March 2022 Journal Club

We chose some studies/articles that might have educational and clinical significance.
We represent the abstract of those articles along a brief commentary and thoughts by our editorial team.
We do not recommend depending on our comments but reading and critiquing the study/paper yourself and make your own decision.

- Influence of age, mechanical power, its fragments and components on the mortality rate in SARS-CoV-2 patients undergoing mechanical ventilation

- Extubation Failure Prediction by Echography of the Diaphragm After Cardiothoracic Surgery: The EXPEDIA Study

- Mechanical ventilation induces lung and brain injury through ATP production, P2Y1 receptor activation and dopamine release
Influence of age, mechanical power, its fragments and components on the mortality rate in SARS-CoV-2 patients undergoing mechanical ventilation

Claudio Luciano Franck, Gustavo Maysonnave Franck, Raquel Galvão Feronato
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Abstract

Introduction
The Acute Respiratory Distress Syndrome caused by the Coronavirus 2019 (SARS-CoV-2) may be associated with the ARDS and Ventilation Induced Lung Injury (VILI). However, there are still doubts about the potential damage generators and their influences on patient outcome

Objective
To analyze the mechanical ventilation factors that influence the mortality in SARS-CoV-2. Assess the outcomes based on age, on parameters of the mechanical ventilator, on Mechanical Power and on its fragments through univariate and multivariate analysis of age, PEEP, Driving Pressure, elastance

Method
Observational, longitudinal, prospective, analytical, and quantitative study of age and of the parameters of the mechanical ventilator, alongside the calculous of the Mechanical Power and its components of patients with SARS-CoV-2

Results
We identified significant impact on the outcome in the univariate analysis of age (p<0.001), respiratory rate (p=0.047), elastance (p<0.001), compliance (p<0.001), driving pressure (p<0.001), inspiratory pressure variation (p<0.001), peak airway pressure (p=0.009), plateau pressure (p<0.013), PEEP (p<0.001), dynamic elastic power (p<0.001) and static elastic power (p=0.005). In the multivariate analysis the increase in age (p<0.001), in elastance (p=0.0029) and in Mechanical Power (p=0.023), and the reduction in PEEP (p=0.044) showed significant impact on the death risk

Conclusion
The increase in age and in mechanical power with increased dynamic elastic power and decreased static elastic power influenced the mortality rate of patients with SARS-CoV-2 undergoing mechanical ventilation, i.e. it is related to the increase in driving pressure to overcome a high elastance and low capacity to recruit for PEEP

Comments
Excellent observational longitudinal prospective study that evaluated multiple factors and their effect on mortality in 147 subjects with COVID-19.

Their results identified age, Mechanical power and each of its fragments to affect the mortality.

The article explains in detail what is Mechanical power:

\[
0.098 \times RR \times Vt \left[ P_{\text{Peak}} - 0.5 \left( P_{\text{plateau}} - \text{PEEP} \right) \right]
\]

and subdivide it into Dynamic and static elastic power and inspiratory flow resistive power:

- Dynamic elastic power = \[
0.098 \times RR \times Vt \times 0.5 \times E \times Vt^2
\]
- Static elastic power = \[
0.098 \times RR \times Vt \times \text{PEEP}
\]
- Inspiratory flow resistive power = \[
0.098 \times RR \times Vt \times R/T_{\text{insp}}
\]

Take home point:
Special attention to the components of Mechanical power is crucial during mechanical ventilation.
Extubation Failure Prediction by Echography of the Diaphragm After Cardiothoracic Surgery: The EXPEDIA Study

Thibaut Genty, Florent Laverdure, Olivier Peyrouset, Saïda Rezaiguia-Delclaux, Jacques Thé’s, and François Ste´phan


Abstract

Background
Successful extubation is difficult to predict. Ultrasound measurement of the diaphragm thickening fraction (DTF) might help predict weaning failure after cardiothoracic surgery.

Methods
We assessed the predictive performance of diaphragm ultrasound in a derivation cohort of 50 prospectively included cardiothoracic surgery subjects ready for a weaning trial and in a validation cohort of 39 subjects ventilated for 6 48 h. DTF was assessed by ultrasound during pressure support ventilation (PSV) then during a T-piece spontaneous breathing trial (SBT). DTF was the percentage change in diaphragm thickness between expiration and inspiration and DTFmax, the higher DTF value of the 2 hemidiaphragms. DTFmax during SBT (static study) and the difference in DTFmax between PSV and SBT (dynamic study) were analyzed. RESULTS: In the derivation cohort, DTFmax during SBT was 25.6 ± 17.3% in subjects with successful extubation and 65.2 ± 17.3% in those with weaning failure (difference 39.7 [95% CI 27.4–51.9], P < .01). During SBT, DTFmax 6 50% was associated with weaning failure (area under the receiver operating characteristic curve [AUC] 0.94 ± 0.05). In the dynamic study, a 6 40% DTFmax increase was associated with weaning failure (AUC 0.91 6 0.06). In the validation cohort, DTFmax during SBT was 20.3 6 17.1% in subjects with successful extubation and 82.0 6 51.6% in those with weaning failure (difference 61.8 [95% CI 41.6–82.0], P < .01). During SBT, DTFmax 6 50% predicted weaning failure (AUC 0.99 6 0.02). In the dynamic study, a 6 40% increase in DTFmax predicted weaning failure (AUC 0.81 6 0.09).

Conclusions
Measuring DTFmax during SBT and the DTFmax change when switching from PSV to SBT may help predict weaning failure after cardiothoracic surgery.

Comments
Well done study on small size patients post cardiothoracic study were the investigators used ultrasound to assess the DTF (Diaphragmatic Thickening Fraction) which is the percent change of diaphragmatic thickness between inspiration and expiration during PSV and T-Piece. Their results showed that the larger changes (50% in PSV and 40% in T-piece) of the DTF correlates with extubation failure.

The level of PSV that was used was pretty high 12-14, also patients on PSV were called static which obviously are not.

Diaphragmatic weakness is a common problem leading to prolonged mechanical ventilation and failure to wean especially in medical patients. The concept of measuring DTF and diaphragmatic excursion during weaning has been increasingly studied over the last 10 years. Some studies showed that it predicts weaning success and other showed that it did not.

Take home point:
The concept is interesting but needs more confirmation studies in both medical and surgical patients before making decision to liberate the patients solely on these criteria.
Mechanical ventilation induces lung and brain injury through ATP production, P2Y1 receptor activation and dopamine release


Abstract

Mechanical ventilation can induce lung injury and exacerbate brain injury due to lung-brain interaction. The current study sought to investigate the mechanism of lung-brain interaction induced by mechanical ventilation and offer theoretical insight into the management of ventilator-induced brain injury. The experimental mice were assigned into the spontaneously breathing group and the mechanical ventilation group and injected with dopamine (DA) receptor antagonist haloperidol or P2Y1 receptor antagonist MRS2279 before ventilation. *In vitro* assay was conducted using lung epithelial cells MLE-12 hippocampal neuron cells and HT-22. Mouse recognition function and lung injury were examined. The condition and concentration of neurons in the hippocampus were observed. The levels of several inflammatory factors, DA, adenosine triphosphate (ATP), P2Y1R, and dysbindin-1 were detected. Mechanical ventilation induced lung and brain injury in mice, manifested in increased inflammatory factors in the bronchoalveolar lavage fluid and hippocampus, prolonged escape latency, and swimming distance and time in the target quadrant with a weakened concentration of neurons in the hippocampus. Our results presented elevated ATP and P2Y1R expressions in the mechanically ventilated mice and stretched MLE-12 cells. The mechanically ventilated mice and P2Y1 receptor activator MRS2365-treated HT-22 cells presented with elevated levels of DA and dysbindin-1. Inactivation of P2Y1 receptor in the hippocampus or blockage of DA receptor alleviated brain injury induced by mechanical ventilation in mice. To conclude, the current study elicited that lung injury induced by mechanical ventilation exacerbated brain injury in mice by increasing ATP production, activating the P2Y1 receptor, and thus promoting DA release.

Comments

Excellent animal study (mice) that investigate the effect of mechanical ventilation on lung injury and brain injury on animals undergoing mechanical ventilation.

The study is very well done though little technical but an eye opener to a new topic of Lung-Brain interaction.

Their results showed not only elevated inflammatory markers but also changes in neurons in the hippocampus as well as cognitive performance on those mice undergoing mechanical ventilation.

**Take home point:**

New concept to consider is the Lung-Brain interaction which is not really well studied in humans and perhaps need lots of attentions and well done studies before we totally understand. Also highlights the need for biomarkers for ventilator induced lung injury in clinical practice.