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Original Contribution

Correlation between extraction force during tracheal intubation stylet removal and postoperative sore throat☆

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Abstract
Study Objective: To examine postoperative sore throat resulting from tracheal intubation stylet removal.
Design: Prospective cohort study.
Setting: Operating rooms and hospital ward.
Patients: A total of 50 American Society of Anesthesiologists physical status 1 and 2 patients who underwent elective abdominal and/or orthopedic surgery under general anesthesia.
Interventions: Patients were allocated to 2 groups: those who developed sore throat postoperatively (ST group) and those who did not (NST group). Comparative analysis of these 2 groups was performed to identify risk factors of the development of sore throat.
Measurements: The extraction force during stylet removal was measured using a force measuring device. Postoperative sore throat was assessed by an anesthesiologist.
Main Results: Nine patients (18%) complained of postoperative sore throat. Increased extraction force ($P = .0054$; odds ratio, 1.84; 95% confidence interval, 1.20-2.84) was the only significant risk factor for the development of postoperative sore throat. An extraction force of >10.3 N was determined as a cutoff for developing postoperative sore throat.
Conclusion: Postoperative sore throat was significantly related to increased extraction force during stylet removal.

1. Introduction

Given that the larynx and pharynx are anatomically vulnerable to mechanical stimuli, tracheal intubation can induce postoperative sore throat after general anesthesia due to mucosal injury in the trachea or vocal cord injury [1]. Several causes of postoperative sore throat related to tracheal

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intubation exist, such as tracheal tube size, damage to the tracheal mucosa from tracheal compression by the tracheal tube cuff, and irritation of the throat caused by insufficient lubrication [2,3].

The process of tracheal intubation itself is a known risk factor for sore throat [4,5]. However, risk factors of sore throat caused by tracheal intubation have not been investigated in detail. Tracheal tube stylets are widely used to assist tracheal intubation and require a certain level of extraction force upon removal.

This study aimed to test the hypothesis that the extraction force during stylet removal influences the development of postoperative sore throat. We also identified risk factors and independent predictors of postoperative sore throat.

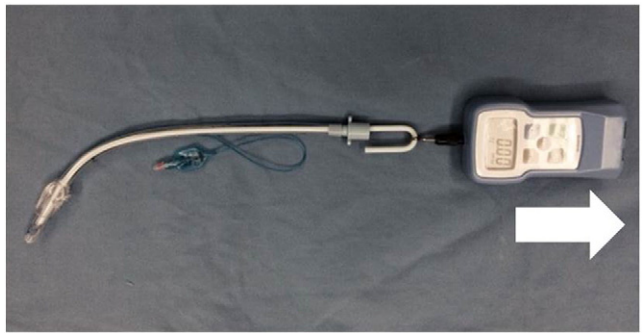

Fig. 1 A picture of the device for measuring extraction force for stylet removal. When the tip of the tracheal tube was inserted, stylet removal began, and the extraction force was measured (arrow: extraction force direction).

2. Patients and methods

The study protocol was approved by the Ethics Committee of Osaka Medical College (Osaka, Japan), and written informed consent was obtained from all patients.

The study was a prospective cohort trial. A total of 50 American Society of Anesthesiologists physical status 1 and 2 patients with Cormack classification 1 and 2 undergoing elective abdominal and/or orthopedic surgery in the supine position under general anesthesia, with no apparent history of pharyngeal or laryngeal disease, were enrolled in the study. Patients undergoing head or neck surgery or oral surgery were excluded given the difficulties of determining whether sore throat resulted from intubation or the surgical wound.

None of the patients received any premedication before the induction of general anesthesia. Anesthesia was induced with propofol 2 mg/kg, fentanyl 2 μg/kg, and rocuronium 1 mg/kg intravenously, and sevoflurane 3% by inhalation, followed by tracheal intubation. Anesthesia was maintained with sevoflurane 1.5% and remifentanil 0.2 μg/kg per minute, and mechanical ventilation was initiated (fraction of inspired oxygen, 0.4). For all patients, flurbiprofen axetil 1 mg/kg and fentanyl 3 μg/kg were administered before the end of surgery. For patients who underwent abdominal surgery, continuous intravenous fentanyl 15 μg/h was administered 24 hours postoperatively to reduce wound pain.

To minimize variations due to intubation technique and to ensure rigorous and consistent data, the same anesthesiologist (first author) intubated all patients. Tracheal tube (Portex Soft Seal; Smith Medical Co, Ltd, Saint Paul, MN, USA) size selection (internal diameter [ID], 6.5-8.0 mm) was based on chest radiography. A tracheal intubation stylet (Tracheal Intubation Stylet; Smith Medical Co, Ltd) with an external diameter of 4 mm was used for all patients according to the manufacturer's instructions. To reduce resistance between the tracheal tube and tracheal intubation stylet, the lumen of the tracheal tube was sprayed with a lubricant (8% lidocaine spray). After achieving sufficient muscle relaxation, the larynx was exposed with a conventional size 3 Macintosh laryngoscope, and all patients were orally intubated with visual confirmation. All patients were intubated without repetition by the same anesthesiologist. To accurately measure the extraction force upon stylet removal, we used a force measuring device (Digital Force Gauge; Shimpo Co, Ltd, Tokyo, Japan). Force measurements are expressed in Newtons.

When the tip of the tracheal tube was inserted, tracheal stylet removal began, and the extraction force was measured. This measurement was conducted throughout the entire process of extracting the stylet. Figure 1 depicts the measurement device. The maximum extraction force was recorded for each patient. After tracheal intubation was completed, the tracheal tube was fixed in the midline with medical tape. During tracheal intubation, the tracheal tube cuff pressure was maintained at 20 cm H_2O, which was confirmed by a cuff pressure measurement device (Cuff Pressure Gauge; Smith Medical Co, Ltd). After the patient regained consciousness, the tracheal tube was immediately extubated using standard techniques. On postoperative day 1, we examined patients complaining of sore throat. The same anesthesiologist assessed patients' postoperative subjective conditions, including sore throat. By definition, those experiencing hoarseness without pain were excluded from the postoperative sore throat category [6].

Statistical analysis was performed with SPSS 17.0 for Windows (SPSS, Inc, Chicago, IL). All data are presented as mean ± SD. Before statistical processing for the evaluation of risk factors, we referenced a published article [7]. To determine the correlation between the ID of the tracheal tube and extraction force of the stylet, linear regression analysis was performed. Optimal cutoff levels of extraction force for predicting postoperative sore throat were determined by receiver operating characteristic (ROC) curve analysis. The optimal cutoff levels were defined as that providing maximal accuracy to distinguish between those who developed sore throat postoperatively (ST group) and those who did not (NST group).

Comparisons between the 2 groups were performed using the χ^2 test or Fisher exact test. For continuous variables,