The effect of high positive-end expiratory pressure on elastance of respiratory system and ventilation distribution during robot-assisted laparoscopic radical prostatectomy

Shono A, Katayama N, Aoyama Y, Ozasa H, Nikai T, Saito Y.
Shimane University Faculty of Medicine, Dept of Anaesthesiology, Izumo City, Japan

Background and Aim

Pneumoperitoneum and steep Trendelenburg position during laparoscopic surgery increase elastance of the respiratory system and impair gas distribution in the lung, resulting in hypoxia. In this study, we investigated the effect of high PEEP on elastance of respiratory system and regional ventilation distribution using Electrical Impedance Tomography (EIT) during robot-assisted laparoscopic prostatectomy (RALP).

Methods

Patients were ventilated with PCV mode, tidal volume was set at 6-8ml/kg/PBW.

Time points		PEEP	Measurements
T0	before induction		Respiratory parameters ✓ Tidal volume, SpO ₂ , Peak inspiratory pressure, FiO ₂ , PETCO ₂ , Respiratory rate, Cdyn,
T1	after induction	5	
T2	before pneumoperitoneum and head down	15	✓ Esophageal pressure (Pes) ✓ Ventilation distribution ✓ Blood gas Hemodynamics ✓ BP, HR ✓ Stroke volume variation ✓ Cardiac Index
T3	20 min after head down	15	
T4	60 min after head down	15	
T5	120 min after head down	15	
T6	10 min after cessation of pneumoperitoneum	15	
T7	after extubation		

❖ Calculation of Elastances: Chest wall (E_{cw}), Lung (E_L)

$$E_{rs} = \frac{\text{Plateau pressure} - \text{PEEP}}{\text{Tidal volume}} \quad E_L = E_{rs} - E_{cw}$$
$$E_{cw} = \frac{\text{Pes at end-inspiration} - \text{Pes at PEEP}}{\text{Tidal volume}}$$

❖ Electrical impedance tomography

❖ Statistics

Data was analyzed by one-way ANOVA with repeated measures and Tukey test as post-hoc analysis.

Results : Demographic data

n = 11	mean ± SD
Age (yr)	67 ± 2
BMI (kg/m ²)	24 ± 2
% Vital Capacity (%)	100 ± 4
FEV1.0% (%)	76 ± 2
Ope time (min)	408 ± 28
Fluid balance (ml)	2145 ± 170

Results : Change in Elastances

Results : Change in distribution of ventilation

❖ Dorsal region : Layer 4

	T1	T2	T3	T4	T5	T6
EIT tidal image						
Layer4 (%) (mean ± SD)	10 ± 2	18 ± 1*	12 ± 3	11 ± 3	9 ± 2	19 ± 2*

The ventilation distribution of the dependent part of the lung didn't decreased significantly at the Trendelenburg position compared to at T1. (* $p < 0.05$ vs T1)

Discussion

Elastance of chest wall increased due to pneumoperitoneum and Trendelenburg position. However, lung compliance was kept constant because lung elastance did not change during surgery. Dorsal ventilation during surgery monitored by EIT showed comparable distribution with at after induction. In addition, P/F ratio did not change through an entire study, indicating that lung collapse caused by pneumoperitoneum and Trendelenburg position might be prevented by applying high PEEP.

Conclusions

Lung elastance would not increase and dorsal ventilation could be maintained when high PEEP is applied before the establishment of pneumoperitoneum and Trendelenburg position.