Impact of different ventilation modalities on lung volumes and pressures during automatic cardio pulmonary resuscitation: a bench study

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Introduction: During cardio-pulmonary resuscitation (CPR), the ventilation strategy applied may affect tidal volume (VT), minute ventilation (VE), lung volume and hemodynamics. Also, by decreasing lung volumes, chest compressions (CC) can create lung injury.

Objective: This bench study aimed to evaluate current recommendations for ventilation during CPR and to compare it to continuous flow insufflation (CFI) with positive pressure.

Materials and methods: In a lung test model specifically designed to allow standardized chest compressions with an automatic device (LUCAS ²⁶), we evaluated manual bag ventilation (10 cycles/minute), volume controlled ventilation (VCV) mode using Oxylog 3000⁶ (respiratory rate at 10/min, VT = 500 ml and zero of end-expiratory pressure). We also tested CFI set at 10 cmH₂O - 12L/min of continuous flow of gas using CPR Boussignac® tube. Ventilation mobilized by CC (black in the figure) and by the conventional ventilatory strategies (gray in the figure), changes in intrathoracic pressure and dynamic lung volume reduction compared from FRC were measured.

Results: With the two conventional ventilatory strategies, main part of minute ventilation was related to CC alone (84% for bag-mask ventilation and 78% for VCV) and lung volume was reduced far below FRC. With CFI, minute ventilation was significantly greater and the loss of lung volume was less important. Finally, with CFI the intrathoracic pressure during compression (red) was positive but remained negative (blue) during decompression thus preserving venous return.

Conclusion: With current conventional ventilatory strategies, ventilation was essentially due to CC and took place entirely below FRC. CFI was more efficient in terms of ventilation, FRC protection and intrathoracic pressure variation. These results show the predominant role played by CC in terms of ventilation and suggest that ventilation with CFI should be considered for CPR.