EDITORIAL

Diaphragmatic Rapid Shallow Breathing Index: A Simple Tool to Give more Power to Predict Weaning?

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Liberating patients from mechanical ventilation (MV) successfully remains one of the foremost and frequently encountered challenges for the intensive care physician. Conventionally, patients are subjected to a spontaneous breathing trial (SBT) varying in duration range 30–120 minutes, during which the patient is closely observed for any worsening clinical signs or respiratory fatigue.[1] Failure in liberation from MV presumably leads to an increased intensive care unit (ICU) and hospital length of stay, greater patient morbidity and mortality, and higher healthcare costs.[2]

A great deal of research has focused on finding successful predictors of liberation from MV. Notable among them is the rapid shallow breathing index (RSBI) described by Yang and Tobin in their seminal article more than three decades back that continues to find relevance even today.[3] The widespread availability of bedside ultrasonography, and physicians being increasingly accustomed to its use have enabled us to gain additional information about the changes in respiratory muscles, lung, and cardiac function during the process of ventilator liberation.[2] The recent investigations focusing on lung, diaphragm, or cardiac ultrasound highlight the potential of ultrasonography to enhance the prediction of extubation outcomes.[4,5]

Diaphragmatic atrophy following a prolonged duration of MV has been well described. Diaphragmatic thickness has been found to decrease at the rate of 6–7.5% per day in ventilated patients.[6] Curiously, a subset of patients may show an increase in diaphragmatic thickness as a consequence of excessive spontaneous efforts or tissue edema that also portends a poor prognosis. Ultrasound visualization of the diaphragm has enabled us to assess diaphragmatic functional activity at the bedside using measurements of diaphragmatic displacement and diaphragmatic thickness fraction. The usual cut-offs to diagnose diaphragmatic dysfunction in the critically ill is less than 11–14 mm for diaphragmatic displacement and 30–36% for thickness fraction.[7]

Spadaro et al. reported the favorable profile of diaphragmatic-RSBI (D-RSBI) as a predictor of weaning failure following a T-tube SBT with an area under the receiver operating characteristic curve (AUROC) of 0.89 compared to 0.72 for RSBI.[8] They modified the traditional RSBI equation by using ultrasonographically measured diaphragmatic displacement instead of tidal volume in the calculation of D-RSBI (expressed as breath/minute/millimeter). The authors hypothesized that the patients with underlying diaphragmatic dysfunction could continue to generate normal tidal volumes during SBT due to accessory muscle activity compensating for diaphragmatic weakness. However, accessory muscles are more likely to fatigue in the subsequent hours leading to excess diaphragmatic load and weaning failure. Given the ability of bedside ultrasound scan (USG) to measure diaphragmatic displacement relatively easily at the bedside, the authors felt that D-RSBI had a better clinical profile and could unmask weaning failure more efficiently compared to RSBI.

In the current issue of *Indian Journal of Critical Care Medicine*, Gupta et al.[9] describe the use of D-RSBI as a predictor of weaning failure in 45 mechanically ventilated patients, in which D-RSBI comprehensively outperformed RSBI as a predictor of weaning failure (AUROC 0.97 for D-RSBI vs 0.70 for RSBI, $p < 0.05$). The findings of the study are in line with similar published research.[10] Around 58% of the current study population were intubated because of hypercapnic respiratory failure due to underlying chronic obstructive pulmonary disease (COPD), in whom extubation to non-invasive ventilation seems to be an accepted practice to avoid re-intubation. This was, however, not pursued in the current study due to the prespecified study protocol and definition of weaning failure.

The limitations of diaphragmatic ultrasonography are manifold. Diaphragmatic measurements suffer from differences in intra-observer and interobserver variability.[11] Small differences in measurement can potentially affect the results. Diaphragmatic excursion is affected by the patient's age, sex, loading conditions of the diaphragm, patient position, respiratory efforts, and timing of measurement during the course of a SBT.[12] Kim et al. found that that diaphragmatic displacement of less than 10 mm at the end of a 2-hour SBT to be a better predictor of weaning failure.[13] Patients in this study had diaphragmatic displacements measured at the beginning of SBT, yet evidently, it did not affect the diagnostic accuracy of D-RSBI. Given the small sample size of the weaning failure group ($n = 9$) in the current study, the possibility of inflated effect size and low reproducibility remains.

It is also important to understand that patients with diaphragmatic dysfunction can still be extubated successfully.[14] Patients may often have other coexistent contributors to weaning failure such as such as cardiac dysfunction, loss of lung aeration, the large volume of secretions, etc. during the process of weaning. So, in practice, it makes intuitive sense to use an integrated approach evaluating cardiac, respiratory muscle, and lung aeration during weaning rather than to look at diaphragm in isolation.[5] Ultrasound evaluation should be used as a complimentary tool to clinical examination to gain insight into these underlying physiological processes and institute corrective measures accordingly.

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