ORIGINAL ARTICLE

Benchmarking the Applicability of Four Methods of Endotracheal Tube Cuff Inflation for Optimal Sealing: A Randomized Trial

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Purpose: *To assess the comparable applicability of four methods of endotracheal tube cuff (ETTc) inflation on the basis of optimal level of intracuff pressure and presence of intubation-related complications.*
Design: *Double-blind, randomized trial.*
Methods: *A total of 139 adult surgical patients scheduled to undergo nitrous oxide–free general anesthesia were assigned into one of four groups according to the method used for ETTc inflation. The cuff pressure and air volume applied in each method, and laryngotracheal complications were recorded.*
Findings: *The highest and lowest ETTc pressure and air volume values were recorded in palpation and minimum leak technique group, respectively. Laryngotracheal complaints were maximized in palpation and minimized in minimal occlusive volume and minimum leak techniques.*
Conclusions: *The air-return back into the syringe method emerges as an attractive and simple-to-perform alternative regarding effective ETTc sealing and low incidence of intubation-related morbidity when a cuff manometer is not readily available.*
Study Registration: *ACTRN12615000699561.*

Keywords: *cuff inflation, cuff pressure, complications, overinflation, underinflation.*

ARTIFICIAL AIRWAY APPLICATION is considered as a prerequisite for mechanical ventilation support in general anesthesia settings. Cuffed endotracheal tubes (ETTc) are one aspect of airway management designed to maintain a secure and safe airway.[1,2] Ideally, an inflated ETTc should

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Conflict of interest: None to report.

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ensure proper sealing between the inflated cuff and the tracheal wall, achieving a pressure sufficient enough to impede aspiration and provide positive-pressure ventilation without air leakage, but not so high to compromise the tracheal mucosal capillary perfusion pressure.[1]

Maintenance of an adequate ETTc pressure is considered a key element of artificial airway management. The optimum maximum pressure limit is determined by the pressure of the tracheal capillary vessels, which start to decline when the cuff exerts a pressure greater than 34 cm H_2O, causing tracheal ischemia.[3] The extent of tracheal injury is proportional to the pressure of the cuff and the duration of exposure.[1,3-9]

The minimum occlusive intracuff pressure required to prevent pulmonary microaspirations is estimated to be around 27 cm H_2O, with the risk for aspiration being more profound with pressures lower than 20 cm H_2O.[2,5,6] Despite the discrepancy about acceptable target limits of ETTc pressure values, a pressure between 20 and 35 cm H_2O is generally suggested for high-volume low-pressure cuffs to achieve adequate sealing and reduce the risk of complications during positive-pressure ventilation.[2,3,5,7,8]

Considering the narrow range of ETTc pressures required to ensure a functionally safe seal with concomitant prevention of tracheal injury, the estimation of cuff pressures seems to be of paramount importance. In clinical practice, assessment of the ETTc inflation pressure, as a critical aspect in intubated populations, is undervalued. This issue is even more pronounced in the emergency setting and in surgical procedures of short to moderate duration, in which most anesthesia providers simply assess the pressure by pilot balloon palpation according to their experience.[3,5,10-17] Besides the palpation estimation approach, other methods commonly applied for ETTc inflation are the minimal occlusive volume (MinVol) that eliminates an audible end-inspiratory leak and minimum leak technique, which allows only a subtle leak to be auscultated at the end inspiration with the use of a stethoscope.[16] Nevertheless, the accuracy of pilot balloon palpation method is disputed,[10,11,14,15,17] whereas audible techniques may be difficult to ensure a tracheal seal in a noisy environment.[11,13,14,16] Limited data assessing the efficacy of these three techniques and their short-term benefits in the surgical setting have been reported.

Thus, we aimed to validate the comparative applicability of three less common methods of ETTc inflation, the air return back into the syringe after cuff overinflation and MinVol and minimum leak techniques, against the pilot balloon palpation estimation method, which constitutes the usual clinical practice, with a view to ascertain optimal level of intracuff pressure in a more accessible and rapid fashion in the surgical population. Furthermore, the impact of each method on endotracheal intubation–related laryngotracheal morbidity on a short-term basis was also assessed.

Methods

Study Population

Ethical approval for this study (ethical committee no. 13,354) was provided by the Research Ethics Committee of AHEPA University Hospital, Thessaloniki (Chairperson, Dr. P. Panteliadis) on March 12, 2015. Written informed consent was obtained from each participant in the study. Patients 18 years or older of an American Society of Anesthesiologists' physical status 1 to 3 scheduled to undergo an elective surgical procedure under nitrous oxide–free general anesthesia necessitating orotracheal intubation were eligible for inclusion in this prospective, randomized, controlled trial. Exclusion criteria included a history of difficult airway intubation, Mallampati score higher than 2, more than two intubation attempts, necessity for double-lumen endobronchial intubation, prone positioning, laryngotracheal pathology, the presence of cough or sore throat before surgery, the presence of tracheostomy or history of previous tracheostomy, and surgical procedures involving the neck or the upper airway surgery.

Anesthesia Setting

All participants were scheduled for general anesthesia with endotracheal intubation. On arrival to the operating room, routine monitoring, such as electrocardiography, noninvasive arterial pressure, capnography, and pulse oximetry, was applied. After preoxygenation and an intravenous induction sequence consisting of propofol (2 mg kg^{-1}),