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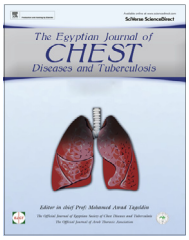

ORIGINAL ARTICLE

Fiberoptic bronchoscopic guidance in percutaneous dilational tracheotomy

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KEYWORDS

Percutaneous dilational tracheotomy;
Critically ill patients;
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Abstract *Objective:* Blind percutaneous dilational tracheotomy (PDT) holds a lot of peri-operative complications. A lot of assisting tools have long been used to facilitate guidance during PDT, e.g., laryngeal mask airway (LMA), ultrasound (US) imaging of the neck, light wand for trans-illumination of the soft tissues of the neck, and flexible fiberoptic bronchoscopy. The aim of this work was to compare between blind and fiberoptic bronchoscopic guided PDT as regards ease of the technique and complications of the procedure.

Design: A randomized prospective comparative trial.

Setting: Critical care department, main Alexandria university hospital.

Patients: Thirty adult patients, requiring elective PDT, and need to maintain a secure airway.

Methods: They were randomly assigned to 2 groups; blind PDT group I and fiberoptic bronchoscopic guided PDT group II. Both groups used Griggs' forceps technique for PDT. Post-operative complications were recorded. End point was 48-h after the procedure.

Results: Number of trials was 1.27 ± 0.46 and 1.00 ± 0.00 for groups I and II, respectively. Success rate was 100% in both groups. Procedural duration (in minutes) was 2.93 ± 1.10 in group I versus 3.93 ± 1.10 in group II. Bleeding was found in 3 patients and 1 patient for groups I and II. Subcutaneous emphysema occurred in one patient in each group, while tube misplacement was recorded in 2 patients in group I and none in group II. Aspiration pneumonia was found in 2 patients in group I and none in group II.

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Conclusion: Use of flexible bronchoscopy has succeeded in decreasing the number of trials of needle insertion and decreasing the incidence of overall complications, while blind technique was better in shortening procedural time and avoidance of hypercapnia.

Introduction

Tracheotomy is nowadays one of the most commonly performed surgical procedures in the critically ill patients [1,2]. Percutaneous dilational tracheotomy (PDT) holds a lot of peri-operative complications like cardiopulmonary arrest, hemorrhage, tube obstruction, or displacement, pneumothorax, pneumo-mediastinum, aspiration, posterior tracheal wall lesion, fracture of tracheal rings, false passage, difficult tube placement, and subcutaneous emphysema [3–7].

A lot of assisting tools have long been used to facilitate guidance during percutaneous tracheotomy and hence reducing the incidence of these peri-operative complications. These include the laryngeal mask airway (LMA), ultrasound (US) imaging of the neck, light wand for trans-illumination of the soft tissues of the neck, and flexible fiberoptic bronchoscopy [8–12].

It seems that there is a long term debate about the benefits and risks of use of the flexible bronchoscope in PDT. The list of pros and cons include the prevention of para-tracheal insertion during PDT, however it may increase the cost and logistic complexity of the procedure. There are some serious complications like hypoxia and reduced minute ventilation causing hypercapnia [13].

For these reasons the idea of using fiberoptic bronchoscopy in PDT will be investigated in this study. Suggestions were made to reduce the risks of bronchoscopic use such as; introducing the bronchoscope intermittently only during certain critical stages of the procedure (e.g., during endotracheal tube withdrawal, needle introduction in the trachea, guide-wire passage, dilator introduction and cannula position control) and by avoiding continuous suction through the bronchoscope [14].

The aim of this work was to compare between blind traditional and fiberoptic bronchoscopic guided percutaneous tracheotomy as regards ease of the technique and complications of the procedure.

Patients and methods

This study was a randomized prospective comparative trial, included 30 adult patients of both genders, requiring elective percutaneous dilatational tracheotomy, selected from ICUs in Alexandria University hospitals. Studied patients were included if they were aged 18 years and more, on prolonged mechanical ventilation, and need to maintain a secure airway.

Patients were excluded for reasons as: uncontrolled bleeding disorders (platelet count less than 50,000, or international normalized ratio more than 2.0, or activated partial thromboplastin time more than 1.5 times the control value), high positive end-expiratory pressure more than 15 cm H_2O, active cutaneous infection over the proposed tracheotomy site, and marked anatomic abnormalities of the trachea or cervical region.

Patients were randomly categorized into two groups (15 patients each) as follows;

1. Group (I); in whom blind PDT was done.
2. Group (II); in whom fiberoptic bronchoscopic guided PDT was done.

Informed consent was taken from first degree relative of every patient. The research was approved from the Ethical Committee of Alexandria faculty of medicine. All selected patients fulfilling the inclusion criteria were subjected to the following on admission: full history, clinical examination, and selective investigations (prothrombin activity, international normalized ratio ''INR'', complete blood count, arterial blood gases analysis and plain chest X-ray before the procedure).

Patients preparation [15] included premedication with sedative, propofol (3 mg/kg)], analgesic, fentanyl (3 μg/kg), and local infiltration of one percent lidocaine. 100% oxygen was applied to the patient for 10–15 min immediately prior to the procedure in order to prevent intra-operative hypoxia.

Percutaneous tracheotomy technique in the blind group (I) was performed through using Portex® Griggs™ Forceps Percutaneous Dilation Tracheotomy Kits (Portex Ltd, Hythe, Kent, UK) with the insertion of a suitable sized tracheotomy tube.

Percutaneous tracheotomy technique in the bronchoscopic group (II) [16] was performed through the Griggs' forceps dilator technique similar to the previous group except : the set PEEP on the ventilator was discontinued [17]. ETT and the tracheal suctioning were done thoroughly by the help of the flexible fiberoptic bronchoscope (Pentax Ltd, U.K.). The choice of site of intended skin incision and then tracheal puncture was helped by the appearance of endoscopic indentation of the anterior tracheal wall on gentle pressure by the finger of the operator and by trans-illumination. ETT withdrawal was done under the visual control of the bronchoscope. All other steps were done by the visual control of the bronchoscope thus avoiding any structural injury.

Post-operative care of tracheotomy [18] included immediate suctioning from the tracheotomy tube (done by the bronchoscope in the bronchoscopic group), Immediate post-operative chest X-ray, Patient's position in bed should be semi setting, Regular suctioning in the first few post-operative days, Humidified oxygen inhalation, and regular wound care.

Measurements and monitoring during and early after the procedure included pulse rate, mean arterial blood pressure, capillary oxygen saturation (using pulse oximetry), ABG, plain chest X-ray, and computed tomography (if needed); both immediately after the procedure and 48 h later. Fiberoptic bronchoscopy through the tracheotomy tube was done 48 h after the procedure.

Post-operative complications were recorded [16] in both groups. They were divided into complications during and early

after the procedure including: cardiopulmonary arrest, conversion to surgical technique, hypoxemia, major bleeding; that caused hypotension, necessitated transfusion of at least 2 units of red cells, led to airway compromise, or required conversion to a surgical procedure to control it, minor bleeding; that was stopped with compression, pneumothorax/pneumo-mediastinum, subcutaneous emphysema, and/or misplacement or false passage into para-tracheal tissues.

Post-operative complications that were followed up 48 h after the procedure include: tube obstruction or displacement, aspiration pneumonia, wound infection, hemorrhage; external or intra-tracheal, over dilatation of the stomal opening, and/or posterior tracheal wall lesion.

Statistical analysis of data

Data were analyzed using SPSS software package version 18.0 (SPSS, Chicago, IL, USA). Quantitative data were expressed using minimum, maximum, mean, standard deviation, median, and IQP while Qualitative data were expressed in frequency and percent. Qualitative data were analyzed using the Fisher exact and Monte Carlo test to compare different groups. Not normally distributed quantitative data were analyzed using the Mann Whitney test for comparing two groups while for more than two groups the Kruskal Wallis test was applied. The level of significance was 5.0%.

Results

Demographic characteristics of the patients (Table 1)

Both studied groups were matched in age, sex, and neck circumference without statistical significant difference in-between.

Main diagnosis (Table 2)

Both studied groups were homogenous in their main diagnosis without statistical significant difference in-between.

Indication of tracheotomy (Table 3)

airway maintenance was found in 5 (33.3%) and 3 (20.0%), while prolonged weaning was found in 10 (66.7%) and 12 (80.0%) for groups I and II, respectively.

Days of intubation before tracheotomy (Table 4)

Days of intubation ranged between 3–17 days and 5–17 days with the mean of 11.20 ± 4.66 and 12.73 ± 3.59 for groups I and II, respectively. There was no statistically significant difference in-between ($P = 0.161$).

Table 2 Comparison between the two studied groups regarding main diagnosis.

Main diagnosis	Group I		Group II	
	No.	%	No.	%
Cerebrovascular stroke	6	40.0	4	26.7
Hepatic coma	1	6.7	0	0.0
Heart failure	1	6.7	0	0.0
Myasthenia Gravis	1	6.7	0	0.0
Road traffic accident	3	20.0	0	0.0
Chronic obstructive pulmonary disease	2	13.3	4	26.7
Interstitial lung fibrosis	0	0.0	1	6.7
Motor neuron disease	0	0.0	1	6.7
Obstructive sleep apnea	1	6.7	2	13.3
Bronchogenic carcinoma	0	0.0	3	20.0

Table 3 Comparison between the two studied groups regarding indication of tracheotomy.

Indication for tracheotomy	Group I		Group II	
	No.	%	No.	%
Airway maintenance	5	33.3	3	20.0
Failed weaning	10	66.7	12	80.0

Table 4 Comparison between the two studied groups regarding days of intubation before tracheotomy.

	Group I	Group II
Duration of ETI		
Range	3–17	5–17
Mean	11.20	12.73
S.D.	4.66	3.59
P	0.161	

Procedure details (Table 5)

Number of trials

Number of trials ranged between 1–2 and 1–1 with the mean of 1.27 ± 0.46 and 1.00 ± 0.00 for groups I and II, respectively. It was statistically higher in group I ($P = 0.016$).

Time of procedure

Time of procedure ranged between 2–5 min and 3–6 min with the mean of 2.93 ± 1.10 and 3.93 ± 1.10 for groups I and II,

Table 1 Comparison between the two studied groups regarding age, sex, and neck circumference.

	Age		Sex		Neck circumference(in cm)	
	Group I	Group II	Group I	Group II	Group I	Group II
Min	19	45	M 7 (46.67%)	M 9 (60.0%)	40	40
Max	88	79			50	48
Mean	53.47	58.67	F 8 (53.33%)	F 6 (40.0%)	44.87	43.73
S.D.	18.18	9.54			2.77	2.43
P	0.168		0.35		0.122	

Table 5 Comparison between the two studied groups regarding procedural details.

	Group I	Group II	*P*
Number of trials			
Range	1–2	1–1	0.016*
Mean	1.27	1.00	
S.D.	0.46	0.00	
Time of procedure (in minutes)			
Range	2–5	3–6	0.009*
Mean	2.93	3.93	
S.D.	1.10	1.10	
Success in tube placement			
Yes	15 (100.0%)	15 (100.0%)	–
No	0 (0.00%)	0 (0.00%)	

* Significant.

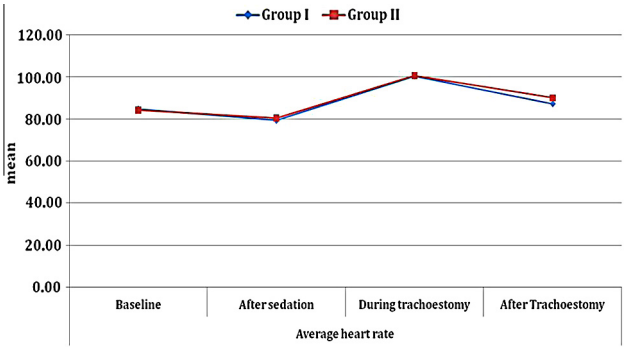

Fig. 1 Comparison between the two studied groups regarding heart rate.

respectively. Group II had statistically longer time than group I ($P = 0.009$).

Success in tube placement

Success in tracheotomy tube placement was found in 100% of patients in both groups.

Heart rate changes (Fig. 1)

In group I, the mean heart rate was 84.87 ± 16.47, 79.47 ± 15.81, 100.47 ± 16.66, and 87.33 ± 13.39 at baseline, after sedation, during and after tracheotomy, respectively. In group II, the mean heart rate was 84.27 ± 13.67, 80.53 ± 11.58, 100.67 ± 11.31, and 90.07 ± 12.21 at baseline, after sedation, during and after tracheotomy, respectively.

Although, heart rate significantly increased during the procedure in both groups, there was no statistical significant difference between both of them regarding heart rate at different times ($P = 0.267$, 0.411, 0.478, and 0.326, respectively).

Mean arterial blood pressure (MABP) changes (Fig. 2)

In group I, MABP was 61.20 ± 7.69, 59.33 ± 6.54, 67.40 ± 7.62, and 62.13 ± 6.61 at baseline, after sedation, during and after tracheotomy, respectively. In group II, MABP was 59.47 ± 5.91, 57.87 ± 6.24, 65.20 ± 6.39, and 62.00 ± 5.36 at baseline, after sedation, during and after tracheotomy, respectively.

Although, MABP significantly increased during the procedure in both groups, there was no statistically significant difference between both of them regarding MABP at different times ($P = 0.247$, 0.268, 0.200, and 0.476, respectively).

Blood gas effects

Oxygen saturation (SaO2) (Fig. 3)

In group I, the mean SaO_2 was 98.33 ± 0.82, 97.47 ± 0.92, 94.80 ± 1.86, and 96.87 ± 1.36 at the baseline, after sedation, during and after tracheotomy, respectively. In group II, the mean SaO_2 was 98.00 ± 1.36, 96.80 ± 1.57, 93.40 ± 1.68, and 97.13 ± 1.41 at the baseline, after sedation, during and after tracheotomy, respectively.

Although, oxygen saturation significantly decreased after sedation and during the procedure in both groups, there was no statistically significant difference between both of them regarding oxygen saturation at different times ($P = 0.212$, 0.083, 0.068, and 0.301, respectively).

Partial arterial carbon dioxide tension ($PaCO_2$) (Fig. 4)

In group I, the mean $PaCO_2$ was 38.53 ± 4.22 and 39.13 ± 4.32 at baseline and after tracheotomy, respectively. In group II, the mean $PaCO_2$ was 43.93 ± 7.57 and 44.67 ± 7.45 at baseline and after tracheotomy, respectively.

It is of notice that group II $PaCO_2$ values were significantly higher than group I values ($P = 0.011$ and 0.010, respectively).

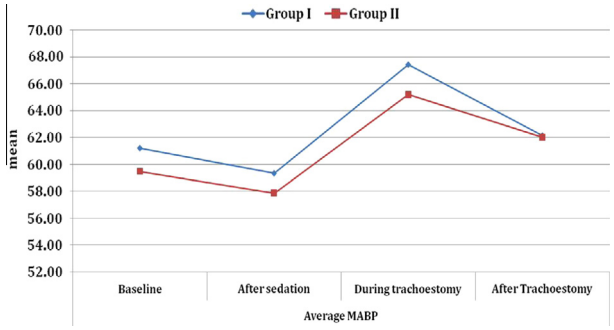

Fig. 2 Comparison between the two studied groups regarding MABP.

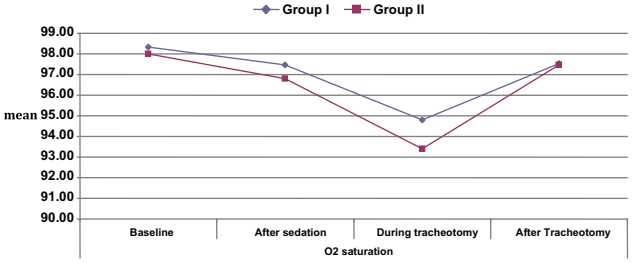

Fig. 3 Comparison between the two studied groups regarding SaO_2.

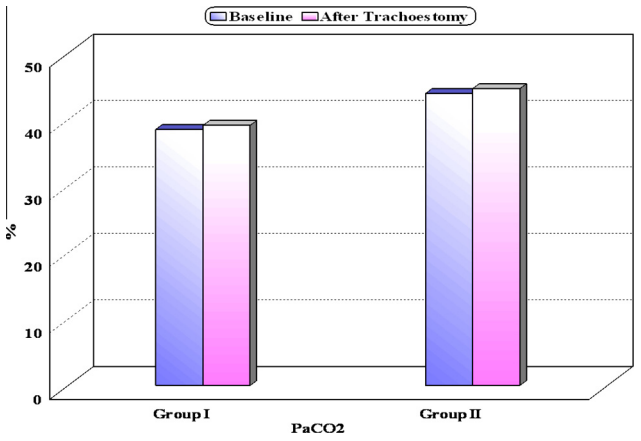

Fig. 4 Comparison between the two studied groups regarding $PaCO_2$.

Complications (Table 6)

Bleeding was found in 3 patients (20.0%) and 1 patient (6.7%) for groups I and II, there was statistically significant difference in-between ($P = 0.034$). Wound infection was found in 2 patients (13.3%) in group I and none in group II, there was statistically significant difference in-between ($P = 0.041$).

Subcutaneous emphysema occurred in one patient in each group (6.7%), while neither pneumothorax nor pneumo-mediastinum was encountered in any of the patients of both groups.

Misplacement was found in 2 patients (13.3%) in group I and none in group II, there was statistically significant difference between them ($P = 0.041$). Tracheal wall affection was found in 1 patient (6.7%) and none for groups I and II, respectively, there was no statistically significant difference in-between ($P = 0.578$).

Aspiration pneumonia was found in 2 patients (13.3%) in group I and none in group II, there was statistically significant difference between them ($P = 0.041$). Neither cardiopulmonary arrest nor hypoxemia occurred at any time during the procedure.

Discussion

Percutaneous dilatational tracheotomy (PDT) has gained popularity since its introduction to work in 1985 by Ciaglia et al. [1]. The blind technique has significant potential complications in addition to relative and absolute contraindications. [19–21] A lot of research work has been accomplished, comparing the blind technique with other techniques using adjunct tools like ultrasound (US) [11,22–25], or Light wand (LW) [26–28].

Blind location of site for tracheotomy tube insertion is unreliable even in patients with clear anatomic landmarks. The incidence of cranial misplacement in "blind" PDT is relatively high. Significant tracheal stenosis remains the most serious late complication of PDT, probably due to high tracheal (above the first tracheal ring) placement of the tracheotomy tube (cranial misplacement). In the two recently published studies by Van Heurn et al. [5], and Walz and Schmidt [7] on autopsy material the authors found cranial misplacement in approximately 17% of patients. On the basis of personal experience, Walz and Schmidt recommended obligatory identification of cricoids cartilage before starting the procedure, and claim that without clear recognition of this important landmark PDT is contraindicated [7].

In the same way, Sirak Petros [29] in 1999 reported that the discussion on the routine use of bronchoscopy during PDT is not yet settled. However, it is indispensable for training purposes and during PDT on patients with difficult anatomy. Moreover, a bronchoscope must be at hand during PDT in case an emergency situation arises.

Bronchoscopy may provide certain benefits, such as confirmation of needle placement, dilatation and tube placement. In 2000, Kollig et al. [24] published a comparative study between ultrasound and bronchoscopic controlled percutaneous tracheotomy and they found no studies, till that time, had examined whether the addition of bronchoscopy leads to a decrease in procedural complications. On the other hand, several reports on the use of bronchoscopy raised concern about potentially unwanted side effects like raised intracranial pressure due to increase in partial carbon dioxide tension [30] and the decreased partial oxygen tension [31].

The two most commonly quoted studies advocating the use of endoscopy are those reported by Barba et al. [14] and Marelli et al. [32]. These studies were not designed to assess the impact of bronchoscopy, because all PDT patients underwent endoscopy. Despite this, general use of bronchoscopy was still recommended.

For these reasons, a comparison between blind and flexible bronchoscopic guided procedures was done in a randomized controlled trial involving two groups of patients who were comparable in age and sex. The lower limit for age was 15 years. This is in accordance with other studies in the literature in which Fowler et al. [33] excluded those under 15 years of age from their study due to the high rate of complications secondary to weaker cartilage, higher trachea and higher dome of pleura.

Olubukola et al. [34] found that neck circumference is significantly correlated with indices of adiposity and can reliably identify children with high BMI. Another study reported the

Table 6 Comparison between the two studied groups regarding the incidence of complications.

Type of complication	Group I		Group II		*P*
	No.	%	No.	%	
Bleeding	3	20.0	1	6.7	0.034
Wound Infection	2	13.3	0	0.0	0.041
Pneumothorax &/or pneumo-mediastinum	0	0.0	0	0.0	–
Subcutaneous emphysema	1	6.7	1	6.7	0.759
Tube misplacement	2	13.3	0	0.0	0.041
Tracheal wall affection	1	6.7	0	0.0	0.578
Aspiration pneumonia	2	13.3	0	6.7	0.041

importance of increased neck circumference to intubation difficulties in obese patients [35]. Others found it as a simple screening measure for identifying overweight and obese patients [36]. And so, it was used in the current study as an indicator for neck obesity without statistically significant difference between both groups.

In the present study, cerebrovascular stroke was the most common primary diagnosis in both groups of patients, being as common as chronic obstructive pulmonary disease in group II and followed by road traffic accident in group I. This was due to the old age of the patients and the high incidence of road traffic accidents. Friedman et al. [37] reported road traffic accident as the most common diagnosis in his study on PDT. On the other hand, Hazzard et al. [38] reported that acute on top of chronic respiratory failure was the most common diagnosis for PDT. Bayhahn et al. [39] reported no significant difference as regards diagnosis.

Prolonged mechanical ventilation was the most common indication for PDT in the present study followed by need for airway maintenance. Dulguerov et al. [40] reported prolonged intubation and mechanical ventilation as the main indications for PDT.

In the same way, the mean duration of endotracheal tube was comparable in both groups. It was 11.20 days for the blind group and 12.73 days for the bronchoscopic group. Ambesh et al. [15] reported 8 days for the Griggs' method group while Fikkers et al. [41] reported 16.9 days and Añón et al. [42] reported 17.3 days for the same method. The average duration of translaryngeal intubation before tracheotomy ranged from 9 to 17 days as reported in many studies [43–45]. Porter and Ivatruy [46] performed PDT after a mean time of 10.8 days of endotracheal intubation. Crofts et al. [47] performed PDT after 12.5 days while it was 7 days for Holdgaard et al. [48].

Number of trials of needle insertion was significantly lower in the bronchoscopic (1 trial) than the blind (1.27 trials) group. This may be due to the use of a flexible bronchoscope which can give direct visualization of the selected site before needle insertion. By reviewing most of the related literature, no comment on this issue could be found while it is a suggested important factor as it may contribute in the reduction of frequency of occurrence of some complications such as bleeding, subcutaneous emphysema, and pneumothorax.

There was statistically significant difference between the 2 groups as regards procedural time which was defined as the time from needle insertion to successful placement of the cannula. In the blind group, the mean time was 2.93 ± 1.10 min while in the bronchoscopic group the mean was 3.93 ± 1.10 min. In the literature, PDT required 21.5 ± 4.90 min [49]. In comparison, Fikkers et al. [41] reported 9.1 ± 8.3 min for the blind Grigg's technique while Añón et al. [42] reported 17.3 ± 1.9 min for the bronchoscopic technique, Ambesh et al. [15] reported 6.5 min. Variability in time between the present study and the previous studies is attributed to different experience gained by the workers from performing more tracheotomies.

Heart rate and MABP values were elevated in comparison to the pre-tracheotomy values in both groups. These changes were of short duration and returned to near baseline immediately after the procedure was completed in the two groups. This happened despite that all patients received sedation and local analgesia. This could be due to severe stress initiated by dilation using initial dilator and forceps that was not ameliorated by local analgesia and sedation. But there was no statistical significance between the two groups as regards heart rate and MABP.

For the blind technique, Fikkers [41] found the incidence of hypotension to be 0.6% while Añón et al. [42] reported 2.6%. These results should be taken with some caution recognizing the marked difference in the number of patients recruited in each study being 171 in the former study and 38 in the latter one.

For the bronchoscopic technique, Romero et al. [16] reported the occurrence of hypotension in one of their eighty non-obese patients (1.25%), while Ambesh et al. [15] did not encounter any cases of hemodynamic instability in his Griggs' method patients. None of the previously mentioned studies reported cardiac arrhythmias as a resulted complication with Griggs' dilating forceps tracheotomy in their work whether blindly or endoscopically.

The oxygen saturation in this study decreased with a statistical significance after sedation and during tracheotomy in both groups, however it was of no clinical significance without dangerous hypoxemia and with return to near baseline after the completion of the procedure.

On comparison between both groups, there was no statistically significant difference as regards the oxygen saturation values at different times of the whole procedure. Oxygen in a concentration of 100% was applied to all patients for 10–15 min immediately preoperatively to prevent the intraoperative desaturation. Postoperatively, 100% oxygen was again applied for 10–15 min for all patients. Besides, less dead space and better pulmonary toilet through tracheotomy tube contributed to significant improvement in oxygen saturation. Griggs et al. [2] experienced intra-operative decrease in the mean oxygen saturation with statistical difference with preoperative values. Postoperatively, there was an increase in oxygen saturation. Waldron et al. [50] experienced nearly the same findings.

Partial arterial CO_2 tension was significantly higher in the bronchoscopic group compared to the blind one after the procedure. One of the possible explanations is that the difference may be attributed to a bias caused by basically higher $PaCO_2$ in the bronchoscopic group as a result of the common incidence of type II respiratory failure in this group (chronic obstructive pulmonary disease in 26.7%, bronchogenic carcinoma in 20% and obesity hypoventilation syndrome in 13.3%, besides, interstitial lung disease and motor neuron disease each in 6.7% of the cases). However, Reilly et al. [30] reported the occurrence of hypercarbia with bronchoscopic percutaneous tracheotomy, the finding that was denied by Ambesh et al. [15].

Regarding complications during procedure; bleeding occurred in 3 patients (20.0%) in the blind group versus one patient (6.7%) in the bronchoscopic group. In all cases bleeding was minor and required no more than brief compression with statistically significant difference between both groups. Dulguerov et al. [40] experienced 143 cases of bleeding out of 1871 (7.8%). Friedman et al. [37] experienced minor bleeding in 13%. Romero et al. [16] encountered bleeding in 4/80 cases (5%) under endoscopic guidance. Ambesh et al. [15] graded bleeding in 5 patients out of their 50 patients (that were subjected to flexible bronchoscopic guided Griggs' technique) as grade III (blood loss 11–50 ml).These variable results may be attributed to the unavailability of a standard classification of the amount of bleeding, making the issue judged by personal experience.

Misplacement of the tracheotomy tube by false passage into para-tracheal tissues was encountered in 2 cases (13.3%) in the blind group and none in the bronchoscopic group. Añón et al. [42] encountered false passage in 1/38 cases (2.6%) without bronchoscopic guidance.

In only one patient in the blind group, the stomal opening was over dilated due to repeated dilatation because of difficult cannulation after the first attempt of dilatation. Ambesh et al. [15] reported 7/30 cases of over dilatation. Nates et al. [51] had postulated that excessive bleeding and other surgical complications of the Griggs forceps technique are caused by uncontrolled dilation of the trachea.

None of the cases in both groups was presented with posterior tracheal wall affection as confirmed postoperatively through direct visualization by flexible bronchoscopy. Louis et al. [52] reported a case of a tracheo-esophageal fistula discovered after the removal of the cannula 23 days after tracheotomy. During the procedure, difficulties occurred during the insertion of the cannula. And he added that this case report highlights the importance of a perioperative continuous endoscopic guidance and the need for rigorous learning.

Pneumothorax and pneumo-mediastinum were not encountered in any of the patients of the blind group as confirmed clinically and radiographically after PDT. This is in accordance with that reported by Ambesh et al. [15].

Studies of non-endoscopically guided PDT have shown the incidence of pneumothorax, pneumo-mediastinum, and paratracheal tube insertion to be up to 12% compared to studies of bronchoscopically guided PDT, which have not shown these complications [53].

In the current study subcutaneous emphysema occurred in one patient of each group (6.7%). This is probably due to tight stoma opening in the subcutaneous tissues and skin about the tracheotomy tube causing a ball-valve effect and excessive coughing (75,133). This emphysema was confined to the neck. It presented within the first day and was self-limiting by the seventh day with the help of intermittent use of 100% O2. Ambesh et al. [15] reported that 3/30 cases (10%) developed subcutaneous emphysema after Griggs' percutaneous tracheotomy under flexible bronchoscopic guidance. For the blind Griggs' technique, Fikkers et al. [54] found the incidence of subcutaneous emphysema to be 1.2% while Añón et al. [42] found it to be 2.6%.

Wound infection was encountered in two patients (13.3%) in the blind group and in none of the bronchoscopic groups. For the blind technique, Fikkers et al. [54] reported wound infection in 2.4% of cases while Añón et al. [42] did not report any cases of wound infection. For the bronchoscopic one, Ambesh et al. [15] encountered this complication in 2/30 of cases (6.7%). Highly variable size of the sample in each study is suggested to be the only possible explanation for these contradictory results. Wound infection may be attributed to traumas from repeated punctures and associated bleeding producing more local inflammatory reaction which may invite infection later on.

Aspiration pneumonia after the procedure was diagnosed in two cases of the blind group (13.3%) in comparison to none in the bronchoscopic group. Ambesh et al. [15] found no evidence of new parenchymal infection or aspiration.

Neither cardiopulmonary arrest nor hypoxemia had occurred at any time during the procedure. Fikkers et al. [54] found hypoxemia in 2/132 (15.6%) of patients. He also experienced cardiopulmonary arrest in 2 patients (15.6%). The first one had an obstruction of the cannula by a mucous plug. The second one arrested shortly after decannulation, possibly due to aspiration.

Clearly the small size of this study limits its power to detect complications and larger studies are necessary. Dulguerov et al. [40] was the first to use a large scale of patients to prospectively study all the complications and detect even the rarest of them, where he worked on 5329 patients.

Also, one of the limitations of this research is the short-term follow up. The late postoperative complications were very difficult to study, as tracheotomy is most commonly performed in critically ill patients, many of whom do not survive, and so, we still do not know the real long-term complication rates of tracheotomy itself; notably tracheal and subglottic stenosis, as well as tracheomalacia. Another obstacle is the presence of the confounding factor in assessing these complications that may be also caused by prolonged trans-laryngeal intubation done before tracheotomy and was proved by post-mortem examination in different studies [5,7].

Conclusion

From all the work previously mentioned we can conclude that PDT when placed in the hands of experienced personnel and applied in its correct indications is a safe and effective procedure. Use of flexible bronchoscopy has succeeded in decreasing the number of trials of needle insertion and decreasing the incidence of overall complications, while the blind technique was better in shortening procedural time and the avoidance of hypercapnia. Although blood gas and hemodynamic changes are common during tracheotomy, they have short term effects without clinically significant events. Usually, they need no more than close monitoring and follow up.

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