Validation of a capnodynamic method for measuring Effective Lung Volume in healthy volunteers

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Conclusion

In healthy subjects in the up-right position ELV and FRC showed a high agreement. This indicates that ELV could be used as a continuous online measurement of FRC during mechanical ventilation. Further, ongoing, studies will evaluate the performance of ELV on anaesthetized patients

Background

Effective lung volume (ELV) can be calculated continuously using a capnodynamic method utilizing a breathing pattern with intermittent cyclic prolongation of inspiratory pauses and correlates well with functional residual capacity (FRC) in healthy lungs in a porcine model.

Aims

The aim of this study was to evaluate and validate ELV as a volume correlated to FRC in healthy volunteers.
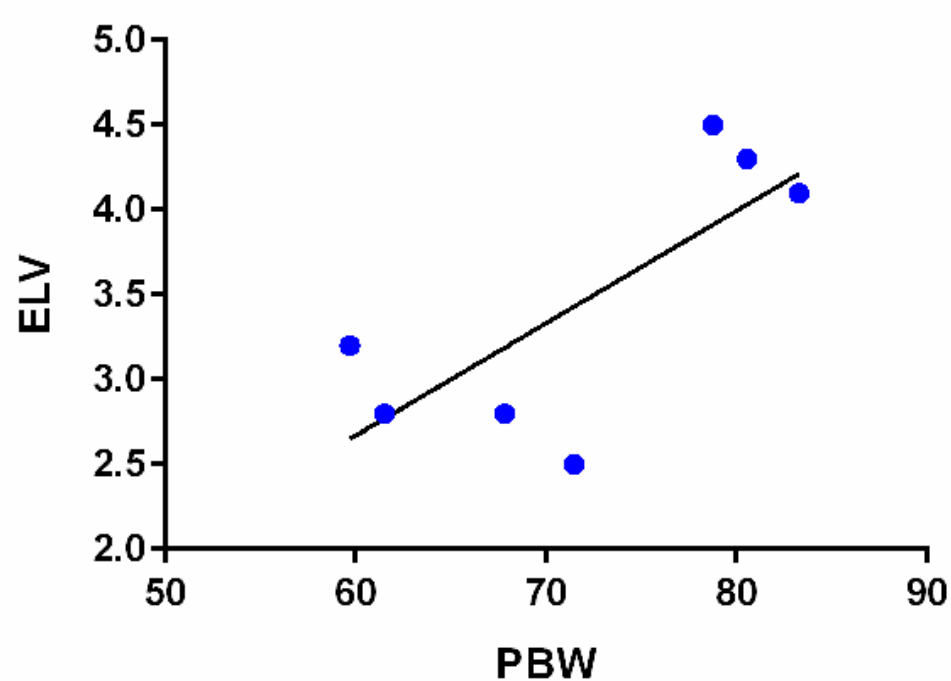
Methods

10 healthy volunteers were passively ventilated in an upright position using the capnodynamic methods breathing pattern without PEEP. ELV was measured in at least three consecutive minutes where breaths were showing a good fit (low error) between measured and calculated expired CO2. Mean ELV was then compared to FRC using body box plethysmography (FRC_{bp}), In four out of ten study subjects we also measured FRC by a nitrogen wash out method for measuring FRC in spontaneous breathing subjects (Exhalyzer), (FRC_{ex}).

$$ELV \cdot \left(F_A CO_2^n - F_A CO_2^{n-1} \right) = EPBF \cdot \Delta t^n \cdot \left(C_v CO_2 - C_c CO_2^n \right) - VTCO_2^n$$
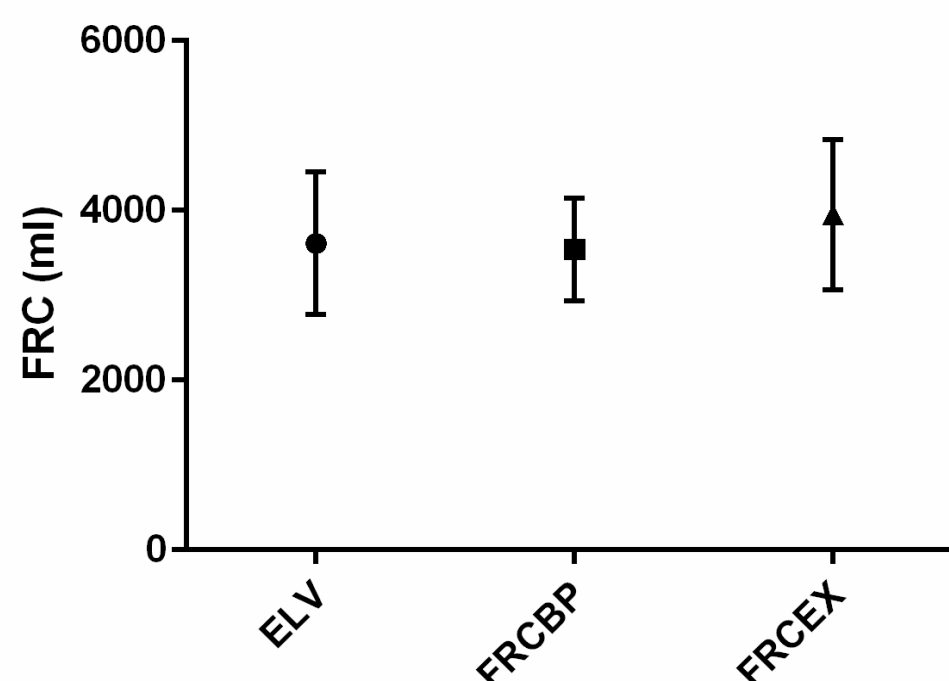
Results

Three of the study subjects were excluded since they could not tolerate to be ventilated in the controlled ventilator mode.

ELV showed a FRC (median (range)) of 3350 ml (2700-4500 ml). FRC_{bp} in the same objects were 3700 ml (2600-4400 ml). FRC_{ex} was slightly higher 3950 ml (2900-5000 ml). ELV and FRC showed high agreement when compared in a Blant-Altman plot with a bias (95% limits of agreement of) of 21 (-754 to 796 ml) ml and a percentage error of 22 %. ELV correlated well with predicted body weight (PBW), r = 0,75.

N=7: Corellation between PBW and ELV

N=7: Median, range for ELV and FRC

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