Perceived Benefits of Tracheostomy: Respiratory Mechanics and Asynchrony

Despite tracheostomy tube placement being a common procedure in the critical care management of acute illness and injury, important questions remain unanswered with regard to its indications, timing, and benefits. The subject matter, specifically, and in its entirety, is complex in nature. The indications for elective tracheostomy, beyond those of anatomic and traumatic necessities, include prolonged intubation, facilitation of liberation from mechanical ventilation, and more efficient pulmonary hygiene.[1-3] The predicted need for prolonged mechanical ventilation in acute respiratory failure and, hence, the timing of tracheostomy, is highly subjective and still controversial.[4,5] Further, the reputed benefits of providing prolonged mechanical ventilation via a tracheostomy tube versus an endotracheal tube include faster liberation from mechanical ventilation, increased patient comfort, reduced sedation needs, lowered work of breathing (WOB), and improved patient safety lack clarity in the literature.[1-3] Systematic reviews and meta-analyses are plagued by the skewed definition of early and late tracheostomy, the inherent clinical and methodologic heterogeneity contained within the studies, and the end points reported.[5,6]

Much of the preceding discussion is well beyond the scope of the paper from Lena et al[7] (for the ASYNICU investigative group) in this issue of RESPIRATORY CARE. Instead, the investigators sought the answer to a discrete question that pertained to the differences in lung mechanics and asynchrony before and after tracheostomy.[7] It is important to keep in mind that those factors that may impact patient-centered outcomes in a meaningful way are most likely part of a multifactorial and multidisciplinary bundle. Any future possibility of a model, satisfactorily predictive of the need for tracheostomy and/or the timing of such, would seek to understand if respiratory system mechanics or perhaps even if other objective criteria of gas exchange or diaphragm function should be integrated. A patient would be screened, for example, for a spontaneous breathing trial, with criteria that may include WOB (resistance or elastance). Patients with values that exceed a threshold would be at risk for prolonged mechanical ventilation, and tracheostomy might be of benefit, owing to data that these mechanics are altered in a positive way and are associated with meaningful clinical outcomes. The ability to reliably obtain these measures at the bedside, within the context of identifying the etiology of spontaneous breathing failure notwithstanding.

SEE THE ORIGINAL STUDY ON PAGE 1389

Important to the identification of the explicit advantages and indications for tracheostomy, Lena et al[7] provide valuable insight into those theoretical mechanisms of tracheostomy to facilitate liberation from mechanical ventilation. Mechanisms associated with tracheostomy include improvement in respiratory system mechanics, notably airway resistance, and, subsequently, a reduced WOB. Early works by Diehl et al[8] and Davis et al[9] compared respiratory mechanics before and after tracheostomy, and found a decrease in airway resistance, (resistive) WOB, and intrinsic PEEP, collectively. Data collection periods were finite periods of time before and after tracheostomy, essentially a snapshot, and used esophageal manometry to find WOB and the pressure-time product. The study by Diehl et al[8] was also designed such that they retained the endotracheal tubes withdrawn during the tracheostomy procedure for bench study in which they found an insidious decrease in effective endotracheal tube diameter due to secretions, which likely caused an increase in airway resistance and WOB. The thermolabile nature of the endotracheal tube always carries a higher in vivo resistance compared with the rigid tracheostomy tube.

As stated in the elegant work by Diehl et al[8] 2 decades ago, "it is important to determine the mechanisms by which work of breathing can be reduced following tracheotomy." In the study by Lena et al,[7] the BetterCare platform (Better Care, Barcelona, Spain) was used to continually monitor a number of output variables from the ventilator and patient monitors. The data in the 24 h before and 24 h after tracheostomy were captured and analyzed. Contrary to previous work, the investigators found no significant change in the continually monitored respiratory mechanics (resistance,

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compliance, inspiratory and expiratory flow, and total PEEP).[7] It could be argued that this contemporary work better defines respiratory system mechanics because of its longitudinal nature. On aggregate, the changes in respiratory mechanics found in previous work and now those unchanged mechanics in this current study do not account for the proclivity to wean from mechanical ventilation after tracheostomy due to a decrease in airway resistance or WOB.

In a novel design concept, owing to the analytical platform used in the study, Lena et al[7] also analyzed asynchronies during the same timeframe before and after tracheostomy. The platform identifies and classifies asynchronies into 4 categories: ineffective triggers, double triggering, short cycling, or prolonged cycling. There was no difference in the occurrence of asynchronies before and after tracheostomy, most likely explained by the extraordinarily low rate of asynchrony before tracheostomy compared with that described in the literature. Analysis of previous data describes an asynchrony index $> 10\%$ in up to a fourth of the patients studied; the asynchrony index before tracheostomy was only 2% across the entire 20-subject cohort.[10]

The current pilot study included subjects whose etiology of respiratory failure was largely representative of the case-mix in ICUs; however, the 20 subjects studied possessed respiratory mechanics and an asynchrony index that were essentially normal, despite liberation failure and tracheostomy. As the investigators point out, it is therefore difficult to find significant differences after tracheostomy. As a result, caution should be used in generalizing these results, not only because of the small sample size but because of the subjects' inherently normal characteristics.

The etiology of liberation failure and/or prolonged weaning can be multifactorial, not always associated with the mechanics of the respiratory system. Future study could possibly cohort patients intended for tracheostomy not according to the reason for mechanical ventilation but according to the reason for liberation failure, although understandably difficult. An approach based on organ system function or dysfunction may allow a more perceptible difference after tracheostomy and in studied interventions. If applied, perhaps those patients with derangement in respiratory mechanics that results in liberation failure may show benefit from tracheostomy due to improvement in mechanics whereas other patients may find benefit in tracheostomy for discretely different reasons.

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