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Original contribution

Endotracheal tube displacement during head and neck movements. Observational clinical trial☆,☆☆

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Abstract

Study Objective: Measure the displacements of endotracheal tube (ETT) tip displacement during head and neck movements.

Design: Observational study.

Setting: Ear-nose-throat (ENT) and neurosurgery operating room.

Patients: We performed a maximal head-neck movement trial on 50 adult patients, American Society of Anaesthesiologists 1 or 2. Patients with body mass index >35 kg · m^{-2}, height <150 cm, airway malformations, pulmonary diseases, difficulties in neck flexion or extension, previous ENT surgery or radiotherapy, gastroesophageal reflux, or dental instability were excluded from the study.

Interventions: ENT and neurosurgery.

Measurements: We measured the change in distance between the ETT tip and the carina, using a fiberscope through the ETT.

Results: After intubation, a wide disparity of tube tip distance to the carina in the neutral position was noted with a median of 5.0 (3.5-7.0) cm. Cephalad tube movement was documented following maximal head and neck extension in 34 (68%) patients and right head rotation in 25 patients (50%). Caudal tube displacement was due to maximal head and neck flexion in 38 patients (76%) and left head rotation in 25 patients (50%). Selective right main bronchus intubation was noted in 2 (4%) patients after maximal head extension.

Conclusion: Maximal head and neck movements led to unpredictable tube displacements. Proper reassessment of tube positioning after head and neck movement of intubated patients is therefore mandatory.

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1. Introduction

General anesthesia may require the placement of an endotracheal tube (ETT) through the vocal cords to secure the airway. Depending on the type and location of the surgery, head and neck movements after intubation and tube fixation may be necessary for better surgical access or exposure. Tube movements following head and neck movements have been described essentially in pediatric literature [1–7], whereas extension amplitudes up to 60° are necessary for microlaryngoscopy and or up to 90° for rigid bronchoscopy and panendoscopy in adults [8–11].

Previous reports have shown that unexpected tube displacement can be the result of head and neck movement [1–4,6,7,12–18]. Because of the airway characterization, it is a known complication in pediatric anesthesia and proper fixation and attention to tube positioning must be paid at all moments, as such displacements can result in serious complications. Selective bronchial intubation [18], ventilatory disorders, or even extubations have been described [15,19]. However, reports suggest contradictory results about tube displacement depending on head and neck mobility [1,2,7,12,16,17,20].

To our knowledge, among the few trials assessing the displacement of the tip of the orotracheal tube, none underwent a standardized and maximal head and neck movement trial in an exclusively adult population. The purpose of this investigation was to assess the movements of tube tip while identifying changes in distances between the ETT tip and carina during standardized head-neck flexion or extension as well as left or right head rotation. Incidence and occurrence of adverse events were also collected.

The aims were to establish the incidence of ETT displacement and amplitude for each of the positions studied and to determine the significance of tube displacement and its clinical impact.

2. Methods

2.1. Institutional review board/consent

After approval from the Human Research Committee of Lausanne Medical School (Prof R. Darioli, protocol number 229/12; 24/08/2012), informed written consent was obtained from 50 adult patients American Society of Anaesthesiologists I or II scheduled for elective neurosurgery or ear-nose-throat (ENT) surgery necessitating general anesthesia.

2.2. Clinical trial registration

The study was registered with ClinicalTrials.gov, Identifier NCT01888679.

This observational trial was carried out in a single institution from 12th December 2012 to 13th March 2013. Patients with body mass index (BMI) > 35 kg · m^{-2}, height < 150 cm, airway malformations, pulmonary diseases, difficulties in neck flexion or extension, previous ENT surgery or radiotherapy, gastroesophageal reflux, or dental instability were excluded from the study. Preoperative evaluation and anesthesia were provided by the anesthetist in charge of the patient, in accordance with the standard practice in our department. After obtaining end-tidal CO_2 > 80% with a facial mask, anesthesia was induced with disoprivan 2-3 mg/kg, fentanyl 2-4 μg/kg, and rocuronium 0.6 mg/kg. Laryngoscopy and orotracheal intubation were performed by the in-charge anesthetist. Tracheal tube (Mallinckrodt Hi-contour oral/nasal tracheal tube cuffed, 6.5 I.D. for women and 7.5 I.D. for men) positioning was defined by the in-charge anesthetist as seeing the tube pass through the vocal cords and positioned in between the 2 respective marks on the tube; for the Mallinckrodt Hi-contour oral tracheal tube, these marks are at a distance of 7 and 9 cm from the tip of the 6.5 ETT and 7.5 and 9.5 cm for the 7.5 ETT, respectively. Bilateral chest auscultation and end-tidal CO_2 confirmed tracheal positioning. Tubes were secured with 2 strong tapes at the right corner of the mouth, according to the standard practice in our department. Particular attention was paid to position the tongue in the anatomical midline position. Tube depth was measured at the upper incisor teeth with the help of the graduation present on tube.

After intubation, a standard study protocol was applied: the ventilator circuit was disconnected from the tube, the cuff was deflated, and the distance between tube tip and carina was measured by the first author, with a fiberscope (Pentax FB 15-P, outer diameter 4.8 mm; Pentax, Tokyo, Japan) introduced in the ETT in 5 standardized situations while the patient was lying flat on the operating table: (1) head in neutral position (N = distance from tube tip to carina in cm). The patient was then moved cephalad in order to allow maximum head and neck mobility and randomization decided on the order of the following sequence: (2) neck extension (E = distance in cm from tube tip to carina after maximal neck extension) followed by head in neutral position again, (3) neck flexion (F = distance in cm from tube tip to carina after maximal neck flexion), (4) right head rotation (R = distance in cm from tube tip to carina after maximal right head rotation), and (5) left head rotation (L = distance in cm from tube tip to carina after maximal left head rotation).

The tube excursions during these different steps were defined as the subtraction of the distance from the ETT tip to the carina, for the different movements, and its position in neutral situation. If the result of the subtraction was positive, upward (cephalad) tube movement was present, whereas a negative value defined further tracheal tube advancement (caudal movement; Fig. 1).

The primary end point was thus to assess amplitude and direction of tube tip displacement depending on head and neck movement. Secondary end point was to analyzse complications related to tube displacement, such as extubation, selective bronchial intubation, or injury.

Sample size calculation was based on a clinically relevant tube displacement of 2 cm as defined by Tanios et al [21] in 2010and yielded a required sample size of n = 50 to detect