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Which Guidance Method during Tracheotomy Procedure in Patients with Short Neck in the ICU?: A Prospective Randomized Study

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Abstract

Purpose: Utilization of fiber optic video bronchoscope (F) alone vs. in combination with ultrasound (U + F) during tracheotomy procedures for patients with remarkable short necks.

Materials and methods: Nineteen patients with short neck who required tracheotomy were enrolled to study. Tracheotomies were performed with Grigg's technique. There was 9 patient in U + F group and 10 in F group. We gathered ICU admission diagnosis, demographic variables, guidance method (U + F or F), thyromental, sternomental and cricosternal distances, neck circumference, neck extension range, procedure duration and complications.

Results: Mean thyromental distance, sternomental distance, neck extension range and neck circumference was similar between groups. There was no major complication in both groups. Minor bleeding occurred in 1 patient in-group U + F and 2 in group F. One of the patients in U + F group had an aberrant enlarged venous anomaly over tracheal rings and he underwent surgical tracheotomy, therefore he was excluded from this study. Duration of the procedures was 7, 4 min and 7 min in U + F and F group respectively.

Conclusion: Using ultrasound and fiber optic bronchoscope together enhance the safety of the tracheotomy procedure and should be considered in patients with short necks who display limited extension.

Keywords

Tracheostomy, Short neck, ICU, Fiber optic bronchoscope, Ultrasound

Introduction

Percutaneous tracheotomy is a common procedure in the intensive care units (ICU). Although majority of the complications related to this procedure are considered minor, serious complications secondary to tracheotomies are still being reported [1-3].

Definition of short neck is not clear in the medical literature, but well known to anesthesiologists since they are flagged for possible difficult airway. Thyromental and sternomental distance, range of neck extension and neck circumference are some of the predictors of difficult airway. These parameters are also utilized for patients with short neck. In addition to many complications of percutaneous tracheotomy, patients with short neck can face more challenges due to this anatomical variation. This study was designed to seek an easier, practical method to make percutaneous tracheostomy procedure safer and less complicated among short necked patients.

We compared tracheotomies that are done with fiber optic video bronchoscope (F) alone to the ones with guidance of both ultrasound and fiber optic video bronchoscope (U + F), in terms of duration and complications.

Materials and Methods

This study was approved by the Ethical and Research Committee of Kecioren Training and Research Hospital (Ethics Approval Number: 762). Written consent was obtained from the relatives of all participants.

Patients and data collection

Nineteen patients who met the inclusion criteria were enrolled in the study from 11 March 2014 through 30 July 2015. Tracheotomy indications included prolonged mechanical ventilation, brain injury, and/or hypoxic encephalopathy with ventilator dependence.

Short-necked patients were defined as having a thyromental distance of less than 6 cm, a sternomental distance of less than 12 cm, and a neck extension range of less than 5 cm, as defined in Chow et al. and Nasa's trial [4,5]. Neck extension was measured as the sternomental distance in a neutral and maximally-extended position. The thyromental distance was measured as the distance between the top point of the mentum and the thyroid prominence in a maximally-extended neck as described in Patil's test. The sternomental distance was measured as a straight distance from the manubrium sterni to the top point of the mentum in a maximally-extended head and neutral position. The cricosternal distance (CSD) was measured as a straight distance from the cricoid cartilage to the sternal notch. Neck circumferences were measured at the level of the thyroid cartilage. All tracheotomies were performed with Grigg's technique (Portex®

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GRIGGS Percutaneous Dilation Tracheostomy Kit with Blue Line Tracheostomy Tubes). Patients with coagulopathy (international normalized ratio > 1.5, platelet count < 50,000), having an infection at the procedure site, or an enlarged thyroid gland were excluded from the study. The tracheotomy time was within the second week of intubation. In total, 19 patients were randomly divided into two groups by a computer. A fiber optic video bronchoscope (Storz®Karl Storz Endoscope 8402 ZX) was used for both groups and ultrasound (Siemens® G20 Sonoline) with a linear probe was used for the U + F group. In one U + F group patient, an aberrant enlarged venous anomaly was observed over the tracheal rings (mostly over the midline of the 2nd and 3rd rings) during the ultrasound examination. This patient was excluded from the study because of our prediction of a high risk of bleeding with difficulty in stopping it during the percutaneous procedure. This patient underwent a surgical tracheotomy. The ICU admission diagnosis, demographic variables, guidance method (U + F or F), thyromental and sternomental distances, neck circumferences, neck extension ranges, procedure durations, heights, weights, days on mechanical ventilation, skin puncture attempts, and major and minor complications were noted. Every patient was monitored with an electrocardiogram, invasive arterial blood pressure, and pulse oximetry. Hemodynamic instability was defined as having a mean blood pressure < 60 mmHg or a heart rate of < 60 beats per minute. Desaturation was defined as an oxygen saturation (SpO_2) of < 90%. Obstructive sleep apnea (OSA) was diagnosed with a history of snoring, observed apnea, and tiredness as reported by the family.

Major complications were defined as tracheal lacerations, tracheoesophageal fistula, pneumothorax, bleeding requiring transfusion, and posterior tracheal wall injury. Minor complications were defined as self-limiting bleeding (< 30 cc).

Tracheotomy procedure

Patients were ventilated with 100% oxygen 3 minutes prior to the procedure. We described the procedure to those patients that were conscious. Before positioning, we administered midazolam (0.05 mg/kg), propofol (2 mg/kg), and rocuronium bromide (0.6 mg/kg). The neck position was extended with towels under the shoulders. A third year resident managed the fiber optic video bronchoscope and withdrew the endotracheal tube. A physician performed the procedure with the assistance of another physician who handled the equipment. Measurements were performed as described above. Neck skin was prepared with povidone-iodine. Following positioning and the antiseptic process, a sterile linear ultrasound probe was used in the U + F group to determine the vascular structures and to perform puncture localization between the second and third tracheal rings. After the gel application on the skin, a needle was slid slightly transversely under the linear ultrasound probe over the tracheal rings to define the location of the puncture and a line was drawn with a marker after indicating the second and third tracheal rings. Vascular structures on the puncture site were also checked with sonography. An endotracheal tube was released from the tape and the cuff was deflated and withdrawn to prevent cuff puncture. A fiber optic video bronchoscope was inserted through the cap of the catheter mouth to provide ventilation during the procedure. An endotracheal tube was positioned slightly under the vocal cords under fiber optic visualization. As soon as there was a slight insertion of the needle inside the tracheal lumen and air aspirated, the tip of the needle was visualized with the fiber optic bronchoscope inside the lumen. The needle was removed and a guide wire was inserted through the catheter. Following a 2 mm transverse incision of the skin to the left and right side of the guide wire, and dilation with a thin dilator, forceps were used to enlarge the stoma. After sufficient dilation with forceps, a tracheotomy cannula was placed and the endotracheal tube was completely withdrawn. All these steps were visualized with a fiber optic bronchoscope to avoid posterior tracheal wall injury. The time started with the insertion of the needle and ended with the cannula insertion in both groups. In the F group, all the steps were the same but the puncture site was defined by palpation of the tracheal rings through the use of anatomical landmarks.

Table 1: Demographic variables, neck measurements.

Variables	Group U + F (n = 9)	Group F (n = 10)	P value
Age	62 ± 23	66 ± 8	0.7
Gender M/F	4/5	6/4	0.4
BMI	24 ± 4	26 ± 3	0.3
OSA	3	5	0.4
Neck circumference (cm)	40 ± 5	42 ± 4	0.1
Thyromental distance (cm)	5.5 ± 1	5.7 ± 1	0.4
Sternomental distance (cm) (extension)	9 ± 1.7	10 ± 1.5	0.4
Cricosternal distance (cm)	3 ± 1	3.5 ± 1	0.5
Neck extension (cm)	3.7 ± 0.7	3.7 ± 0.4	0.9
Ventilator day via ETT	12 ± 4	12 ± 2	0.9

BMI: Body mass index; OSA: Obstructive sleep apnea; ETT: Endotracheal tube

Table 2: Complications and number of puncture attempts.

Variables	Group U + F (n = 7)	Group F (n = 6)	P value
Complications	1 (minor bleeding)	2 (minor bleeding)	0.5
Procedure duration (min)	7.4 ± 4	7 ± 1.7	0.7
Hemodynamic instability	1	2	0.5
Desaturation	1	1	0.9
Number of puncture attempts	1.2 ± 0.4	1.1 ± 0.4	0.6

There was no statistically significant difference between groups.

Statistical analysis

Statistical analysis was performed with SPSS (SPSS Inc., Chicago, IL, USA) version 20. A chi-square test was used to compare groups.

Results

Demographic variables were similar between groups. There was no significant difference in body mass index (BMI), thyromental and sternomental distances, neck circumferences, days of mechanical ventilator use prior to the procedure, and the presence of OSA (Table 1).

There was one case of self-limiting bleeding in the U + F group and two cases in the F group, however, these were determined to be only minor bleeding (Table 2). No major complications were seen. Each group showed one desaturation and one hemodynamic instability, which did not exceed 1 minute and no medication was required. There were no significant differences in the number of puncture attempts, procedure durations, hemodynamic instability occurrences, and desaturation between groups. One patient in the U + F group demonstrated an enlarged venous structural anomaly between the second and third tracheal rings; this patient was excluded from the study and underwent an open surgery. During the open surgery, this patient bled and ear, nose, and throat surgeons had difficulty in stopping the bleeding. This venous structure was determined to be the anterior jugular vein by the ENT surgeon.

Discussion

A percutaneous tracheotomy is a well-known and widely-used procedure in many centers. It is feasible to perform this technique in patients with normal neck anatomy, but the number of patients with neck abnormalities in the intensive care unit (ICU) cannot be ignored. There are many trials seeking the safest and most reliable method for performing a percutaneous tracheotomy. To the best of our knowledge, percutaneous tracheotomy reports regarding short-necked patients or patients with limited neck extension are rare in the literature. The definition of a short neck is not clear and there are no standards for neck length in the literature. Mahajan and colleagues reported formulations to standardize neck length in the pediatric population but there is a paucity of trials in adults regarding neck length [6]. Although there is no definition of a short neck, the current patient population was considered to be in the difficult airway group due to the shortness of their thyromental and sternomental distances. Ben et al. revealed the feasibility of percutaneous tracheotomies in conditions such as short neck, fat neck, or obesity, against other authors who considered these conditions as a relative complication. In their trial, they performed percutaneous tracheotomies with the Grigg's technique on 154 ICU patients having these adverse conditions. They concluded that complications in patients with adverse conditions were similar to patients with normal conditions [7].

Previous studies have focused on the outcomes of percutaneous tracheotomies in obese and non-obese populations. These studies, which are based on correlations between neck lengths and tracheotomy outcomes, did not reveal significantly different outcomes [8-12]. Our patients were not obese, their necks were difficult due to their shortness and immobility.

Technical developments have provided safer conditions for tracheotomy candidates, especially in those with adverse conditions. Ultrasound and fiber optic guidance are increasingly used to perform percutaneous tracheotomy procedures in the ICU. Guinot et al. evaluated the feasibility of ultrasound in obese patients requiring percutaneous tracheotomies and reported the benefits of ultrasound that included the guidance of the puncture site and providing information on neck anatomy in the obese population. In their study, 26 patients were short-necked and their median cricoid-manubrium distance was 5.5 cm (range: 4.5 to 7 cm) [8]. In our study, the mean CSD was 3 and 3.5 cm in the U + F group and F group, respectively. Tabaee and colleagues reported no correlation between neck length and tracheotomy complications; they further concluded that patients with a short neck may not carry higher risks during percutaneous and surgical tracheotomy procedures [11]. In their study, the mean CSD was 2.7 cm in the neutral position and 3.7 cm in the extended position. Gobatto et al. performed a retrospective cohort to compare the efficacy of an ultrasound-versus a bronchoscope-guided percutaneous tracheotomy [13]. They found that the ultrasound-guided percutaneous tracheotomy was an effective and safe method with similar complication rates and outcomes to the bronchoscopy-guided method. The median length of the procedure was 12 minutes (range: 8-15 minutes) and 15 minutes (range: 15-21 minutes) in the ultrasound and bronchoscope groups, respectively. In our study, there was no significant difference between groups. The ultrasound technique used in their study was real-time sonography. In our study, we did not use real-time sonography, rather, we used the combination of the ultrasound and bronchoscope and visualized the tracheal lumen by a fiber optic video bronchoscope, which ensured a colorful and more precise image. Flint and colleagues described a bedside ultrasound screening method to evaluate the pretracheal vascular structures, which might lead to bleeding during a percutaneous tracheotomy. After sonographic examination, they used direct bronchoscope guidance for tracheal needle access, which is similar to our U + F group technique, however, they referred short-necked patients for surgical tracheotomy [14].

Neck extension range is another notable point for a tracheotomy procedure. Percutaneous tracheotomy trials in patients with limited neck extension have been used in cervical trauma patients [15,16]. Ben Nun et al. reported outcomes of percutaneous tracheotomy in 38 patients with cervical spine fractures. They performed the procedure without neck extension. Two minor complications were seen and they concluded that a percutaneous tracheotomy is a safe and feasible procedure in patients with cervical spine fractures [15]. In their study, there was no information on neck lengths and guidance methods. Limited neck extension may not elicit challenges in anatomically normal-length necks. Our complication rate was higher, which may be due to the combination of short necks and limited neck extension.

A limitation of this study was the small number of patients with short necks and necks with limited extension who required percutaneous tracheotomies in the ICU. Furthermore, this was a single-center study and we could not follow up all patients for long-term complications due to patient transfers to their home or other centers.

In conclusion, an ultrasound examination of the neck before performing a percutaneous tracheotomy procedure may be lifesaving in patients with anatomical abnormalities. Using the combination of an ultrasound and a fiber optic video bronchoscope may improve the outcomes of percutaneous tracheotomy procedures in patients with difficult necks.

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