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Letter to the Editor

Capnographic waveforms obtained in experimental Thiel cadaver model after intubation

We read with interest the study of Silvestri et al. [1] describing capnographic waveforms obtained in two frozen cadavers, after intubation. These observations highlight the possibilities of realistic simulation, but might present limitations in reproducibility [2]. Here, we report our experience of a more physiologic scenario based on an experimental Thiel cadaver model where we directly administrated CO_2 in the lung. These observations interestingly complete those reported by Silvestri et al. particularly given the possibility of extending this model to CO_2 simulation during Cardiopulmonary Resuscitation (CPR). Methods.

Thiel cadavers were harvested from a specific donation program at the anatomy laboratory of Université du Québec à Trois-Rivières (UQTR). The experiment was conducted in accordance with Canadian regulations following ethic committee approval (CER-14-201-08-03.17). Two cadavers were intubated via direct laryngoscopy. After placement verification by chest auscultation and chest X-ray, the endotracheal tube (ET) was connected to a Monnal T60 ventilator (ALMS, Antony France). The absence of CO_2 was confirmed via two different CO_2 sensors (mean stream and side stream), immediately after intubation. Then, CO_2 was insufflated at low flow (2/min of 10% CO_2) through a catheter positioned into the proximal bronchial tree. The typical End Tidal CO_2 ($ETCO_2$) waveform was recorded at the airways opening during ventilation, illustrating the CO_2 and alveolar gas mixture in the lung (Fig. 1A). The ET was removed and the cadavers were stored at room temperature (20 °C) overnight.

Results

Eighteen hours after ET removal, intubation was repeated on the same cadavers using CO_2 monitoring. Proper ET placement was confirmed by obtaining $ETCO_2$ variations (Fig. 1B) while oesophagus intubation was immediately detected by a flat $ETCO_2$. Almost 15 min of conventional mechanical ventilation were needed for complete CO_2 washout.

Discussion

The specific setup developed with this Thiel cadaver model allowed us to reproduce real $ETCO_2$ tracings. Interestingly, in absence of additional CO_2 administration, the CO_2 initially detected could be completely washed out with continuous ventilation. It suggests that the CO_2 detection likely resulted from CO_2 trapped by collapsed lung airway tissue, rather than a post-mortem process as mentioned by Silversti et al.

The realistic environment of airway management simulation, using Thiel cadavers, has been recently reported [3]. They differ from fresh cadavers mainly because of tissue textures close to living patients, providing a more realistic tactile sensation during head's mobilisation and intubation. As we performed CPR simulation at 20 °C, we observed that this temperature is favourable to lung compliance and produces a more physiological behaviour, similar to Out-of-Hospital Cardiac Arrest (OHCA) patients. Indeed, we previously reported respiratory mechanics characteristics of Thiel cadaver that were consistent with clinical observations obtained in real OHCA patients [4,5].

Conclusion

In conclusion, compared to frozen cadavers, our model offers a unique opportunity for the development of educational program on airways management and CPR training. In addition, this realistic model is sufficiently stable over time to be used on repeated occasions.

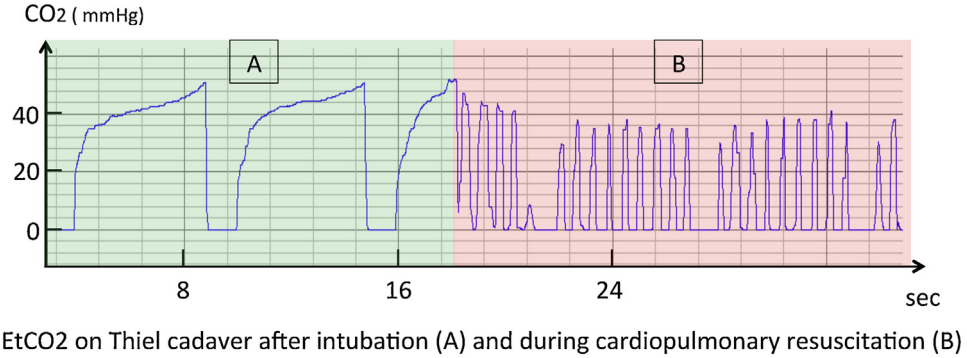

Fig. 1. $EtCO_2$ on Thiel cadaver after intubation (A) and during cardiopulmonary resuscitation (B).

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Conflicts of interest

Dr J.C.M. Richard and M. Rigollot are employed by the society Air Liquide Medical Systems (Antony, France) and the hospital of Annecy (research activity). Dr. Savary and the group CAVIAR has received research fundings from Air Liquide Medical Systems (Antony France).

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