Characterization of the transthoracic impedance waveform fluctuations during controlled ventilation modes

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INTRODUCTION

- ❖ Transthoracic impedance (TTI) waveform provides important information about ventilations during cardiac arrest.
- ❖ The objective was to characterize ventilation caused TTI changes in relation to tidal volumes (TV), insufflation time, ventilation frequency and patient Body Mass Index (BMI).

METHODS

- ❖ Twenty-one subjects scheduled for abdominal surgery in general anaesthesia were enrolled in the study (12 BMI<25, 9 BMI>25). Written consents were signed by all participants.
- ❖ Subjects were mechanically ventilated with different tidal volumes: 6 modes (150ml-800ml), then at TV 400 ml: 4 modes with different ventilation frequencies (12min⁻¹-30min⁻¹) and 7 modes with different gas insufflation times (0.5s-3.5s,).
- ❖ Continuous waveforms were recorded using LP15 defibrillators (Stryker, USA), with its pressure transducer connected to the airway. TTI ventilation waveform was obtained through filtering.
- ❖ Ventilation peak, insufflation onset and expiration offset times for TTI and pressure waveforms were automatically detected, then manually audited.
- ❖ TTI amplitude and duration were computed for each ventilation.
- ❖ Regression analysis was used to assess the influence of TV, frequency and insufflation time on TTI amplitude and duration, controlling for BMI.

RESULTS

- ❖ Expiration amplitude showed positive relation with TV (slopes 1.59Ω/lt, frequency 12min⁻¹), no relation with frequency (slope 0.003 Ω/min⁻¹, p>0.05, volume 400ml) and small negative relation with insufflation time (-0.041Ω/sec, volume 400ml and frequency 10min⁻¹).
- ❖ Slopes for TTI amplitude showed significant differences between normal weight (1.93Ω/l) and overweight (1.31Ω/l) subjects, p<10⁻⁹ (figure A).
- ❖ Durations had small positive relation with TV (slope 0.48sec/l), strong negative relation with frequency (-0.051sec/min⁻¹) and strong positive relation with insufflation time (0.89) (figure B).
- ❖ Slopes for durations showed no significant differences between normal and overweight subjects, p>0.05.

Above:

A) Mean change in impedance for each tidal volume.

B) Tidal volume duration measured in the TTI signal plotted against the known insufflation time.

Left: TTI signal markings from left to right: inspiration onset, TTI peak and expiration offset were automatically annotated in the TTI curve.

DISCUSSION

- ❖ Recent literature suggest that some ventilatory patterns during CPR may cause pulmonary injury and impact outcome.^{1,2}
- ❖ Information on duration and approximate TV of provided ventilations during CPR is therefore of interest.
- ❖ This study confirms previous findings³ that the expiratory amplitude from TTI peak to TTI offset exert linear positive correlation to tidal volume.
- ❖ This correlation is however affected by patient BMI, and other factors may influence TTI/TV relations during CPR.
- ❖ The duration of TTI change is correlated to the duration of the provided TV, independently of patient BMI.
- ❖ Therefore, TTI may be used to retrieve information about TV (adjusted for BMI) and duration of provided ventilations during CPR.

CONCLUSION

- ❖ TTI ventilation amplitude is controlled by tidal volume, with significant differences between normal weight and overweight patients.
- ❖ Duration of TTI fluctuation is controlled by insufflation time when tidal volume is kept constant.
- ❖ Quantitative measures were obtained for amplitudes and durations to characterize ventilation in the TTI waveform. This can be used to retrieve more information about ventilation patterns during CPR than merely ventilation frequency.

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