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SHORT COMMUNICATION

To assess the changes of tracheal cuff pressure after a calibrating orogastric tube insertion

Kuo-Chuan Hung

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Abstract Insertion of a medical instrument into the esophagus may affect tracheal tube pressure. This study evaluated the potential effect of a calibrating orogastric tube insertion on tracheal cuff pressure in patients undergoing laparoscopic bariatric surgery. Adult patients who were scheduled for elective bariatric surgery requiring insertion of a calibrating orogastric tube were assessed for eligibility for this study. After successful tracheal intubation, the tracheal tube with a high-volume, low-pressure cuff was adjusted to range from 25 to 30 cmH_2O using a manometer. Tracheal cuff pressure was monitored continuously while the calibrating orogastric tube was being advanced. The change of tracheal cuff pressure was recorded after the calibrating orogastric tube had been left in situ for 3 min. After insertion of the calibrating orogastric tube, the median tracheal cuff pressure increased from 28 [27–28 (25–30)] to 36 [30–42 (26–64)] cmH_2O ($P < 0.001$) and was greater than 35 cmH_2O in 30 of 60 patients (50 %). Our results suggest that the tracheal cuff pressure should be routinely monitored in patients undergoing laparoscopic bariatric surgery requiring insertion of a calibrating orogastric tube.

Keywords Orogastric tube · Tracheal cuff pressure · Bariatric surgery

Bariatric surgery, one of the fastest growing areas of surgery, has been shown to achieve significant durable weight loss and to effectively treat obesity-related diabetes, hypoventilation, hypertension, and serum lipid abnormalities [1]. This surgical procedure has also been proposed for the treatment of type 2 diabetes mellitus (DM) in non-obese patients [2, 3]. During laparoscopic bariatric surgery, a calibrating orogastric tube, which is often placed into the esophagus after tracheal intubation, may be used to facilitate gastric pouch formation. However, this device may not be used without concern. In our previous report, we found that the insertion of a transoesophageal echocardiographic (TOE) probe into the esophagus may increase tracheal tube pressure in 38 patients undergoing cardiac surgery [4]. This study aimed at confirming these findings with a larger sample size; for this study, we evaluated the change of tracheal cuff pressure after insertion of a calibrating orogastric tube in patients undergoing bariatric surgery.

Adult patients who were scheduled for elective bariatric surgery requiring insertion of a calibrating orogastric tube were assessed for eligibility for this study. Patients who had a history of esophageal or gastric pathology (e.g., Zenker's diverticulum, esophageal varices, upside-down stomach) that would contraindicate use of the calibrating orogastric tube were excluded from the study. The study was approved by the hospital ethics committee, and written informed consent was obtained from all patients.

On arrival in the operating room, patients were placed in a supine position. Standard monitoring was applied with a five-lead electrocardiogram, noninvasive blood pressure, pulse oximetry, body temperature, and capnometry. Anesthesia was induced with propofol and fentanyl. Rocuronium was then given to facilitate orotracheal intubation. A Mallinckrodt tracheal tube (Hi-Lo; Mallinckrodt Medical, Athlone, Ireland) with a high-volume, low-pressure cuff was used in this study. For patients with body

K.-C. Hung (✉)
Department of Anesthesiology, E-DA Hospital, I-Shou University, 1 E-Da Road, Jiau-shu Tsuen, Yan-Chau Shiang, Kaohsiung 824, Taiwan, ROC
e-mail: ed102605@gmail.com

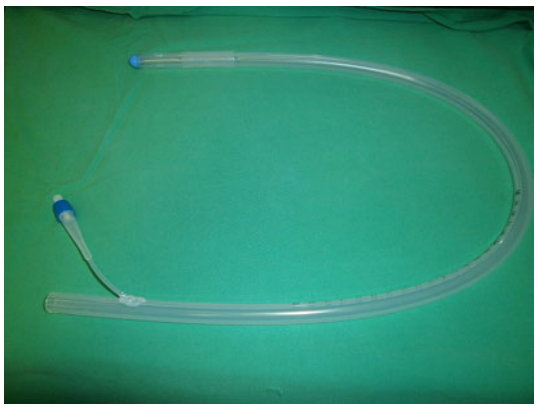

Fig. 1 The calibrating orogastric tube (36-French) consists of a 745-mm-long silicone tube with a *rounded*, *closed tip*. At the proximal end, the tube is equipped with a check valve that mates with a syringe used to fill a balloon located approximately 6.8 cm form the distal tip. At the distal end, the tube has two suction/irrigation holes that allow removal of fluids and irrigation during the procedure

mass index (BMI) greater than 35 kg/m^2, the size of the tracheal tube was 8.0 mm for men and 7.5 mm for women. For patients with BMI less than 35 kg/m^2, a smaller tracheal tube was chosen (7.5 mm for men and 7.0 mm for women). Tracheal intubation was performed by anesthesiologists, and successful tracheal intubation was confirmed by checking breathing sounds and end-expiratory CO_2. After successful intubation, the tracheal cuff was inflated at the discretion of the anesthesiologists.

Before insertion of the calibrating orogastric tube (Obtech Medical Sarl, Switzerland) (Fig. 1), the tracheal cuff pressure was adjusted to range from 25 to 30 cmH_2O using a manometer (Mallinckrodt, Athlone, Ireland). After the mandible had been lifted and slightly flexed, the calibrating orogastric tube was inserted blindly. If blind insertion of the calibrating orogastric tube was not possible after two attempts, the device was inserted under direct vision using a Macintosh laryngoscope. Tracheal cuff pressure was monitored continuously while the calibrating orogastric tube was being advanced. After successful insertion, the anesthesia nurse recorded the tracheal cuff pressure after the patient's head and neck were placed in the neutral position and the calibrating orogastric tube had been left in situ for 3 min.

All tracheal cuff pressures were measured at end-expiration during mechanical ventilation. Positive end-expiratory pressure (PEEP) and nitrous oxide were not used. A pressure persistently more than 30 cmH_2O was adjusted back to 25–30 cmH_2O. This adjustment constituted the endpoint of the study, and surgery then commenced. Any complications associated with use of the calibrating orogastric tube (e.g., dental injury, upper gastrointestinal bleeding, esophageal perforation) were noted.

To detect an increase in tracheal cuff pressure from 30 to 35 cmH_2O after calibrating orogastric tube insertion, assuming a difference in standard deviation of 8, we calculated that 29 participants would be needed to have a type I error of 0.05 and have a power of at least 0.9. We decided to include 60 participants in the current study. The changes of tracheal cuff pressure were analyzed using paired *t*-tests (normally distributed data) or Wilcoxon signed-rank test (non-normally distributed data). All data are expressed as the median [IQR (range)] or number of patients (%). Statistical significance was defined as a P value less than 0.05. Statistical analyses were performed utilizing Statistical Package for the Social Sciences (SPSS) version 13.0 (SPSS, Chicago, IL, USA).

Table 1 Demographic data of 60 patients undergoing laparoscopic bariatric operations

Age, years	34 [27.5–39.5 (20–64)]
Height, cm	164 [159.5–171 (148–185)]
Weight, kg	97.3 [85.5–119 (46–174)]
BMI, kg/m^2	37.7 [32.3–42.2 (17–59)]
Male/female	17 (28)/43 (72)

BMI body mass index values are given as median [IQR (range)] or number (%)

Sixty patients were enrolled and included in the analysis. The demographic data of the participants are shown in Table 1. The success rate of tracheal intubation at first attempt was 95 % (57/60). Tracheal intubation was considered to be difficult in three patients with BMIs of 39.4, 43.5, and 49 kg/m^2. The trachea was intubated successfully at the third attempt in these patients, who were administered dexamethasone 5 mg intravenously. After successful tracheal intubation, the tracheal cuff pressure was adjusted to range from 25 to 30 cmH_2O in all patients. There were no gas leaks around the tracheal tube after adjustment.

The calibrating orogastric tubes were inserted into the esophagus successfully at first attempt in all patients, and no significant resistance or difficulties were encountered during advancement of the calibrating orogastric tube. The median [IQR (range)] tracheal cuff pressure increased significantly from the baseline value of 28 [27–28 (25–30)] to 36 [30–42 (26–64)] cmH_2O ($P < 0.001$) (Fig. 2) after the calibrating orogastric tubes had been inserted and left in the esophagus for 3 min. A tracheal cuff pressure more than 35 cmH_2O was observed in 50 % (30 of 60) of patients; a tracheal cuff pressure more than 60 cmH_2O was observed in 4 patients (6.7 %) (64, 62, 62, and 62 cmH_2O). All the tracheal cuff pressures had been adjusted to 25–30 cmH_2O by the end of the study. No complications from tracheal intubation or calibrating orogastric tubes insertion were observed throughout the study or at the end of the operation.

The posterior membraneous tracheal wall is in contact with the esophagus [5]; therefore, a medical device within

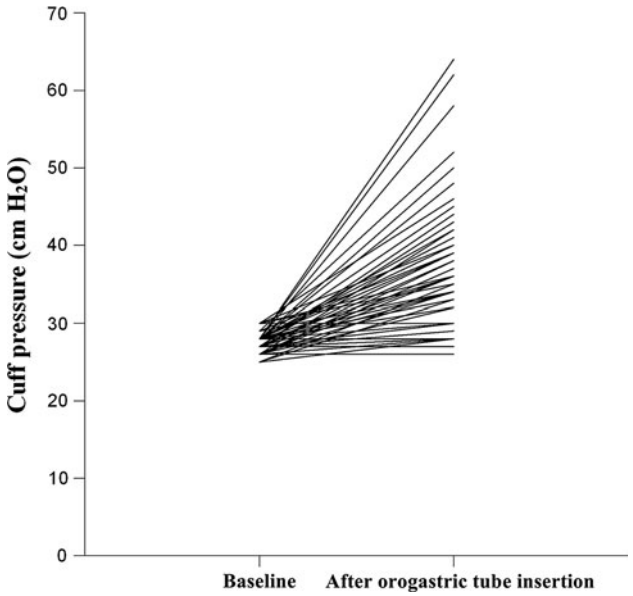

Fig. 2 Cuff pressure change in 60 patients after calibrating orogastric tube insertion. There is a significant increase in median tracheal cuff pressure after calibrating orogastric tube insertion (28 vs. 36 cmH_2O; $P < 0.001$). Wilcoxon's test was applied for statistical analysis

the esophagus may compress the tracheal wall and increase tracheal cuff pressure. The calibrating orogastric tube is used to measure the pouch size during laparoscopic bariatric surgery. As use of this device may be associated with the occurrence of procedure complications [6], in our institute a large-bore calibrating orogastric tube (36-French) is commonly used to reduce the risk of stapling of the instrument. The current study demonstrates that the median tracheal cuff pressure increased from 28 to 36 cmH_2O ($P < 0.001$) and was greater than 35 cmH_2O in 30 of 60 patients (50 %) after insertion of the calibrating orogastric tube into the esophagus. We also found that there was an approximately twofold increase in tracheal cuff pressure in some patients (4/60, 6.7 %).

Mucosal damage of the trachea has been demonstrated to occur after 15 min under a tracheal cuff pressure greater than 30 cmH_2O in one animal model [7]. In a clinical study, Liu et al. [8] demonstrated that an overinflated cuff could lead to tracheal mucosa damage for patients even in procedures of short duration (1–3 h). By limiting the tracheal cuff pressure to less than 30 cmH_2O, the incidence of pharyngeal morbidity can be reduced even for patients undergoing brief procedures [8, 9]. Considering that the tube cuffs commonly tend to be overinflated (40–80 %) in patients under general anesthesia [10, 11], routine monitoring of tracheal cuff pressure may be recommended during bariatric surgery requiring inserting a calibrating orogastric tube.

In our previous report, mean tracheal cuff pressure increased from 27.7 to 36.2 after insertion of a TOE probe with a diameter of approximately 15 mm [4]. The maximum tracheal cuff pressure measured was 52 cmH_2O [4]. Although the calibrating orogastric tube is not so stiff as a TOE probe, its use also leads to a significant increase in median tracheal cuff pressure (28 vs. 36, $P < 0.001$). Our finding that only 50 % of patients had a tracheal cuff pressure greater than 35 cmH_2O is consistent with one of our previous reports (45 %) [4]. These findings may be attributed to the fact that the trachea and esophagus are not always aligned.

Some limitations of our study should be taken into account. First, the investigator recording the data was not blinded to the calibrating orogastric tube insertion. However, because the study involved the recording of objective numerical data, this may not have biased the results. Second, laryngotracheal complications such as a sore throat were not evaluated in our patients postoperatively. A randomized and controlled study may be required to evaluate whether these laryngotracheal complications can be reduced effectively by monitoring the tracheal cuff pressure in this patient population.

In conclusion, the current study demonstrates that insertion of a calibrating orogastric tube can significantly increase the tracheal cuff pressure, even though the cuff was not overinflated. As more and more laparoscopic bariatric surgeries are being performed for obese patients to achieve loss of weight or for type 2 DM patients to achieve remission, we recommend that the tracheal cuff pressure should be routinely monitored after calibrating orogastric tube insertion to minimize the possibility of tracheal morbidities.

Conflict of interest No funding or competing interests are declared.

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