MEDICAL SCIENCE MONITOR

CLINICAL RESEARCH

e-ISSN 1643-3750
© Med Sci Monit, 2017; 23: 4684-4688
DOI: 10.12659/MSM.907006

Received: 2017.09.06
Accepted: 2017.09.18
Published: 2017.09.30

Bedside Percutaneous Dilatational Tracheostomy by Griggs Technique: A Single-Center Experience

Authors' Contribution:
Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

ABCDEFG 1 İbrahim Tayfun Şahiner
ABCDEFG 2 Yeliz Şahiner

1 Department of General Surgery, Hitit University School of Medicine, Erol Olçok Training and Research Hospital, Çorum, Turkey
2 Department of Anesthesiology and Reanimation, Hitit University School of Medicine, Erol Olçok Training and Research Hospital, Çorum, Turkey

The Ethics Committee of Hitit University Faculty of Medicine (2017/40) approved this study, which was presented as an oral presentation at Balkan States Anesthesia Days IV, 17–20 May 2017, in Sarajevo, Bosnia, and Herzegovina

Corresponding Author: Yeliz Şahiner, e-mail: yelizsahiner@gmail.com

Source of support: Departmental sources

Background: The study evaluated reliability and outcomes of percutaneous dilatational tracheostomy (PDT) performed via Griggs' method in the intensive care unit.

Material/Methods: We examined 78 patients who underwent bedside PDT in the intensive care unit (ICU). Demographic characteristics were recorded. In addition, ventilator-related pneumonia, duration of performing PDT, and rates of complications, mortality, and morbidity were assessed.

Results: The mean age of patients was 68.7 years, and 56.4% were females (n=44). The most common indication for ICU was pneumonia (44.9%, n=35), followed by trauma (24.8%, n=13). Mean opening of PDT was 21 minutes. Mean duration of intubation prior to PDT was 21±6 days. Mean FiO_2 before and after PDT was 58.7% and 49.1%, respectively. PEEP ratios before and after PDT were 5 and 3, respectively. Seventy-one patients (91%) needed no sedation after PDT. Mechanical ventilator-induced pneumonia was observed in 32.1% (n=25) of patients. The overall complication rate after PDT was 37.1%, most of which were minor. The most common and early complication of PDT was bleeding (28.2%, n=22). Other minor complications included hypotension (3.8%, n=3), desaturation (3.8%, n=3), and subcutaneous emphysema (1.3%, n=1).

Conclusions: Tracheostomy offers advantages in terms of improving patient comfort, facilitating weaning of patients from the respirator, and providing clearance of pulmonary secretions by reducing pulmonary dead-spaces. PDT is a simple and reliable procedure with lower complication rates. Its advantages include implementation at bedside, with a shortened procedure duration and accelerated wound healing.

MeSH Keywords: Intensive Care Units • Neck • Obesity • Patient Safety • Point-of-Care Systems • Tracheostomy

Full-text PDF: https://www.medscimonit.com/abstract/index/idArt/907006

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Background

Tracheostomy, either surgical or percutaneous, is a commonly performed procedure in intensive care units (ICU). This surgical intervention aims to provide a safe airway to those critically ill patients dependent on prolonged mechanical ventilatory support or those requiring an alternative airway for various reasons [1].

In 1985, Ciaglia described percutaneous dilatational tracheostomy (PDT) where dilatation was performed gradually from small to large blunt-ended dilators. Griggs modified this technique by adding guide wire dilated forceps (GWDF), which was similar to blunt-edged modified Howard-Kelly forceps. Later, Ciaglia Blue-Rhino (dilatation at a single step) and PercuTwist (controlled rotational dilatation with single-screw dilatator) methods were described. Various techniques of PDT are still used worldwide [2,3].

Tracheostomy is typically used as bedside PDT in the ICU or as surgical tracheostomy (ST) in the operating room [4]. PDT is preferred over ST in ICU patients due to its easy applicability in the ICU, so that it eliminates problems that may arise during transfer of patients under mechanical ventilation to the operating room. The procedure could be performed at bedside by ICU physicians, regardless of the presence of a surgeon or availability of an operating room.

PDT offers many benefits, including ease of application, smaller incision, less tissue trauma, lower rate of infection, use at bedside, and optimal utilization of ICU personnel [3]. Therapeutic use and indications of PDT may easily expand in most previously contraindicated conditions if training, experience, and successful management is provided [1]. PDT facilitates clearance of pulmonary secretions, reduces risk of subglottic stenosis secondary to endotracheal tube, decreases the need for sedative use in the ICU, and promotes early weaning from a mechanical ventilator. It also decreases length of ICU stay, thereby reducing therapy-related costs [4].

ST may be preferred in patients with disturbed anatomy, history of neck surgery or radiotherapy, unstable cervical vertebra injury, or pediatric patients, or in facilities where no competent physician or adequate resources are present to perform PDT in ICU [3].

In this study, we used Griggs' method during PDT and modified the standard procedure of safe airway management to use a laryngeal mask to avoid accidental extubation of the endotracheal tube and perforation of the endotracheal tube cuff, and to prevent hypoxia.

Material and Methods

Upon approval by the Ethics Committee of Hitit University Faculty of Medicine (2017/40), data of 78 patients who underwent PDT at the ICU of the Anesthesiology and Reanimation Department of Hitit University Faculty of Medicine between 2014 and 2016 were assessed in a retrospective fashion. Patients in whom PDT was performed due to prolonged mechanical ventilation, airway protection against aspiration, or prolonged tracheal toilet, acute respiratory stress syndrome (ARDS), and failed weaning after serious head trauma were included to the study. Those with unstable cervical vertebra fracture, surgical tracheostomy, platelet (PLT) count <60 000 mm^3, INR >1.5, FiO_2 >0.8, and PEEP >12 cm H_2O were excluded from the study. All patients who were excluded from the study underwent open tracheostomy.

Preparation of the patient and PDT technique

All patients were administered general anesthesia with propofol 3 mg/kg, fentanyl 1µg/kg, and rocuronium 0.8 mg/kg. Controlled mechanical ventilation with inspiratory oxygen concentration (FiO_2) 100% was applied and vital signs were continuously monitored during the procedure.

Prior to initiation of PDT, the endotracheal tube was removed and a standard laryngeal mask airway (LMA) appropriate for patient's age was placed to avoid accidental perforation of the endotracheal tube cuff and to prevent accidental extubation [2].

We assessed whether the lungs were ventilated after placement of the LMA. Afterwards, neck distance was extended via a roll placed between the shoulders. Aseptic measures were taken at the anterior neck through use of povidone-iodine prior to palpation of the suprasternal notch, thyroid, cricoid cartilage, and first 3 tracheal rings.

Skin and subcutaneous tissue was infiltrated with 2% lidocaine/epinephrine, and subcutaneous tissue was eliminated with a 1-cm horizontal incision. The trachea was perforated with a 14-gauge needle in the posterior-caudal direction, and tracheal access was confirmed upon air aspiration of the syringe that was filled with 5 cc of lidocaine. After tracheal puncture, a J-tip guide wire was inserted according to Griggs' technique. For the initiation of stoma formation, an initiating dilator was introduced over the guide wire and then removed. Afterwards, a guide wire-tipped forceps (GWDF) was placed to the guide wire and when the forceps opened, soft pretracheal tissues were allowed to expand. The Griggs' forceps was re-applied to the guide wire and advanced until resistance was felt and it was advanced until the tip of the forceps passed into the tracheal lumen. Then, the Griggs' forceps was opened to stomatize the trachea, and the forceps was removed in open position. A specially designed tracheostomy tube with obturator and cuff was

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Table 1. Demographic characteristics.

Parameter	Results
Age (years)	68.7 (minimum 21, maximum 72)
Sex (Male/Female)	34/44 (43.6%/56.4%)
BMI (kg/m^2)	24.07±3.4
Crico sterna distance (cm)	2.71±0.28
Duration of procedure (minutes, Including LMA placement)	21±3.2
APACHE II Score	26.9 (range: 8–45)
Glasgow Scale	7.6 (range: 3–15)

advanced over the guide wire and the introducer that was adequately lubricated was added into the formed tracheal stoma. Then, the obturator and guide wire were removed. After placement of a tracheostomy tube, surrounding parts of the tracheal stoma were covered with sterile povidone iodine sponge.

The time elapsed from skin incision to the placement of a tracheostomy tube was recorded. Its position was verified by chest X-ray. Demographic variables and any perioperative or late postoperative complications were recorded. Statistical analyses were performed with SPSS software. An overall 5% type-1 error level was used to infer statistical significance.

Results

PDT through Griggs' technique was performed on 78 patients hospitalized at the ICU between years 2014 and 2016. The mean age of patients was 68.7 years (range: 21-72). Gender distribution showed 56.4% (n=44) were female and 43.6% (n=34) were male. Mean body mass index of the subjects was 24.07 kg/m^2 (Table 1).

Apache II score was 26.9 (range: 8–45) and mean Glasgow Scale was 7.6 (range: 3–15). Mean length of ICU stay was found as 76.4 days (range: 10–300 days).

Indications for admission to the ICU were pneumonia (44.9%, n=35), trauma (24.8%, n=13), cardiac diseases (10.3%, n=8), myasthenia gravis (9.0%, n=7), cerebrovascular diseases (9.0%, n=7), gastrointestinal disorders (6.4%, n=5), and malignancy (3.8%, n=3) (Table 2).

The mean duration of the procedure at the ICU (including placement of LMA) was 21 minutes, and the mean time elapsed to open PDT was 21±6.0 days for intubated patients.

Table 2. Indications for admission to Intensive Care Unit.

Indication	Number	%
Pneumonia	35	44.9%
Trauma	13	24.8%
Cardiac diseases	8	10.3%
Myasthenia gravis	7	9.0%
Cerebrovascular diseases	7	9.0%
Gastrointestinal disorders	5	6.4%
Malignancy	3	3.8%
Total	**78**	**100%**

Table 3. Incidence of complications.

Complication	Number (n: 78)	%
Minor (total)	**29**	**37.1%**
Minor bleeding	22	28.2%
Transient hypotension	3	3.8%
Desaturation SpO_2 <85%	3	3.8%
Subcutaneous emphysema	1	1.3%
Tracheal ring fracture	0	0
Major (total)	**2**	**2.6%**
Major haemorrhage	0	0
False passage	0	0
Posterior tracheal wall injury	0	0
Oesophageal perforation	0	0
Pneumothorax	1	1.3%
Cardiac arrest	1	1.3%
Conversion to open surgery	0	0

FiO_2 values before and after PDT were 58.7% and 49.1%, respectively. PEEP values before and after PDT were 5 and 3, respectively.

After PDT procedure, 91% of patients (n=71) showed reduced need for sedation. Mechanical ventilation-related pneumonia was observed in 25 patients (32.1%), where mostly isolated organism was *Pseudomonas aeruginosa*.

The rate of preoperative and early complications was 39.7%, most of which were minor. The most common perioperative and early complication of PDT was minor bleeding (28.2%, n=22), which spontaneously stopped with compression and no need for additional measures or interventions. Other minor

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complications included hypotension (3.8%, n=3), desaturation (3.8%, n=3), and subcutaneous emphysema (1.3%, n=1). One patient developed pneumothorax, for which a chest tube was inserted by a thoracic surgeon. Another patient died during PDT after cardiac arrest (Table 3).

Discussion

PDT was recently preferred in critically ill patients when prolonged control of airway is required. Tracheostomy offers reduction of pulmonary dead-spaces, easy clearance of pulmonary secretion, facilitation of weaning from a mechanical ventilator, and decreased risk of nosocomial infections. Bedside procedure alleviates the risk of transferring unstable and critically ill patients from the ICU to the operating room and its accompanying risks [3].

Furthermore, several techniques have been developed to minimize complications and ensure patient safety during percutaneous tracheostomy. After surgical technique, first Ciaglia was described for percutaneous tracheostomy, followed by Griggs, Ciaglia Blue-Rhino, Percu-twist, and Fantoni translaryngeal methods [5]. Each of these techniques were compared with others to discuss their advantages and disadvantages [6]. It is desirable to have a technique that ensures reduced PDT-related morbidity and mortality and facilitates the procedure. All these techniques have been designed to simplify the procedure to offer applicability at bedside setting to avoid transfer into the operating room at the expense of a small incision with less wound complications.

Nevertheless, some techniques showed advantages over others. For instance, Griggs' technique provided addition with only a dilatation and under visual aid, compared with the Ciaglia multi-dilator technique. Fantoni technique offers intratracheal placement of the tube and Frova method decreases the risk of cartilage fracture [7]. Therefore, novel and current approaches to reduce complication rates and improve procedural success while using these techniques include visualization with fiberoptic bronchoscopy and determination of neck anatomy by ultrasonography. Bronchoscopy is a safe and very effective method to confirm the placement of the needle at the insertion site during dilatation and placement of the tracheostomy cannula [8,9]. Access to fiberoptic techniques or bronchoscopy every time is not possible in all ICUs. However, the experience of the performing physician rather than the choice of technique is considered as one of the critical issues to reduce complications.

We choose Griggs' technique during percutaneous tracheostomy procedure in this study based on our extensive experience using this method. The palpability of the tracheal rings when the neck is correctly positioned indicates the easy applicability of the procedure. Considering that obesity usually affects the abdomen, we believe that the procedure is often easy to perform unless morbid obesity is present. The most common complication that we observed with Griggs' technique during percutaneous tracheostomy was minor bleeding (41%), which could be controlled with compression are requires no additional intervention. In this study, all minor bleeding complications were prevented simply by compressing a sterile gas. In fact, bleeding complications may be reduced either by performing the procedure after INR and platelet count follow-up and fresh frozen plasma replacement if appropriate, or by administering local anesthetics with adrenaline to the subcutaneous tissue around the puncture site. Since PDT is an elective procedure, there is usually sufficient time to complete required preparations.

Accidental perforation of the endotracheal tube (ETT) cuff and unintended extubation during PDT are life-threatening complications. Ambesh et al. reported the rates of cuff perforation and unintended extubation during the preoperative period were 6.6% and 3.3%, respectively [10]. While these are substantial rates, these may also lead to significant morbidity and mortality in patients with difficult airways. Therefore, to improve patient safety, we modified Griggs' technique by using a standard laryngeal mask to avoid unintended extubation, cuff perforation, or inadequate ventilation. In fact, we observed that laryngeal mask use is associated with increased procedural success and patient safety. We believe that it prevents unintentional passage of the J-guide wire through the ETT murphy eye and bending of the wire, and reduces the risk of esophageal injury. The laryngeal mask is removed after ensuring ventilation of the patient upon placement of the tracheostomy cannula. This abolishes the need for using fiberoptic bronchoscopy. Intravenous general anesthetics are used during bronchoscopy, and patients may have other complications such as hypoxia, hypercarbia, and increased intracranial pressure, which are secondary to inadequate ventilation [9,11,12]. Indeed, critically ill ICU patients poorly tolerate such complications [13]. Furthermore, these may progress into other serious problems such as prolonged duration of the procedure, offset of the anesthetic effect, and consequent bronchospasm. Use of ultrasonography prior to PDT could confirm the access site, but it is not superior to fiberoptic bronchoscopy if the patient has a difficult neck anatomy.

In a meta-analysis, Cabrini et al. compared PDT techniques performed between 1998–2010, and reported that Griggs' technique as safe and effective as other techniques. Covering 13 studies (5 of which did not use fiberoptic bronchoscopy) and 1030 patients, this review reported the rate of minor complications was 31% [14].

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In their review covering the literature through 2002, Dongelmans et al. reported that major complications after multi-dilator (Ciaglia) technique ranged between 0% and 14% (mean: 3.0%, n=4066) per 28 studies and that GWDF technique used in 6 studies had a complication rate of 0-4.9% (mean: 3.0%, n=461), and that Ciaglia Blue-Rhino technique caused complication rates between 1.3% and 5.0% (mean: 2.8%, n=2836) according to 3 available studies [10].

Higgins et al. reviewed 15 studies in their meta-analysis and reported lower PDT-related complication at the expense of a higher accidental decannulation rate [15]. A meta-analysis of 17 studies by Delaney et al. indicated PDT was associated with a lower rate of wound infection but was similar in terms of bleeding or other complications, compared with surgical tracheostomy [16].

In conclusion, comparisons between individual methods are not sufficient to clearly establish superiority of one over others due to incomplete case series or small sample sizes [7]. Therefore, comparison of Blue-Rhino method and other methods arises from the availability and widespread usability of the method. It is obvious that the duration of the procedure is shorter in methods where a simple dilator is used. Higgins et al. reported that no definite conclusion could be drawn about the ideal method due to significant statistical heterogeneity in these studies [15].

Conclusions

PDT is safer, quicker, and simpler than surgical tracheostomy in ICU patients. Both Ciaglia Blue-Rhino and Griggs forceps methods are feasible techniques with similar complication rates [17]. We preferred Griggs' technique during bedside PDT in the ICU due to our higher experience using this technique. Studies have not been able to prove superiority of one technique over others. In the present study, our aim was to share our experiences rather than to make a technical comparison. Use of technologically advanced methods (e.g., fiberoptic bronchoscopy or ultrasonography) in PDT improves the success of the procedure. As in all invasive procedures, the experience of the practitioner and shortened duration of the procedure reduces complication rates.

The procedures performed in critically ill patients in the ICU carry substantial risks, requiring close monitoring of vital signs and mechanical ventilator parameters during the procedure. In addition, checking for bleeding, assessment of airway integrity, X-ray evaluation, and follow-up of late-phase complications should be performed.

Conflicts of interest

None.

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