Efficacy of ventilation through a customized novel cuffed airway exchange catheter: a tracheal/lung model study

Editor—Airway exchange catheters (AECs) are commonly used in difficult airways management as a guide for re-intubation or ventilation when attached to a jet ventilator. However, barotrauma resulting in pneumothorax has been a major concern when using jet ventilation with AECs. The cause of these complications is often the excessive driving pressure with jet ventilation (15–50 psi) or airway obstruction. Therefore, it has been suggested that minimizing intratracheal pressure and prolonging expiratory times can reduce the risk of barotrauma. We propose an alternative method of ventilation via an AEC with a customized cuff (Fig. 1). A cuffed AEC was created by placing a 5 cm long latex cuff over the distal side ports of a 14 and 19 Fr AEC (Cook Critical Care, Bloomington, IN, USA) and inserting a 1 cm long internal resistor (14 G i.v. catheter for 14 Fr AEC or 11 Fr Cook AEC for 19 Fr AEC) into the distal tip of each AEC (Fig. 1). Briefly, because the lumen of the cuff freely communicated through the side ports with the lumen of the AEC, the cuff inflated during inspiration due to pressure generated by the resistor and during exhalation, the cuff deflated allowing expiratory flow around the AEC (Fig. 1).

We evaluate the efficacy of ventilation through novel cuffed AECs using a tracheal/lung model study. The lung model (Dual adult TTL training/test lung, Model 1600, Michigan Instruments Inc., MI, USA) was connected to the distal end of a tracheal model (Airway demonstration model, Laerdal, Stavanger, Norway). The lung model was adjusted to simulate normal lung mechanics (compliance 50 ml cm H2O⁻¹, resistance 5 cm H2O litre⁻¹s⁻¹). The proximal end was connected to an intensive care unit (ICU) ventilator (Puritan Bennett™ 840, Covidien, Boulder, CO, USA) set to pressure control with peak pressure 40 or 70 cm H2O. Ventilation was performed at a respiratory rate of 10 bpm with inspiratory-expiratory (I:E) ratios of 1:2, and 1:1. The distal tip of the AEC was placed 3 cm above the carina of the tracheal model. A flow/pressure sensor (NICO Cardiopulmonary Management System, Model 7300, Respironics Corp., Murrysville, PA, USA) was placed between the distal end of the tracheal model and the model lung.

With the cuffed AEC, ICU ventilator was able to generate reasonable tidal volume [493 (151) ml with 19 Fr, range: 328–694 ml and 293 (103) ml with 14 Fr, range: 180–429 ml]. The mean peak inspiratory airway pressure was 11.5 (2.8) cm H2O with 19 Fr (range: 8.4–15.3 cm H2O) and 7.5 (2.2) cm H2O with 14 Fr (range: 5.0–10.4 cm H2O). Our results indicate that cuffed AEC may enable practitioners to use ordinary ICU ventilator and achieve reasonable tidal volume and provide at least partial ventilatory support at much lower driving pressure than with the jet ventilation. The ability to ventilate patients using lower pressure settings may reduce the risk of barotraumas. Because the high resistance generated by the small inner diameter of the AEC, peak inspiratory airway pressure was within a lung protective range. In addition, ICU ventilators are much more commonly available than jet ventilators. Because this study was not conducted on patients, results from our study should be cautiously extrapolated to actual patient care until clinical studies can be conducted.

Fig 1 Illustration of cuff operation. (a) Inflated cuff and conventional AEC. (b) Deflated cuff and conventional AEC.
Declaration of interest
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J. Oto
M. Q. Sun
R. M. Kacmarek
Y. Jiang*
Boston, USA
*E-mail: yjiang@partners.org

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Sugammadex after magnesium sulphate administration in a morbidly obese patient undergoing general anaesthesia

Editor—Magnesium sulphate is believed to affect the reversal of rocuronium-induced neuromuscular block (NMB) by sugammadex.1 I recently cared for a 47-yr-old woman (weight, 110 kg; height, 163 cm; BMI, 41 kg m⁻²) with a history of arterial hypertension and ischaemic heart disease undergoing laparoscopic sleeve gastrectomy for morbid obesity. Her medications included a once-daily regimen of acetylsalicylic acid (100 mg), carvedelol (6.25 mg), and ramipril (1.25 mg). Magnesium sulphate 40 mg kg⁻¹ (lean body weight, LBW)² was given in a total of 100 ml normal saline before anaesthesia induction. Anaesthesia was induced with fentanyl 3 µg kg⁻¹ and propofol 2 mg kg⁻¹ (LBW) and maintained with desflurane and remifentanil, titrated to a state entropy value of 35 (S). After loss of consciousness, the ulnar nerve was stimulated through surface electrodes with square-wave 0.2 ms pulses, delivered as 2 Hz train-of-four (TOF) pulses at 15 s intervals. The adductor pollicis muscle response was measured acceleromyographically (TOF-Watch SX, Organon Teknik, Ireland). Stabilization, calibration, and baseline responses were recorded at the time of anaesthesia induction before rocuronium administration, and neuromuscular monitoring was continued until the TOF ratio returned to ≥ 1.0. NMB [twitch height from 91% (baseline) to 0%] was achieved with a rocuronium 0.9 mg kg⁻¹ (ideal body weight, IBW)² bolus before tracheal intubation in 90 s. NMB was maintained with subsequent boluses of rocuronium, titrated to achieve moderate NMB (T₁–T₂) (rocuronium 80 mg total dose) (Fig. 1A). Remifentanil was stopped at the end of the uneventful 90 min surgical procedure. Ondansetron 4 mg and ketoprofen 100 mg were given i.v. to reduce postoperative nausea and vomiting (PONV) and limit the use of narcotics for postoperative pain management. A second dose of magnesium sulphate 40 mg kg⁻¹ (LBW) was given. NMB was potentiated decreasing from T₂ to 7 post-tetanic counts. Sugammadex 4 mg kg⁻¹ (total body weight) was administered after 6 min to reverse the rocuronium-induced NMB. Complete reversal of NMB (TOF ratio of 1.10) was achieved within 60 s. The twitch height reached a stable value of 74% within 7 min after sugammadex administration (Fig. 1A). Desflurane was then discontinued, the patient awakened, and the tracheal tube was smoothly removed. The patient had no evidence of pain, PONV, signs of residual

Fig 1 Completed (A) and detailed (A) TOF tracing from a morbidly obese patient undergoing laparoscopic sleeve gastrectomy under general anaesthesia. Rocuronium-induced NMB was induced with rocuronium 0.9 mg kg⁻¹ and maintained with boluses of rocuronium (total dose of 80 mg) titrated to achieve a moderate (T₁–T₂) NMB (A). Magnesium sulphate 40 mg kg⁻¹ was administered near tracheal intubation and extubation, before anaesthesia induction, and the reversal of NMB (A and a). Reversal of NMB was achieved with sugammadex 4 mg kg⁻¹ (A and a). The blue lines represent first twitch values (twitch height, %), the dashed blue lines correspond to the post-tetanic counts, the red dots are the TOF ratios, and the continuous blue line above represents the temperature expressed as degree Celsius (°C).