintain end-expiratory transpulmonary pressure close to zero for the protection from excessive alveolar derecruitment and with ventilator settings in place to constrain and prevent high end-inspiratory transpulmonary pressures that could lead to ventilator-induced lung injury (Dostal & Dostalova, 2023; Shimatani et al., 2023). As importantly, the physiologic data from the esophageal balloon indicated that much higher PEEP levels might be used than most clinicians would usually apply for a patient with severe ARDS and obesity. The arterial blood gas analysis 4 hours after initiation of esophageal balloon-guided ventilation was reassuringly unchanged. pH was 7.00 and increased to 7.25, $PaCO_2$ was 94 mmHg and was reduced to 59 mmHg (–37% decrease), PaO_2 was 84 mmHg and increased to a mean of 99 mmHg (18% increase), oxygen saturation increased from +3 to +98% (range 61.0 - 63.1%). These data suggested an enhanced alveolar recruitment and gas exchange and excretory capacity as a result of transpulmonary pressure-guided PEEP optimization.

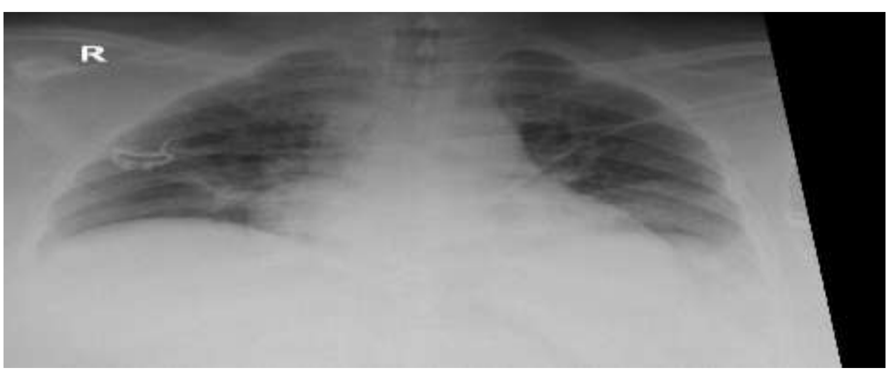
Table 1. Esophageal Balloon-Guided PEEP Titration Timeline

Date / Time	PEEP (cmH_2O)	FiO_2 (%)	Clinical Rationale
On (Admission)	8	100	Initial PRVC; only 132 mL delivered vs 500 mL set; esophageal balloon inserted

16/04/2026 11:00 AM	**25**	100	Optimal PEEP transpulmonary pressure confirmed safe use of high PEEP
16/04,/2026 16:00 PM	20	100	Step-down per improving transpulmonary pressure and gas exchange
17/04/2026 01:00 AM	16	80–100	Continued downward titration per transpulmonary pressure trend
17/04/2026 to 19/04/2026	Progressive taper	Weaning	Stepwise reduction guided by transpulmonary pressure and chest imaging
20/04	**Extubated**	—	**Successful liberation from mechanical ventilation (day 4)**



CXR- before applying Esophageal Balloon



CXR- after applying Esophageal Balloon

DISCUSSION

This case demonstrates the challenge inherent in using standard ventilator settings in invasive mechanical ventilation in patients with morbid obesity. Also, morbid obesity increases pleural and chest wall pressures, so that increased airway pressures may not be representative of the impact on lung parenchyma (Mireles-Cabodevila et al., 2023;

Shimatani et al., 2023). In the present patient, a delivered tidal volume of only 132 mL despite the target tidal volume of 500 mL indicated also restricted and a lack of alveolar recruitment, and standard ventilator settings were likely to be biased by the underlying physiology (at least in terms of pressure or flow-based control). The use of esophageal manometry resulted in changes in clinical management as PEEP could be titrated with transpulmonary pressure, not airway pressure. A PEEP of 25 cmH_2O may have been considered to be a risk factor for barotrauma; however, esophageal pressure measurements indicated that the high pleural pressure, which has always been a concern for such lung pressure, directly leads to low effective distending pressure at the lung (Baedorf Kassis & Talmor, 2021). This physiologic data led to the increased PEEP levels as a way to promote alveolar recruitment without high risk for over-distension. Transpulmonary pressure-directed ventilation was more customized and could be used for mechanical problems in the lungs or lower abdominal pressure due to obesity compared to conventional ARDSNet-based ventilation.

Most of the improvement in oxygenation and ventilation after PEEP requirements guided by esophageal balloon indicates that this strategy probably played a role in lung recruitment toward successful extubation. However, such factors as catheter placement errors, calibrating the device, and a single case report cannot prove any causation, since recovery may also have been a result of concurrent supportive treatments (Piquilloud et al., 2024).

A key advantage of the esophageal balloon in this case was its ability to provide continuous, real-time monitoring of lung mechanics throughout the entire ICU course, rather than offering only a single static assessment. Unlike conventional ventilator parameters, which reflect a composite of lung and chest wall properties, continuous esophageal pressure monitoring allowed the clinical team to track transpulmonary pressure on an ongoing basis and to detect dynamic changes in pleural pressure as the patient's respiratory status evolved (Jonkman et al., 2023; Mireles-Cabodevila et al., 2023). This continuous monitoring capability was integral to the stepwise PEEP de-escalation strategy employed in this case: rather than reducing PEEP on a fixed schedule or based on static arterial blood gas values alone, each downward titration step—from 25 cmH_2O on 16 April to 20 cmH_2O later that day, then to 16 cmH_2O on 17 April, and progressively lower thereafter—was informed by real-time transpulmonary pressure data confirming that alveolar recruitment was maintained and overdistension was avoided at each new setting (Dostal & Dostalova, 2023; Shimatani et al., 2023). This individualized, physiology-driven weaning approach—made possible only because the esophageal balloon remained in place as a continuous monitoring tool—is in contrast to empirical PEEP reduction, which in a morbidly obese patient carries a high risk of precipitating alveolar derecruitment and clinical deterioration (Baedorf Kassis & Talmor, 2021; Ball et al., 2024). Notably, this patient was successfully and fully extubated within four days of esophageal balloon insertion—a clinically significant outcome given the severity of her initial presentation (pH 7.00, $PaO_2/FiO_2 \approx 84$ mmHg, delivered tidal volume of only 132 mL) and her high-risk profile as a morbidly obese post-surgical patient. The speed of recovery to extubation readiness suggests that continuous transpulmonary pressure-guided ventilation facilitated more efficient lung recruitment and a safer weaning trajectory than would likely have been achievable with standard empirical ventilator management alone (Beitler et al., 2019; Sarge et al., 2021).

CONCLUSION

Esophageal manometry-guided ventilation is a physiologically-based treatment for severe ARDS in a morbidly obese surgical patient. It may be an example of a safe use of PEEP higher than that which would have been employed by airway pressure alone, by estimating pleural pressure and enabling transpulmonary pressure-guided PEEP titration. The enhanced gas exchange with successful extubation suggests that esophageal balloon monitoring may be an important adjunct for monitoring the true lung mechanics in obese ARDS patients, who do not have accurate ventilator parameters and chest radiography, but have poor lung function.

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