Beshay *et al.*
Ain-Shams Journal of Anesthesiology (2023) 15:92
https://doi.org/10.1186/s42077-023-00388-6

Ain-Shams Journal of Anesthesiology

ORIGINAL ARTICLE Open Access

A novel technique for safe blind percutaneous tracheotomy: retrospective case-series study on three hundred eighty-six patients

Bassem N. Beshay[1], Islam M. Elbardan[2], Moustafa A. Moustafa[2*] and Ahmed S. Shehab[2]

Abstract

Background Griggs' technique with assisting tools for bedside percutaneous tracheotomy (PDT) is safe and fast and carries few complications in expert hands. Assisting tools are not routinely available in many ICUs. The study aims to evaluate the impact of a novel technique for blind percutaneous tracheotomy on success rate, duration of the procedure, and rate of complications. This retrospective case-series study was conducted in the different intensive care units in Alexandria University Hospitals. Three hundred eighty-six patients were recruited from 1 January 2018 to 31 December 2021. After skin incision and blunt pre-tracheal dissection, a needle was inserted to access the airway, transfixing the endotracheal tube (ETT). A change in the alignment of the needle tip inside the trachea from caudal to cranial accompanied the withdrawal of the ETT off the trachea. In situ caudal needle redirection for subsequent guidewire passage distally into the trachea was done. The rest of the procedure was continued as Griggs' technique.

Results The success rate was 100%. The procedure duration (in seconds) was 125.73±19.52. No procedure-related deaths or major intra-operative complications were encountered. Only three patients developed pneumothorax and subcutaneous emphysema, managed by intercostal tube insertion.

Conclusions The novel technique for blind percutaneous tracheotomy was successful with no significant procedure-related complications. The duration of the procedure was comparable to the literature.

Key points

Question Can we use ETT as a guide for protecting the posterior tracheal wall during unassisted percutaneous tracheostomy procedures?

Findings Minimal rate of complication and desaturation within the accepted time for unassisted percutaneous tracheostomy using ETT as a guide during insertion.

Meaning Transfixing anterior ETT wall can be used effectively for unassisted percutaneous tracheostomy procedures.

Keywords Intensive care unit, Trachea, Tracheostomy, Tracheostomy cannula, Critically ill

*Correspondence:
Moustafa A. Moustafa
m.3abdelaziz@hotmail.com; moustafa.abdelaziz@alexmed.edu.eg
Full list of author information is available at the end of the article

Background

Tracheotomy is one of the most common procedures in the intensive care unit (ICU). Since 1985, percutaneous tracheotomy (PT) has gained widespread acceptance as a method of creating a surgical airway at the patient's bedside, and new techniques for PT have been developed (Byhahn et al. 2005; Freeman et al. 2000; Putensen et al. 2014). In 1985, Ciaglia et al. (Ciaglia et al. 1985) described percutaneous dilatational tracheotomy (PDT). Later, Griggs et al. (Griggs et al. 1990) introduced tracheotomy using a guidewire dilating forceps (GWDF), by which the trachea is opened using a blunt-tipped forceps previously advanced over the metal guide in the tracheal lumen. In 1998, the classical technique of Ciaglia was modified using a single dilator. Such modification offered the advantage that the stoma is produced by a single dilatation, avoiding the need for successive dilatations (Byhahn et al. 2000).

PDT heralds many peri-procedural complications, such as bleeding, difficulty placing the tube, false passage, posterior tracheal wall injury, pneumothorax, pneumomediastinum, and subcutaneous emphysema (Romem and Gilboa 2022). Given the ability to prevent serious complications, fiberoptic bronchoscopy is the most widely used safe method. However, its application as a routine co-adjuvant technique is controversial since the endoscopic guide produces a rise in airway pressure, hypoventilation, and an increase in intracranial pressure, contraindicating its utilization in some patients. Moreover, bronchoscopy increases the cost of the procedure (Johnson et al. 2001; De Leyn et al. 2007). Capnography helps confirm the intratracheal location of the needle at the time of puncture. The disadvantage of capnography is the lack of direct visualization of the precise position of the needle and metal guide within the trachea (Mallick et al. 2003). Ultrasound is a non-invasive procedure that can be useful for locating aberrant vascular structures (Kollig et al. 2000).

One of the main advantages of percutaneous tracheotomy is bedside performance, thus eliminating the hazards, expenses, and logistics involved in operating room set-up usually required for open surgical tracheotomies. Many ICUs do not have bronchoscopy or ultrasound machines routinely available, especially in developing countries. The primary aim of this work was to study the impact of a novel technique for percutaneous tracheotomy without assisting tools on the procedure's success rate. The secondary aim was to estimate the procedure duration and complication rate in 386 patients.

Methods

The present study's patient data has been collected retrospectively from the medical records of patients admitted to Alexandria University Hospitals' intensive care units and undergone percutaneous tracheotomy from 1 January 2018 to 31 December 2021. Alexandria University Hospitals (11 hospitals) are considered the only hospitals serving tertiary medical care to about 16.48 million people across four governorates: Alexandria, Behira, Matrouh, and Kafr-Elshaikh (Total population of Egypt 2021). They provide multidisciplinary care around the clock with a total capacity of 3600 beds, fully equipped 331 intensive care unit (ICU) beds, 111 neonatal ICU beds, and 23 pediatric ICU beds. The largest of them is the Alexandria Main University Hospital, receiving more than 100,000 patients per year with a total capacity of 1696 beds and fully equipped 223 ICU beds.

The Medical Ethics Committee of Alexandria Main University Hospitals (IRB # 00012098) was approved on 18 Nov 2021. Written informed consent for tracheotomy was adopted from all the patients or the patient's next of kin. The trial adhered to EQUATOR guidelines for observational studies and was registered in the Clinical Trial Registry (NCT05343442, date of registration: 25/04/2022). All methods were performed following the Declaration of Helsinki.

All percutaneous tracheotomies were performed electively on intubated patients at the bedside. Inclusion criteria were adult patients ≥ 18 years indicated for tracheotomy. Exclusion criteria were uncorrectable coagulopathy and unsuitable anatomy (e.g., previous cervical surgery, cervical trauma, or tumors).

Data collection on enrollment was age, sex, neck circumference, and indication for tracheostomy. Patients were sedated with midazolam 1–2 mg and fentanyl 100–200 mμ, paralyzed with atracurium 0.5 mg/kg, and monitored with five lead electrocardiography, mainstream capnography, pulse oximetry, and noninvasive blood pressure. Synchronized intermittent mandatory ventilation (SIMV) mode was used, and the ventilator was set to deliver 6–8 mL/kg tidal volume, respiratory rate 16/minute, and a fraction of inspired oxygen (FiO_2) 100% starting 15 min before and until 5 min after the procedure. Proper pre-procedural suctioning from both the tracheal tube and mouth cavity was done.

Guidewire dilating forceps (Griggs') technique (Griggs et al. 1990) was applied for tracheotomy in all patients. Proper patient positioning was done by neck extension by placing a rolled towel between the shoulder blades while keeping the neck and bed in a neutral position. The operative site was sterilized with a 10% povidone-iodine solution before draping. Lidocaine 2% was used for local anesthesia before beginning the intervention.

A transverse (1 cm) skin incision was made midway between the cricoid cartilage and the suprasternal notch, i.e., opposite the 2nd–3rd or 3rd–4th tracheal rings. Blunt dissection of subcutaneous fat and pre-tracheal tissue with a mosquito clamp in a vertical direction was done until the tracheal rings were palpable (Paran et al. 2004).

A novel technique for safe blind airway access

After palpating the trachea through the incision, a 14-Gauge cannula over the needle is advanced caudally into the trachea, piercing and penetrating the rigid anterior wall of the endotracheal tube (ETT). The success of airway access is recognized by a sudden loss of resistance while protecting the posterior tracheal wall with the inner side of the ETT, with the non-dominant hand fixing the trachea during the process (Fig. 1).

Endotracheal piercing of the needle is further confirmed by aspirating air bubbles into a saline-filled syringe attached to the cannula over the needle. A cooperator does ETT cuff deflation. Delicate gradual withdrawal of the tracheal tube of the trachea changes the direction of the transfixing cannula over the needle cephalad (Fig. 2).

ETT withdrawal is continued until full dislodgement of the transfixing cannula over needle-directed cephalad off the ETT. In situ caudal redirection of the cannula over the needle inside the trachea is a mandatory step to ensure subsequent free passage of the guidewire distally into the trachea. To prevent injuring the bared posterior tracheal wall by the sharp needle's tip during caudal redirection, 1 mm needle withdrawal from the plastic cannula is done to make its distal end non-traumatizing. Successful complete withdrawal of the cannula over the needle from the anterior wall of the ETT is tested by smooth caudal redirection of the cannula over the needle without any readvancement of the ETT (Fig. 3).

Proper caudal placement of the cannula over the needle into the tracheal lumen is reconfirmed by aspirating air bubbles into the saline-filled syringe attached to the cannula over the needle once more. The needle is removed, leaving the cannula in place (Fig. 4). The J-guidewire is inserted through the caudally directed cannula into the trachea, and the cannula is subsequently removed.

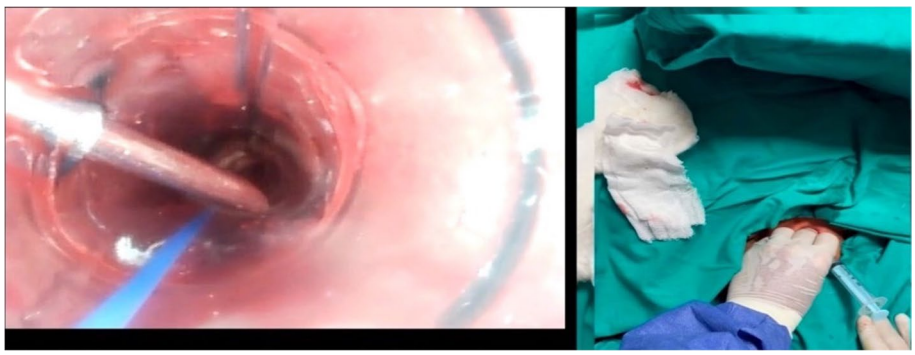

Fig. 1 A 14-Gauge cannula over the needle was advanced caudally into the trachea piercing and penetrating the rigid anterior wall of the endotracheal tube (ETT). The success of airway access was confirmed by the sudden loss of resistance while protecting the posterior tracheal wall by the inner side of the ETT. The trachea is kept fixed in place by the non-dominant hand

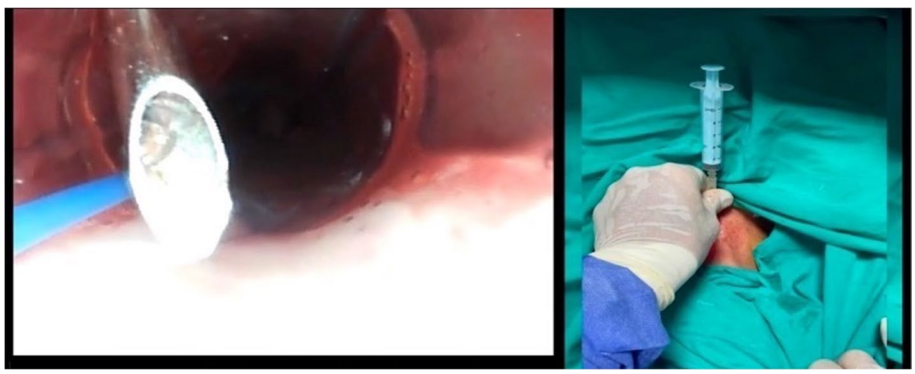

Fig. 2 Gradual withdrawal of the ETT leading to a cranial redirection of the catheter over the needle followed by its release off the anterior wall of the ETT

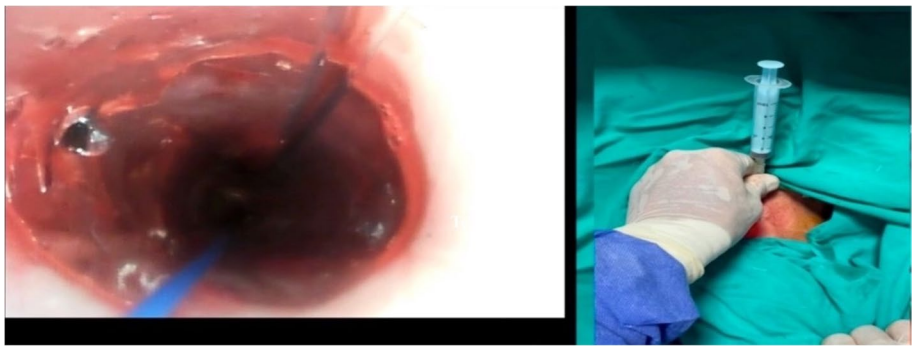

Fig. 3 Successful release of the tip of the cranially directed cannula over the needle off the anterior wall of the ETT

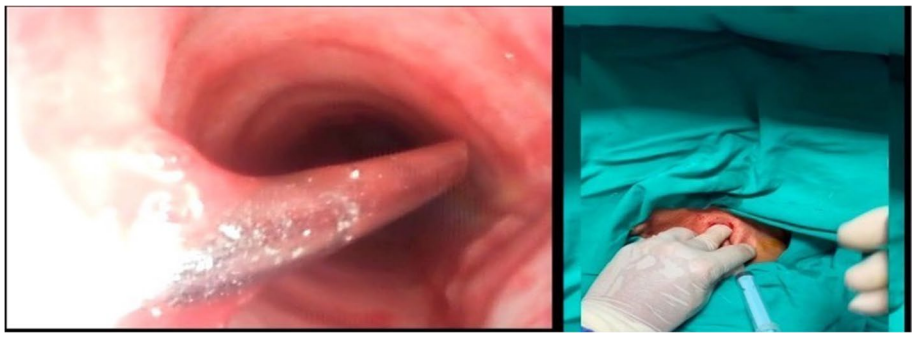

Fig. 4 Proper caudal redirection of the cannula over the needle after slightly into the tracheal lumen (to avoid posterior tracheal wall injury) was reconfirmed by aspirating air bubbles into the saline-filled syringe attached to the cannula over the needle once more. The needle was then removed leaving the cannula in place for subsequent J-guidewire insertion

Procedure time was recorded with a digital stopwatch (two times were recorded: (1) novel technique time (NT time): time from tracheal tube puncture until J-guidewire insertion into the trachea and (2) total technique time (TT time): time from skin incision till tracheotomy tube insertion). Peri-procedural complications were recorded, including failure (with mentioning action taken to accomplish tracheotomy), cardiac arrest, bleeding, desaturation below 92%, false passage, posterior tracheal wall injury, pneumothorax, pneumomediastinum, and subcutaneous emphysema. Bleeding was subclassified into mild (1 to 5 ml), moderate (5 to 20 ml), severe (20 to 50 ml), and serious (>50 ml or surgical intervention/transfusion required). The volume of blood loss was calculated by measuring the weight difference of gauze before and after the procedure (Pilarczyk et al. 2016).

For safety purposes, flexible video bronchoscopy (KARL STORZ Endoskope GmbH & Co. KG Germany) was performed by a second cooperator during the procedure in the first twenty patients to confirm midline tracheal puncture, changes in cannula over needle directions, the integrity of the posterior tracheal wall, proper positioning of the guidewire, and dilators, as well as tracheotomy tube while passing into the trachea.

Statistical analysis

Data were collected and entered into the computer using the SPSS (Statistical Package for Social Science) program for statistical analysis (version 21). Data were entered as numerical or categorical, as appropriate. Kolmogorov-Smirnov test of normality revealed no significance in the distribution of the variables, so the parametric statistics were adopted (IBM corp. 2012; Field 2013). Data were described using minimum, maximum, mean, and standard deviation. Categorical variables were defined using frequency and percentage. Comparisons were made between more than two independent normally distributed subgroups using a one-way analysis of variance (ANOVA) test (Montgomery 2001). When the F ratio of ANOVA was significant, the Levene test of homogeneity of variances was done, and if significant, Brown-Forsythe Robust test was adopted. Post hoc multiple comparisons were done using the Hochberg method (Ruxton and Beauchamp 2008). Pearson's correlation was done. An alpha level was set to 5% with a significance level of 95%.

A scatter plot with a best-fit (regression) line was used. Interpreting the size of a correlation coefficient was done (Mukaka 2012).

Results

A total of 412 cases met the inclusion and exclusion criteria of the current study. Among those cases, complete baseline data has been found in 386 cases. Patients' age ranged between 19 and 92 years with a mean±S.D of 58.87±14.24 years. One hundred ninety-seven patients (51.04%) were males. Their mean neck circumference was 35.69±2.23 cm. Prolonged mechanical ventilation due to medical (and neurological) causes was the main indication of performing tracheotomy (52.07%) (six of them were COVID-19 patients), followed by head injury (37.05%). Neuromuscular diseases (5.7%) and compromised airway (5.18%) were fewer indications (Table 1).

Novel technique time (NT time) ranged between 27 and 84 s with a mean±S.D of 46.48±8.33 seconds. Total technique time (TT Time) ranged between 75 and 205 s with a mean±S.D of 125.73±19.52 s. Mild bleeding was the most common complication recorded in 331 patients (84.75%), followed by moderate bleeding in 38 patients (9.84%). Desaturation occurred in 33 patients (8.55%); late pneumothorax in 3 patients (0.78%), a recorded complication due to positive pressure ventilation and was managed accordingly; and subcutaneous emphysema in 6 patients (1.55%). Other complications like (severe and serious) bleeding, false passage, posterior tracheal wall injury, pneumomediastinum, and failure to accomplish the procedure were not encountered in the studied patients. No deaths related to the procedure were encountered (Table 2).

Novel and total technique times showed negligible correlation with age (−0.139** and −0.092, respectively). Neck circumference positively correlated moderately with NT and TT times (0.659** and 0.671**, respectively) (Table 2).

NT time showed a stepwise prolongation from no to mild to moderate bleeding. Such prolongation was statistically significant ($p = 0.004$). When comparing different grades of bleeding to NT time, only the moderate bleeding group was statistically significantly longer than the no bleeding group ($p_3 = 0.003$). When correlated with grades of bleeding, TT time showed a stepwise prolongation from no to mild to moderate bleeding, which was statistically significant ($p < 0.001$). When comparing different grades of bleeding to TT time, the mild bleeding group was statistically significantly longer than the no bleeding group ($p_2 = 0.015$). Also, the duration in the moderate bleeding group was statistically significantly longer than the mild bleeding group ($p_3 < 0.001$) (Table 2).

Table 1 Baseline patients' criteria at the time of enrolment

	Value/number (%)
Age (years)	
Range	19–92
Mean ± S.D.	58.87±14.24
Sex	
Male	197 (51.04%)
Female	189 (48.96%)
Neck CMF (cm)	
Range	28.8–45.9
Mean ± S.D.	35.69±2.23
Indication	
Prolonged MV	201 (52.07%)
Head injury	143 (37.05%)
Neuromuscular disease	22 (5.70%)
Compromised airway	20 (5.18%)

Values are presented as number (*n*), percentage (%), range, and mean ± standard deviation (SD). *BMI (kg/m²)*, body mass index in kilogram per meter square; *Neck CMF (cm)*, neck circumference in centimeters; *MV*, mechanical ventilation

Table 2 Novel technique time, total time, correlation with age, neck circumference and grades of bleeding and recorded complications of the procedure in studied patients

	NT time (sec)	TT time (sec)
Range	27–84	75–205
Mean ± S.D.	46.48±8.33	125.73±19.52
Correlation of NT, TT with age, neck CMF		
Age	−0.139** *Pc*=0.006	−0.092 *Pc*=0.072
Neck CMF	0.659** *Pc*=0.000	0.671** *Pc*=0.000
Bleeding		
No (17) (4.40%)	46.06±1.25	124.41±11.40
Mild (331) (84.75%)	46.02±8.22	124.16±18.68
Moderate (38) (9.84%)	50.68±9.42	140.03±23.73
	$p_1 = 1.000$ $p_2 = 0.156$ $p_3 = 0.003$*	$p_1 = 1.000$ $p_2 = 0.015$* $p_3 < 0.001$*
Complications		
Bleeding	*Mild* *331*	*Moderate* *38*
Desaturation	33 (8.55%)	
Pneumothorax	3 (0.78%)	
S.C emphysema	6 (1.55%)	

Values are presented as number (*n*), percentage (%), range, and mean ± standard deviation (SD). *Neck CMF (cm)*, neck circumference in centimeters; *NT time*, novel technique time in seconds; *TT time*, total technique time in seconds; *S.C emphysema*, subcutaneous emphysema; *Pc* are *p* values for Pearson correlation significance (two-tailed)

P values are for ANOVA test at degree of freedom (df) = 2. Sign. bet. groups: significance between groups done using Hochberg method. *p1:* comparing between no and mild bleeding. *p2:* No and moderate bleeding. *p3:* mild and moderate bleeding. Test of sign.: test of significance. *Significant at $p \leq 0.05$. ** Positive correlation

Discussion

Percutaneous dilatational tracheotomy (PDT) has gained popularity since its introduction to our Critical Care Medicine Department in 1999, as more than 2000 cases have been successfully operated, nearly replacing the surgical technique on an elective basis (Beshey 2002). Several studies compared different percutaneous techniques with various assisting tools, like ultrasonography and bronchoscopy (Hassanin et al. 2013; Hamdy 2017; Beshey et al. 2014a; Beshey et al. 2014b). The largest (Beshey et al. 2014a) was a comparative study between cricothyrotomy and PDT using Griggs' forceps technique on an emergency basis in 169 failed airway patients. It was concluded that although the success rate and time to complete both procedures were comparable, performing PDT as a definitive airway was superior to the temporary cricothyrotomy with its ventilatory obstacles.

To date, all studies on percutaneous tracheotomy stressed the importance of endotracheal tube withdrawal, avoiding its puncture while performing tracheotomy to ensure smooth operation. Despite the importance of this step, it leaves the trachea exposed to false passage, para-tracheal insertion, and posterior tracheal wall injury (Romem and Gilboa 2022). Several assisting tools like bronchoscopy and ultrasonography have been evaluated in previous studies to decrease the incidence of such complications (Mallick et al. 2003; Kollig et al. 2000; Hassanin et al. 2013; Hamdy 2017). Another issue is that some tracheas are weak to the degree that they become narrowed upon ETT withdrawal. At the same time, the patient's neck is extended, increasing the incidence of peri-operative complications even with bronchoscopic guidance.

Accordingly, the idea was created as leaving ETT in place, working as a protective tracheal stent during needle insertion as an initial necessary step to access the airway. Adopting such an idea has a lot of advantages. First, it enables safe blind airway access through the semi-rigid ETT inside the trachea. Second, it avoids sudden release of the needle into the trachea and, consequently, posterior tracheal wall injury. Finally, and in the same sequence, false passage and para-tracheal insertion are remote complications.

The trigger beyond this idea was patient zero, who was a female tracheostomized after prolonged mechanical ventilation using a bronchoscope-assisted dilating forceps technique. Unexplained progressive rise in her peak pressures and bradycardia without cardiac arrest were noticed upon smooth completion of the procedure due to bilateral tension pneumothorax. Immediate needle decompression followed by bilateral intercostal tube insertion was done. Such events were not explained even by post-procedure revision using bronchoscopy. Computed chest tomography with virtual reconstruction bronchoscopy was done after stabilization and revealed resolving bilateral pneumothorax and pneumomediastinum with small rent in the posterior tracheal wall. Feeding gastrostomy was done, and the patient died 1 month later due to her original disease (spontaneous subarachnoid hemorrhage).

After initial airway access by needle insertion and to accomplish tracheotomy, there should be some modifications of the conventional technique in order not to hinder subsequent steps. The challenge was safely releasing the ETT off the trachea while the needle transfixed both together. This was thoroughly described in the current work.

The current study was carried out to evaluate such modification of percutaneous tracheotomy on success rate, duration of procedure, and rate of complications. Over 4 years, 386 patients were tracheostomized using this technique and included in this retrospective case series study.

The described technique in this work was a merge of guidewire dilating forceps (Griggs') technique (Griggs et al. 1990) as the original technique, blunt pre-tracheal dissection as described by Paran et al. (Paran et al. 2004), and our modification in airway access as detailed in our methodology. Griggs' technique for percutaneous tracheotomy has been applied in our institution since 2002 (20, 23), with less duration and lower complication rates. Şahiner İT and Şahiner Y (Şahiner and Şahiner 2017), in their study, concluded that their acquaintance with Griggs' technique led to fewer complications. However, they recommended using assisting tools to decrease the rate of complications. Paran et al. (Paran et al. 2004), in their study evaluating a modified PDT without bronchoscopic guidance, concluded that modified blind PDT with limited surgical pre-tracheal dissection was simple and safe when performed by physicians with surgical training.

In the current study, the mean novel technique time (NT time) was less than a minute, while the mean total procedure duration (TT time) was 2–2.5 min. The entire period in our study was comparable, even shorter than that recorded in the literature (Beshey 2002; Hassanin et al. 2013; Hamdy 2017; Beshey et al. 2014a; Beshey et al. 2014b; Şahiner and Şahiner 2017; Pattnaik et al. 2014). Both times showed a moderately positive correlation with neck circumference. This can be explained simply by the longer time spent during blunt pre-tracheal dissection before airway access in those with bigger neck circumferences.

No procedure-related deaths or major intra-operative complications were encountered in the studied patients. Mild and moderate bleeding (84.75 and 9.84%, respectively) were self-limited by local compression.

Desaturation in the present study occurred in 33 patients; 30 improved immediately after the procedure. The rest (3 patients; 0.78%) developed pneumothorax and subcutaneous emphysema and were managed by intercostal tube insertion. Isolated subcutaneous emphysema was evident in 3 patients and was relieved by widening the tight skin incision around the tracheotomy to abolish its ball valve effect.

Pattnaik et al. (Pattnaik et al. 2014), in their study, concluded that the Griggs technique (without bronchoscopic assistance), modified with the technique developed by Paran et al. (Paran et al. 2004), was safe with less time and a lower complication rate. (Hassanin et al. 2013) conducted a study on fibreoptic bronchoscopic guidance in PDT and concluded that blind PDT, when done by experienced personnel, was a safe and effective procedure. It showed a shorter procedure time and avoided hypercapnia. Bronchoscopic guidance decreased the number of needle insertion trials and overall complications rate.

Rezende-Neto et al. (Rezende-Neto et al. 2011), in their prospective case series study on 100 patients, reported a safe and simple technical modification for PDT, merging both Griggs' and Percu-Twist techniques in a reusable kit. They concluded that such modification was safe and simple to execute, with the need for long-term follow-up of complications.

Six patients in the current study were COVID-19 positive and were successfully and safely managed. The procedure did not disrupt the closed ventilation circuit, ensuring protection for healthcare workers. Angel et al. (Angel et al. 2020) studied novel PDT for critically ill COVID-19 patients. They developed a novel PDT technique that placed the bronchoscope alongside ETT, not inside, to improve visualization during the procedure. This technique lessened the risk of virus aerosolization during the procedure. They concluded that this technique appears to be safe and effective for COVID-19 patients and safe for healthcare workers.

Kumar et al. (Kumar et al. 2021) concluded in their study that mini-surgical PDT was faster than bronchoscope-guided PDT with comparable incidence of complications and could be used safely in ICUs where fibreoptic bronchoscope is not available. Lin et al. (Lin et al. 2021) in their systematic review and meta-analysis comparing the effectiveness of ultrasound-guided-tracheotomy (UGT) and conventional blind anatomic landmark-tracheotomy (LT) found that despite increased first trial success rate and fewer complications with UGT, the procedure duration and major bleeding rate were comparable.

Sangwan and Chasse (Sangwan and Chasse 2016) reviewed retrospectively 60 PDTs done using a modified technique (with intermittent bronchoscopy and ultrasound by a single operator). This was done to prevent hypoventilation associated with the use of continuous bronchoscopy. They found no procedure-related deaths or major intra-operative complications with a possibility of reducing accidental intra-operative airway loss and bleeding while possibly improving gas exchange.

The success rate in the present study was 100% without the need to convert to alternative techniques to accomplish tracheotomy. Dennis et al. (Dennis et al. 2013) evaluated more than 3000 PDT procedures regarding bedside PDT safety in the critically ill. They found that the safety of this technique, even in the obese population, was demonstrated by its low complication rate. Routine bronchoscopic guidance was not necessary. They concluded that specially trained procedure nurses and process improvement programs contribute to the safety and efficacy of this procedure.

Piercing the ETT is potentially dangerous if the airway is lost. Moreover, if the ETT is not positioned correctly, this would result in a rupture of the cuff or the pilot balloon. However, we did not encounter such threats in the present study; all preparations for immediate tracheal tube replacement should be available and ready.

The present study has several limitations. It was a retrospective study with all its inherited biases. Moreover, the study was a single-center study, and the technique was performed by a single investigator with a long experience in the studied technique.

Conclusions

In this retrospective case-series study on 386 patients over 4 years, blind percutaneous tracheotomy via the described novel technique was performed effectively in all patients. The duration of the procedure was comparable, even shorter than other blind techniques described in the literature. No procedure-related deaths or major intra-operative complications were encountered. Only three patients developed pneumothorax and subcutaneous emphysema and were managed with intercostal tube insertion. This novel modification of percutaneous tracheotomy may be beneficial if added to the armamentarium of intensivists.

Abbreviations

PDT	Percutaneous dilatational tracheotomy
PT	Percutaneous tracheostomy
ICU	Intensive care unit
ETT	Endotracheal tube
GWDF	Guide wire dilating forceps
SIMV	Synchronized intermittent mandatory ventilation
NT time	Novel technique time
TT time	Total technique time
SPSS	Statistical Package for Social Science
ANOVA	Analysis of variance
UGT	Ultrasound-guided technique
LT	Landmark technique

Acknowledgements
Not applicable.

Authors' contributions
Author name: BB
This author selected the idea of the study and helped collect results, collect data, and help write the final draft.
Author name: IE
This author helped collect data and approved the final draft of the manuscript.
Author name: MM
This author helped write the manuscript.
Author name: AS
This author helped conduct the study, collect data, and approve the final draft of the manuscript.

Funding
None.

Availability of data and materials
The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
The Medical Ethics Committee of Alexandria Main University Hospitals (IRB # 00012098) was approved on 18 Nov 2021. A written informed consent for tracheotomy was adopted from the patient's next of kin. The trial adhered to EQUATOR guidelines for observational studies and was registered in the Clinical Trial Registry (NCT05343442, registration date: 22 April 2022).

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

Author details
[1]Critical Care Medicine Department, Faculty of Medicine, Alexandria University, Alexandria, Egypt. [2]Anaesthesia and Surgical Intensive Care Department, Faculty of Medicine, Alexandria University, Champollion Street, Alexandria 21521, Egypt.

Received: 29 March 2023 Accepted: 28 October 2023
Published online: 10 November 2023

References

Angel L, Kon ZN, Chang SH, Rafeq S, Palasamudram Shekar S, Mitzman B et al (2020) Novel percutaneous tracheostomy for critically ill patients with COVID-19. Ann Thorac Surg 110(3):1006–1011
Beshey BN, Asaad H, Ibrahim E (2014a) Emergency percutaneous tracheotomy in failed intubation. Chest. 145:205A
Beshey BN, Helmy TA, Asaad HS, Ibrahim EM (2014b) Emergency percutaneous tracheotomy in failed intubation. Egypt J Chest Dis Tuberc 63(4):939–945
Beshey BN (2002) Comparative study between conventional surgical tracheostomy and percutaneous dilational tracheostomy in critically ill patients. M.S. Thesis. Alexandria University, Faculty of Medicine
Byhahn C, Lischke V, Halbig S, Scheifler G, Westphal K (2000) Ciaglia blue rhino: a modified technique for percutaneous dilatation tracheostomy. Technique and early clinical results. Anaesthesist 49:202–206
Byhahn C, Westphal K, Zwissler B (2005) Percutaneous tracheostomy: past present and future perspectives. In: Vincent JL (ed) Yearbook of intensive care and emergency medicine. Springer, Berlin, pp 30–38
Ciaglia P, Firsching R, Syniec C (1985) Elective percutaneous dilatational tracheostomy: a new simple bedside procedure: preliminary report. Chest 87:715–719
De Leyn P, Bedert L, Delcroix M, Depuydt P, Lauwers G, Sokolov Y et al (2007) Tracheotomy: clinical review and guidelines. Eur J Cardiothorac Surg 32:412–421
Dennis BM, Eckert MJ, Gunter OL, Morris JA Jr, May AK (2013) Safety of bedside percutaneous tracheostomy in the critically ill: evaluation of more than 3,000 procedures. J Am Coll Surg 216(4):858–867
Field A (2013) Discovering statistics using IBM SPSS statistics, 4th edn. SAGE Publications Ltd, London, California, New Delhi
Freeman BD, Isabella K, Lin N, Buchman TG (2000) A meta-analysis of prospective trials comparing percutaneous and surgical tracheostomy in critically ill patients. Chest 118:1412–1418
Griggs WM, Worthley LIG, Gilligan JE, Thomas PD, Myburg JA (1990) A simple percutaneous tracheostomy technique. Surgery 170:543–545
Hamdy E (2017) Fiberoptic bronchoscopic guided versus ultrasound guided percutaneous tracheotomy in critically ill patients. M.D. thesis. Alexandria University, Faculty of Medicine
Hassanin EG, Elgnady AA, El-Hoshy MS, Beshey BN, Abdelhady AM (2013) Fiberoptic bronchoscopic guidance in percutaneous dilational tracheotomy. Egypt J Chest Dis Tuberc 62(3):519–527
IBM corp. (2012) IBM SPSS statistics for windows, version 21.0. IBM corp., Armonk, NY
Johnson JL, Cheatham ML, Sagraves SG, Block EF, Nelson LD (2001) Percutaneous dilational tracheostomy: a comparison of single versus multiple-dilator techniques. Crit Care Med 29:1251–1254
Kollig E, Heydenreich U, Roetman B, Hopf F, Muhr G (2000) Ultrasound and bronchoscopic controlled percutaneous tracheostomy on trauma ICU. Injury 31:663–668
Kumar A, Kohli A, Kachru N, Bhadoria P, Wadhawan S, Kumar D (2021) Fibreoptic bronchoscope-guided vs mini-surgical technique of percutaneous dilatational tracheostomy in intensive care units. Indian J Crit Care Med 25(11):1269–1274
Lin KT, Kao YS, Chiu CW, Lin CH, Chou CC, Hsieh PY et al (2021) Comparative effectiveness of ultrasound-guided and anatomic landmark percutaneous dilatational tracheostomy: a systematic review and meta-analysis. PLoS One 16(10):e0258972
Mallick A, Venkatanath D, Elliot SC, Hollins T, Nanda Kumar CG (2003) A prospective randomised controlled trial of capnography vs. bronchoscopy for Blue Rhino percutaneous tracheostomy. Anaesthesia 58:864–868
Montgomery D (2001) Chapter 3: experiments with a single factor: the analysis of variance. Design and analysis of experiments. I. John Wiley & Sons
Mukaka MM (2012) A guide to appropriate use of correlation coefficient in medical research. Malawi Med J 24(3):69–71
Paran H, Butnaru G, Hass I, Afanasyv A, Gutman M (2004) Evaluation of a modified percutaneous tracheostomy technique without bronchoscopic guidance. Chest 126:868–871
Pattnaik SK, Ray B, Sinha S (2014) Griggs percutaneous tracheostomy without bronchoscopic guidance is a safe method: a case series of 300 patients in a tertiary care Intensive Care Unit. Indian J Crit Care Med 18:778–782
Pilarczyk K, Haake N, Dudasova M, Huschens B, Wendt D, Demircioglu E et al (2016) Risk factors for bleeding complications after percutaneous dilatational tracheostomy: a ten-year institutional analysis. Anaesth Intens Care 44(2):227–236
Putensen C, Theuerkauf N, Guenther U, Vargas M, Pelosi P (2014) Percutaneous and surgical tracheostomy in critically ill adult patients: a meta-analysis. Crit Care 18:544
Rezende-Neto JB, Oliveira AJ, Neto MP, Botoni FA, Rizoli SB (2011) A technical modification for percutaneous tracheostomy: prospective case series study on one hundred patients. World J Emerg Surg 6:35
Romem A, Gilboa H (2022) Percutaneous tracheostomy in the ICU: a review of the literature and recent updates. Curr Opin Pulm Med 29(1):47–53
Ruxton GD, Beauchamp G (2008) Time for some a priori thinking about post hoc testing. Behav Ecol 19(3):690–693
Şahiner İT, Şahiner Y (2017) Bedside percutaneous dilatational tracheostomy by Griggs technique: A single-center experience. Med Sci Monit: Inter. Med J Experiment Clin Res 23:4684–4688

Sangwan YS, Chasse R (2016) A modified technique for percutaneous dilatational tracheostomy: a retrospective review of 60 cases. J Crit Care 31(1):144–149

Total population of Egypt as of 2021, by governorate (in millions) (online). (Cited 2021 March 28th). Retrieved from https://www.statista.com/statistics/1229759/

Publisher's Note