Cardiopulmonary Rehabilitation Using Adaptive Servo-Ventilation After Cardiac Surgery

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The NIPPV mode has been classified as continuous positive airway pressure (CPAP) with static airway pressure throughout both the inspiratory and expiratory cycles, and bi-level positive airway pressure (BiPAP) with support pressure in the inspiratory phase coupled over CPAP. Adaptive servo-ventilation (ASV) is a more advanced and sophisticated mode of BiPAP, automatically controlling the inspiratory rise time, the I:E ratio, and minute ventilation with a self-learning algorithm that adjusts these parameters based on samples obtained from the patient’s prior breathing pattern (Figures 1.2). Because ASV has high tolerability with its synchronized and stable respiratory pattern of smooth positive pressure, recent studies reported that it is superior to prior NIPPV supports in improving cardiac and respiratory conditions in acute or chronic heart failure, as well as decreasing sympathetic nerve tone and the levels of atrial and B-type natriuretic peptides. However, the efficiency of ASV for cardiopulmonary rehabilitation in patients after cardiac surgery has not been well documented.

In this issue of the Journal, Tashiro et al² compared an ASV system with conventional cardiopulmonary rehabilitation program for the patients after OPCAB surgery, with the setting of end-expiratory pressure of 4 cmH₂O, minimum support pressure of 4 cmH₂O, maximum pressure support of 10 cmH₂O, for 30 min/day during postoperative 5 days. They demonstrated that a cardiopulmonary rehabilitation program with ASV after OPCAB surgery resulted in a more stable homodynamic postoperative condition, lower C-reactive protein values and body weight, and reducing the duration of hospital stay.

The efficiency of positive airway pressure support, including ASV, might be the result of decreasing the extravascular lung water volume, which increases especially after exubation after cardiac operation, and reducing the transmural pressure of the left ventricle and peripheral vascular resistance to increase cardiac output, and reducing cardiac sympathetic nerve activity by stimulating pulmonary stretch receptors by lung inflation.

They also describe an important finding for OPCAB surgeons that the incidence of postoperative atrial fibrillation (AF) was significantly lower in the ASV group (10% occurrence) compared with the non-ASV group (33% occurrence). AF is one of the most common complications after OPCAB and is associated with an increased risk of stroke and longer hospital stay.

OPCAB is an established technique for achieving multivessel coronary artery revascularization, and has the potential to be associated with lower in-hospital mortality and complications, which was not inferior even to the results of percutaneous catheter intervention (PCI). But only stroke is reported to be a problematic complication compared with PCI, because OPCAB has the possibility of an intraoperative episode of cerebral hypoperfusion and aortic plaque embolization during aortic partial clamping and declamping, and thromboembolization by AF after surgery. The incidence of stroke associated with CABG ranges from 1.6% to 3%, depending on patient population and individual surgical procedures; because OPCAB has the possibility of an intraoperative episode of cerebral hypoperfusion and aortic plaque embolization during aortic partial clamping and declamping, and thromboembolization by AF after surgery. The incidence of stroke associated with CABG ranges from 1.6% to 3%, depending on patient population and individual surgical procedures; because OPCAB has the possibility of an intraoperative episode of cerebral hypoperfusion and aortic plaque embolization during aortic partial clamping and declamping, and thromboembolization by AF after surgery. The incidence of stroke associated with CABG ranges from 1.6% to 3%, depending on patient population and individual surgical procedures; because OPCAB has the possibility of an intraoperative episode of cerebral hypoperfusion and aortic plaque embolization during aortic partial clamping and declamping, and thromboembolization by AF after surgery. The incidence of stroke associated with CABG ranges from 1.6% to 3%, depending on patient population and individual surgical procedures; because OPCAB has the possibility of an intraoperative episode of cerebral hypoperfusion and aortic plaque embolization during aortic partial clamping and declamping, and thromboembolization by AF after surgery.

AF occurs in 16–30% of patients in the early postoperative...
period following CABG. The majority of episodes of AF occur by day 3. It is well known that postoperative AF is influenced by multiple risk factors including volume overload, cardiac afterload, and inflammation. In order to prevent AF after OPCAB, several trials and studies were performed in Japan focusing on the efficacy of perioperative oral or intravenous β-blocker administration, because the occurrence of AF is speculated to relate to high levels of sympathetic nerve tone, blood catecholamines or cytokines.

From that point of view, the study by Tashiro et al, which demonstrated that ASV significantly reduces the frequency of post-cardiac surgery AF, is greatly important information for OPCAB surgeons. They can expect ASV rehabilitation to be a promising tool to reduce the frequency of postoperative AF, which is strongly related to the serious complication of stroke. These days, most cardiac surgeons are challenged by cardiac or vascular repair in older aged and high-risk patients. In order to achieve better results of lower postoperative morbidity but also earlier recovery and shorter hospital stay, cardiac surgeons might introduce cardiopulmonary rehabilitation with this novel positive airway pressure support system from just after operation.

**Figure 2.** Characteristics of pressure pattern during breathing cycle and indication of usage of continuous positive airway pressure (CPAP), bi-level positive airway pressure (BiPAP) and adaptive servo-ventilation (ASV). EEP, end-expiratory pressure; PS, support pressure.

**References**


