Is there an optimal mode of ventilation following cardiac surgery?

There have been several advances in the perioperative care of both adults and children having cardiac surgery. Improvements in the technology of cardiopulmonary bypass (CPB), advances in the techniques of surgery, a better understanding of the pathophysiology of the postoperative period, and refinements in anesthetic and ICU care have led to changes in the perioperative management of these patients. These changes have led to improved outcomes and shortened hospital stays. In many patients, a fast-track approach is taken so that endotracheal extubation occurs in the operating room or within hours following completion of the surgical procedure.[1-3] Fast-tracking not only results in cost-savings, but may also eliminate the potential risks of prolonged endotracheal intubation and mechanical ventilation including nosocomial infections and airway trauma. The attainment of the goal of early extubation requires an adequate function of both the cardiovascular and respiratory systems. Such care requires not only meticulous attention to intraoperative surgical and anesthetic care, but also techniques that facilitate rapid recovery of the respiratory function.

Respiratory dysfunction and the need for mechanical ventilation following cardiac surgery remains the most frequently reported cause of postoperative morbidity.[4,5] In patients undergoing cardiac surgery, death caused by respiratory complications has been reported as being more frequent than that due to cardiac causes.[6] A major cause of respiratory dysfunction is the loss of functional residual capacity with atelectasis, which occurs more frequently in patients undergoing cardiac surgery CPB than in other surgical populations.[7]

Given these concerns, alterations in the methods and techniques of mechanical ventilation that limit the development of atelectasis or reverse it once it has occurred may be helpful in expediting early extubation.

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To that end, Samantaray and Hemanth have published in this month's issue of the Saudi Journal of Anaesthesia, the results of their prospective trial comparing two commonly used modes of mechanical ventilation, PRVC or pressure-regulated volume controlled ventilation and PCV or pressure-controlled ventilation.[8] In order to concentrate their efforts on a subset of patients who could most benefit from an improved ventilatory strategy, the authors chose to include only patients with a PaO_2/FiO_2 ratio of less than 300, a criteria that is now generally considered indicative of acute lung injury (ALI). The patients were then randomized to either PRVC or PCV and the outcomes determined by calculation of the oxygenation index (OI). OI is calculated as the PaO_2 divided by the product of the FiO_2 and the mean airway pressure. The OI was calculated prior to surgery and then at 1 and 2 h following the initiation of mechanical ventilation. The authors noted a steady and significant increase in the OI in both groups at both the first and second hour. When comparing the two groups, the improvement in oxygenation using PRVC occurred despite a lower mean airway pressure (8.6 ± 0.8 versus 7.7 ± 0.5 mmHg, $P=0.001$). No other difference was noted in the clinical outcome and postoperative course of these patients.

This study attempts to address the important question of what is the optimal mode of ventilation following cardiac surgery and other procedures what may mandate a short period of postoperative mechanical ventilation. When mechanical ventilation first started, patients were generally ventilated in the volume-control mode where the tidal volume was set and inspiration ended when that volume was delivered. Mostly from work in caring for patients with acute lung injury and adult respiratory distress syndrome, we have learned that although mechanical ventilation is frequently life-saving, the techniques we use may impact on overall morbidity and mortality.[9,10] When evaluating these studies, it becomes apparent that the mode of ventilation (pressure vs volume) was likely not the primary factor responsible for determining the outcome, but rather it was the fact that avoiding high distending pressures is the most critical factor. Regardless of the mode of ventilation that is chosen, attention to the determinants of mean airway pressure and oxygenation are important. Mean

airway pressure is a function of positive end expiratory pressure, peak inflating pressure, and the inspiratory time. When faced with a patient with low-functional residual capacity, atelectasis, and poor oxygenation, these factors can frequently be manipulated to improve oxygenation without resulting in a significantly higher plateau pressure. The latter being the primary determinant of iatrogenic lung injury.

In the ongoing search for new modalities of ventilation that provide oxygenation and ventilation while limiting iatrogenic lung injury, the recent years have brought us PRVC which seeks to provide the advantages of both volume- and pressure-limited ventilation. Like volume-limited ventilation, a preset tidal volume is generally ensured and yet, like pressure-limited ventilation, this is done with a decelerating flow pattern and with an adjustment of the flow rate to avoid deleterious increases in plateau pressure. As we pursue clinical trials related to this current manuscript, we must continue to strive to identify strategies that effectively limit the duration of postoperative mechanical ventilation and its associated sequelae. Although one could infer that an improvement in oxygenation would facilitate this goal, larger studies are needed to clearly identify strategies that will result in higher goals including improved survival, decreased duration of mechanical ventilation, earlier ICU discharge, shorter hospital stays, and cost savings. Such differences are likely to be easier to identify in a subset of critically ill patients who have a higher risk of requiring prolonged mechanical ventilation including those exposed to prolonged CPB times, those undergoing complex surgical procedures, and those with preexisting comorbid conditions involving the respiratory tract including chronic obstructive pulmonary disease. I would encourage the authors to continue their work in these difficult patients who may not survive despite our best efforts.

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