

- 6 Blumenthal S, Borgeat A, Maurer K, *et al.* Preexisting subclinical neuropathy as a risk factor for nerve injury after continuous ropivacaine administration through a femoral nerve catheter. *Anesthesiology* 2006; **105**: 1053–6
- 7 Chaudhry V, Cornblath DR. Wallerian degeneration in human nerves: serial electrophysiological studies. *Muscle Nerve* 1992; **15**: 687–93
- 8 Shields RW Jr, Harris JW, Clark M. Mononeuropathy in sickle cell anemia: anatomical and pathophysiological basis for its rarity. *Muscle Nerve* 1991; **14**: 370–4
- 9 Whitlock EL, Brenner MJ, Fox IK, Moradzadeh A, Hunter DA, Mackinnon SE. Ropivacaine-induced peripheral nerve injection injury in the rodent model. *Anesth Analg* 2010; **111**: 214–20

doi:10.1093/bja/aet269

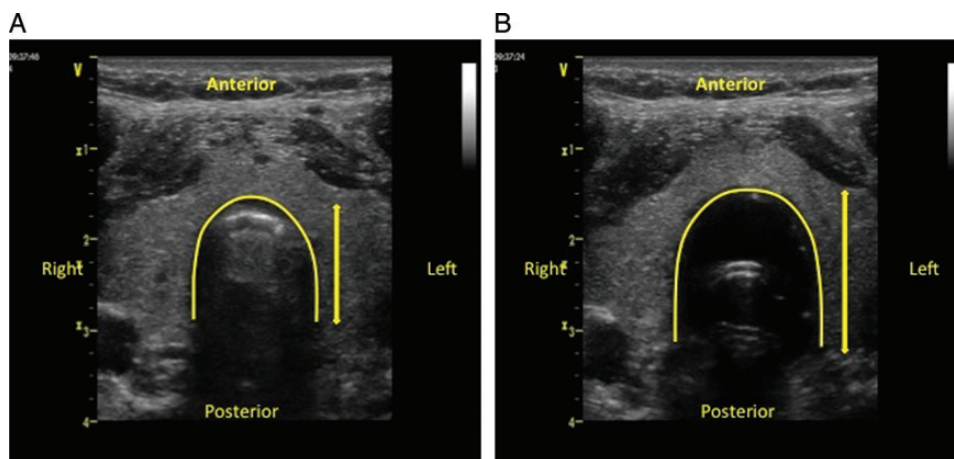
### Accurate and easy to learn ultrasound sign to confirm correct tracheal intubation in cadaver model

Editor—The proper placement of a tracheal tube into the trachea should be systematically checked after each intubation to avoid morbi-mortality related to hypoxaemia.<sup>1</sup> No strategy is ideal,<sup>2</sup> although ultrasound is promising. The study aimed to assess the performance of a new ultrasound sign for correct intubation, the increase in the antero-posterior diameter of the trachea during cuff inflation (Fig. 1), by an experienced sonographer and its learnability among novices after a short training course.

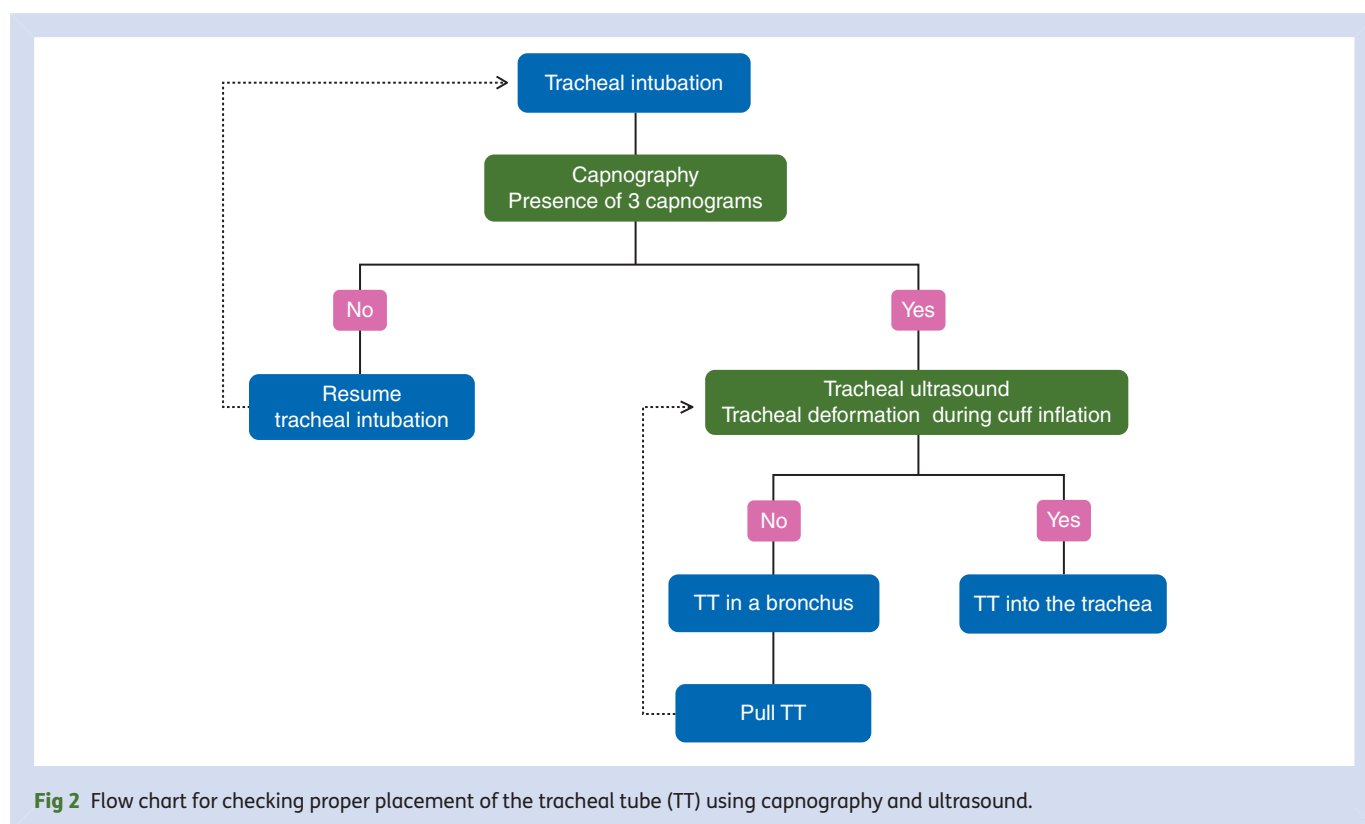
Freshly embalmed cadavers from people having donated their bodies to science were used in these studies, in accordance with French law (Collection number: DC-2008-137). Twenty freshly embalmed cadavers were randomly intubated correctly or not three times, leading to 60 assessments (30 tracheal intubations, 15 bronchial intubations, 15 oesophageal intubations). Correct tracheal intubation was defined as tube tip located into the trachea between the glottis and the

carina. Incorrect intubation was defined as tube tip located either in the oesophagus or in a bronchus. All tube tip positions were checked with a laryngoscope and a disposable fibrescope (Ambu®, aScope™, Ballerup, Denmark). A piece of tissue was placed on the cadaver's head to hide the tracheal tube so that the sonographer was blinded to the tube position. A second operator, with good experience in ultrasound and blinded to the position of the tube, determined if the tracheal tube was correctly positioned or not. Ultrasounds were performed using a 10 MHz ultrasound probe flat (Vivid-e® General Electric, UK) according to the manufacturer's instructions. The probe was placed on the longitudinal middle line on the neck between the sternum and cricoid cartilage as previously described.<sup>3</sup> The operator looked for the better plan in this line to give a cross-section of the trachea. Then, the cuff of the tracheal tube was filled with an ultrasound contrast solution, a mixture of 1 ml of air and 15 ml of gelatin (Gelofusine 4%®, B/BRAUN, Melsungen, Germany). Then, easiness to learn this method was assessed after a 20 min training course using 32 novices performing 64 assessments in eight cadavers in the same manner as in the observations made by experimented operator.

The trachea deformation during cuff inflation allowed identification of correct intubation by an experienced sonographer with a sensitivity of 90% [95% confidence interval (CI) 83–95], specificity of 97% (95% CI 92–99), positive predictive value of 97% (95% CI 91–99), and negative predictive value of 91% (95% CI 84–95). Using the ultrasound criteria, novices identified correct intubation with a sensitivity of 91% (95% CI 76–97), specificity of 94% (95% CI 80–98), positive predictive value of 94% (95% CI 79–98), and negative predictive value of 91% (95% CI 76–97). The performance of students was not significantly different from that of the experienced operator ( $P > 0.20$  for all criteria). The method proposed to diagnose correct intubation was safe. Only one cuff rupture among 124 assessments (0.8%) was noted and all cuffs could be completely emptied at the end of the experiment. Large studies are



**Fig 1** Ultrasound transversal view of the trachea (contoured in yellow) with the tracheal tube in the correct place. (A) With deflated tracheal tube cuff. (B) With inflated tracheal tube cuff, leading to the increase in the antero-posterior diameter of the trachea (yellow arrows).



**Fig 2** Flow chart for checking proper placement of the tracheal tube (TT) using capnography and ultrasound.

required to define the place of this new tool compared with actual techniques. However, in situations where conventional techniques like chest X-ray or bronchoscopy are not available quickly, ultrasound may be useful to diagnose proper placement of the tracheal tube in combination with capnography. Indeed, capnography makes it possible to rule out oesophageal intubation in a few seconds (time to observe three capnograms), but cannot differentiate between tracheal intubation and selective intubation. The proposed ultrasound criterion may help to differentiate these two situations in a short time, in < 1 min. A flow chart for checking proper placement of tracheal tube using capnography and ultrasound is proposed in Figure 2.

## Funding

The study was funded by University of Poitiers, France.

## Acknowledgements

The authors thank Nicolas Deboevere, Matthieu Deborde, Ludivine Dion, Charles Pradeau, Olivier Pecqueriaux, Chloé Morgand, Martin Moiroud, Carole Soudy, Alice Dupouy, Vincent Dupont, Mathieu Schertz, Marion Mesrine, Sylvain Lepape, Elsa Cantos, Valentin Parthenay, Roland Alexandre, Paul Rooze, Julien Cousin, Simon Forget, Alexandra Counilh, Céline Colin, Alexandre Gauthier, Céline Coussou, Rémi Hervochon, and Nicolas Jacques for their helpful participation.

## Declaration of interest

None declared.

T. Kerforne<sup>1</sup>  
 F. Petitpas<sup>1</sup>  
 M. Scepi<sup>1</sup>  
 T. Loupec<sup>1</sup>  
 J. Dufour<sup>1</sup>  
 H. Nanadoumgar<sup>1</sup>  
 J. P. Richer<sup>1</sup>  
 A. Cornu-Skurnik<sup>2</sup>  
 M. Bendahou<sup>2</sup>  
 B. Riou<sup>2</sup>  
 B. Debaene<sup>1</sup>  
 O. Mimoz<sup>1\*</sup>

<sup>1</sup>Poitiers, France

<sup>2</sup>Paris, France

\*E-mail: o.mimoz@chu-poitiers.fr

- Peterson GN, Domino KB, Caplan RA, Posner KL, Lee LA, Cheney FW. Management of the difficult airway: A closed claim analysis. *Anesthesiology* 2005; **103**: 33–9
- Knapp S, Kofler J, Stoiser B, et al. The assessment of four different methods to verify tracheal tube placement in the critical care setting. *Anesth Analg* 1999; **88**: 766–70
- Uya A, Spear D, Patel K, Okada P, Sheeran P, McCreight A. Can novice sonographers accurately locate an endotracheal tube with a saline-filled cuff in a cadaver model? A pilot study. *Acad Emerg Med* 2012; **19**: 361–4

doi:10.1093/bja/aet270