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Original contribution

Evaluation of double-lumen endotracheal tube extubation force by extraction angle: a prospective randomized clinical trial☆,☆☆

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Abstract

Study Objective: Gentle and noninvasive double-lumen tracheal tube (DLT) extubation is important for both airway and circulatory management, especially after lung resection. We performed a prospective randomized clinical trial comparing DLT extubation force based on 2 different extraction angles.

Design: Randomized clinical trial.

Setting: Operating room.

Patients: Sixty adult patients scheduled for elective surgery under general anesthesia using DLT with ASA physical status 1 to 3.

Interventions: Sixty patients who underwent lung resection with a DLT were randomly assigned to extraction angles of 60° (30 patients) and 90° (30 patients) relative to the ground.

Measurements: Extubation forces and changes in vital signs were compared between groups. Results were analysed with the Mann-Whitney U test, non-paired t test, and χ^2 test. $P < .05$ was considered significant.

Main Results: Less extraction force was needed at 60° compared to 90° (90°, 13.9 ± 2.3 N; 60°; 7.1 ± 2.1 N; $P < .001$). The rate of increase in systolic and diastolic blood pressure (post-extubation/pre-extubation) was significantly smaller at 60° than at 90° (systolic blood pressure, $P < .001$; diastolic blood pressure, $P = .002$).

Conclusions: Our findings suggest that DLT extubation at 60° requires less force than at 90° and was accompanied by a smaller increase in blood pressure. Thus, extraction at 60° may be less invasive and beneficial for patients undergoing DLT extubation.

1. Introduction

Recovery from anesthesia is always challenging, particularly at the moment of tracheal tube extubation [1,2]. From the perspective of airway management, a failure to extubate is associated with various conditions, such as hypoxia, hypercapnia, vomiting, aspiration, inadequate ventilatory drive, and laryngospasm. These can rapidly progress and lead to serious

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complications. In addition to respiratory events, emergence from general anesthesia can occasionally result in undesirable side effects, such as agitation, abnormal hypertension or tachycardia, and arrhythmia, which may cause bleeding from the surgical wound site and an increase in intracranial and intraocular pressure [3–5]. For at least these reasons, noninvasive tracheal extubation with minimal force is important for avoiding circulatory and airway collapse. We previously showed that extubation at 60° relative to the ground required a smaller extubation force and was associated with fewer changes in vital signs than at 90° [6].

The double-lumen tracheal tube (DLT) is essential for one-lung ventilation. However, its diameter and length are much larger than single-lumen tubes and is considered highly invasive to patients under mechanical ventilation with the DLT. Furthermore, gentle and noninvasive double-lumen tracheal tube (DLT) extubation is important for both airway and circulatory management, especially after lung resection, as it minimizes bucking and pneumothorax. However, the effects of DLT extraction angle on extubation have not yet been evaluated.

The extraction angle of the tracheal tube may influence extubation force. However, no studies have addressed DLT extubation force based on different extraction angles. We hypothesized that the extubation force will decrease if the tracheal tube is extracted at 60° relative to the ground compared to vertical extraction at 90°. To this end, we performed a randomized clinical trial comparing extubation force and vital sign changes by extraction angle.

2. Methods

This study was approved by the institutional review board of Osaka Medical College, and written informed consent was obtained from each patient. This study was registered in the University Hospital Medical Information Network Clinical Trials Registry (UMIN000015656).

Fig. 1 shows the Consolidated Standards of Reporting Trials (CONSORT) flowchart for patient recruitment. From November to April 2015, 70 patients were assessed for eligibility; 2 refused and 8 were excluded. After obtaining written informed consent, 60 patients (age range, 20-80 years) who were scheduled to undergo general anesthesia with tracheal intubation were assigned at random by using an envelope method to one of 2 groups: extubation at 60° (30 patients) and 90° (30 patients) relative to the ground (Fig. 1). Exclusion criteria were contraindications to rapid induction (eg, full stomach, gastroesophageal reflux), anticipated difficult airway patients (eg, difficult head tilting or mouth opening), ischemic heart disease, and tooth instability [7].

Percutaneous oxygen saturation, invasive blood pressure, heart rate, electrocardiography, and end-tidal carbon dioxide tension were monitored for each patient. Without any premedication, anesthesia was induced with a bolus, or continuous target-controlled infusion, of propofol 1 to 2 $mg \cdot kg^{-1}$ and remifentanil 0.3 to 0.5 $\mu g \cdot kg^{-1} \cdot min^{-1}$. Rocuronium 0.8 to 1.0 $mg \cdot kg^{-1}$ was administered as a muscle relaxant. The size 3 or 4 blade of the McL was used according to the anesthesiologist's preference. DLT (Bronchocath; Smith Medical Co., Ltd., Kent, UK) size selection was performed by the staff anesthesiologist based on manufacturer recommendations [8]. The number of intubation trials and Cormack's classification were assessed. The tip of the tracheal tube was placed about 2 cm into the trachea and fixed at the right side of the mouth. Anesthesia was maintained by continuous administration of desflurane or sevoflurane, remifentanil, and rocuronium. The decision to use epidural block, peripheral nerve block, continuous fentanyl administration, or intravenous acetaminophen for postoperative analgesia was made by the anesthesiologist.

After examination, the continuous infusion of sedatives and analgesics was stopped, and muscle relaxation was reversed with a sufficient dose of sugammadex, as recommended by the manufacturer. The tracheal tube was moved to the center of the submandibular area. A force measuring device (Digital Force Gauge, Shimpo Co Ltd, Tokyo, Japan) was attached to the centre of the tracheal tube cuff (Fig. 2). Extubation was performed when

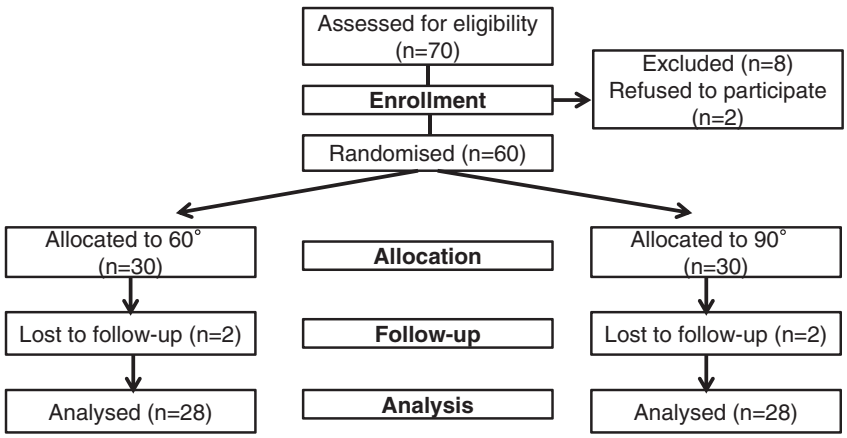

Fig. 1 CONSORT flowchart for patient recruitment.