Biolife 5(2):201-206
AN INTERNATIONAL QUARTERLY JOURNAL OF BIOLOGY & LIFE SCIENCES
ISSN (online): 2320-4257
www.biolifejournal.com
BIOLIFE RESEARCH ARTICLE

Fiberoptic bronchoscopic guided versus ultrasound guided percutaneous tracheotomy in critically ill patients

Tamer Helmy[1], Bassem Beshey[2], Mohamed Megahed[3], Emad Hamdy[4]

[1] *Professor of Critical Care medicine, Faculty of medicine, Alexandria University, Alexandria, Egypt*
[2-3] *Assistant professor of Critical Care medicine, Alexandria University, Alexandria, Egypt*
[4] *Assistant lecturer of Critical Care medicine, Alexandria University, Alexandria, Egypt*

Email: : doctor.islam.ahmed@gmail.com

ABSTRACT

A lot of assisting tools have been used as guidance during percutaneous dilational tracheotomy PDT, we compared fiberoptic bronchoscopic guided versus ultrasound US guided PDT and using both techniques together as regards ease of the technique and complications of the procedure. Design: A randomized prospective study. Setting: Critical care department, main Alexandria university hospital. 75 critically ill patients, requiring elective PDT. Patients were assigned to 3 groups; fiberoptic bronchoscopic PDT (Group I), US guided PDT (Group II) and using both techniques (Group III). All groups used the Ciaglia technique for PDT. Duration of the procedures and perioperative complications were recorded. In group I, total time was 6.15 ± 1.48 minutes while in group II was 6.99 ±1.55 minutes and it was 13.78 ± 2.34 minutes in group III. Hypoxia was found in 4 patients in group I versus 1 and 3 patients in group II and III respectively. Bleeding occurred in 3 patients in group I, 1 patient in group II and 2 patients in group III. US and bronchoscopic-guided PDT are associated with similar complication rate and clinical outcome but using both techniques together may increase the duration of the procedure without additive value.

Keywords: Percutaneous tracheotomy, PDT, Hypoxia, bronchoscopic, Ciaglia technique

INTRODUCTION

Percutaneous dilational tracheostomy (PDT) is commonly performed in the intensive care unit (ICU)[(1)] Although low rate of complication of the procedure, serious adverse events are still observed[(2)] hence it was the need for guidance using bronchoscope or US.

Bronchoscope can be used in trans illumination to localize the site of the puncture, confirm the needle position,prevent injury to the posterior tracheal wall ,dilate the tracheal stoma under visual control and confirm the position of the tracheotomy tube.[(3)] However, the bronchoscope cannot identify the superficial structures such as the thyroid gland and vascular structures in the neck region and thus cannot prevent complications related to these structures (punctured vessels or a punctured thyroid.

US may be of value in visualization of the superficial structures and subsequently preventing such complications[(4)], US has the ability to determine the tube size and length selection[(5)],identify the most appropriate site of the tracheal puncture, and insert the needle into the trachea, similar to the technique used in US-guided vascular puncture. In1999, the first real-time US-guided PDT was described followed by the publication of several reports, including a systematic review.[(4,6)]

Accordingly, aim of this work was to assess the possible additive role of Using neck mapping to allocate the superficial structures before puncturing the anterior trachea wall and completion of the procedure with the assistance of fiberoptic bronchoscope trying to minimize the serious complications.

How to Site This Article:
Tamer Helmy, Bassem Beshey, Mohamed Megahed, Emad Hamdy (2017). Fiberoptic bronchoscopic guided versus ultrasound guided percutaneous tracheotomy in critically ill patients. *Biolife*. 5(2), pp 201-206
doi:10.17812/blj.2017.5209
Received: 24 February 2017; Accepted: 12 April, 2017; Published online: 11 May 2017

PATIENTS AND METHODS

Seventy-five adult patients who were selected from those indicated for elective percutaneous tracheotomy from those admitted to critical care medicine department in Alexandria University hospitals.

Sample size calculation was done using Epi-save software to conduct this study as regards duration of the technique, success rate and complications of the procedure.it was estimated to detect change of the procedure duration by 1 minute from 3.93±1.1 minutes. Which was used as an indicator for the ease of the procedure?

With an assumption the of 95% confidence level and 80% power of study.

Pregnant patients, those younger than 18 years old and any patients who had contraindication of PDT or bronchoscopy were excluded from the study.

An informed consent was taken from each patient or his first of kin. The protocol was approved by the local ethical committee of Alexandria faculty of medicine.

Then the Patients were categorized into three groups (25 patients each):

Group 1: performing fiberoptic bronchoscopic guided percutaneous tracheotomy.

Group2: performing ultrasound guided percutaneous tracheotomy.

Group3: performing combination of both ultrasound and bronchoscopic guided percutaneous tracheotomy.

In all patients, percutaneous tracheotomy was performed using the Ciaglia technique utilizing a percutaneous tracheotomy introducer set (C-PTIS-100-HC, BLUERHINO, COOK, USA)® by the following steps[7]:

- Application of 100% oxygen to the patient for 10-15 minutes was done immediately prior to the procedure in order to prevent intraoperative hypoxia whether during the procedure or bronchoscopy.
- One cm transverse incision in the midline was made between the first and second or second and third, tracheal rings.
- The tip of the ETT was retracted just below the vocal cords.
- A 15 G puncture needle with a saline-filled syringe was introduced perpendicularly tothe skin and advanced until the needle was seen to pass the anterior trachea wall during an aspiration of air.
- The guide wire was introduced; the needle will be removed.
- The 14Fr dilator was used to generate the initial stoma followed by the single-stage curve dilator over the guide wire.
- An 8-mm tracheotomy tube will be placed over a 24 French lubricated dilator for tracheal insertion.

In group 1: a flexible video bronchoscopy STORZ (KARL STORZ-ENDOSKOPE) produced by KARL STORZ Gmbh & Co. KG Germany, 2007 was used by the co-operator to:

1. Withdrawal of the ETT under visual control of the bronchoscope and so impalement of the ETT didn't occur.
2. Transillumination was used to choose the site of intended skin incision.
3. Then tracheal puncture was helped by appearance of endoscopic indentation of anterior tracheal wall on gentle pressure by finger of the operator.
4. All later steps were done also under visual guidance of the bronchoscope so that avoiding any structural injury.

In group 2: Prior to PDT, US (MINDRAY, SHENZEN, china, 2012) was used by the co-operator to.

1. Perform longitudinal sections to identify the cricoid cartilage, the tracheal rings, and the site of the puncture.
2. Then perform transversal sections to allocate the arteries, veins, thyroid, trachea, and endotracheal tube and measure the depth of the anterior tracheal wall from the skin.
3. Then visualize the needle in an 'out-of-plane' mode (that is, the needle path will be determined by the presence of a distinct acoustic shadow ahead of the needle) on a transversal section of the neck region.

In group 3: PDT was done with the guidance of both US and bronchoscope.

1. US was done first to assess the neck anatomy as in group 2
2. Then PDT was performed later with the guidance of bronchoscope as in group1.

I. Post-operative care of tracheotomy[8]

- The bronchoscope was inserted through the tracheotomy tube to confirm tracheal placement and asses the occurrence of complication.
- Immediate post-operative chest X-ray, to ascertain the length and position of the tracheotomy tube and to rule out complications such as pneumothorax and pneumomediastinum. This was repeated after 48 hour or computed tomography (if needed) was done if complication was suspected.

II. The following measurements were recorded to every patient:

1. Clinical measurements.

Vital sign and oxygen saturation were measured continuously, throughout the procedure till 30 minutes' post-operative.

2. Durations of the procedure.

- Two durations were measured for all the patients:
  a) **Time I (insertion time):** which was the time (in minutes) from the skin incision till the insertion of the tracheotomy tube.
  b) **Time II (total time):** which was the time (in minutes) starting after kit preparation till the insertion of the tracheotomy tube.

3. Success rate including

a) Number of failures to accomplish the procedure.
b) Number of punctures per procedure.

4. Complications[9]

A. Perioperative Complications include

- Cardiopulmonary arrest.
- Conversion to surgical technique: the need to abandon the PDT procedure and use a surgical approach either in the ICU or in the operating room.
- Hypoxemia: a drop in oxygen saturation to less than 90% at any time during the procedure.
- Bleeding.
  - Major bleeding: bleeding can cause hypotension, necessitates transfusion of at least 2 units of red cells, leads to airway compromise, or need conversion to a surgical procedure to stop it.
  - Minor bleeding: bleeding that can be stopped with compression or other hemostatic maneuvers and does not cause hemodynamic instability, does not necessitate a transfusion of red cells, and does not require surgery.
- Posterior tracheal wall injury.
- Pneumothorax/pneumomediastinum:
- Misplacement or false passage into paratracheal tissues.
- Overdilatation of the stomal opening.

Endpoint of the study was 30 minutes after completion of the procedure.

RESULTS

In this study there was no significant difference between the three groups as regards demographic data or indication (table-1).

As regards the duration group III had longer total duration than group I and II with statistically significance difference P<0.001 but the insertion time had no statistically significance difference (table-2).

It was found that there was no significant difference between the three groups as regards complication during the procedure either major or minor (table-3).

DISCUSSION

By reviewing the literatures, we did found multiple researches focusing on the importance of performing percutaneous dilatational tracheostomy with guidance to minimize possible serious complications. [10-12]

On the other hand, several reports on the use of bronchoscopy raised concern about potential unwanted side effects like raised intracranial pressure due to increase in partial carbon dioxide tension[13]and the decreased partial oxygen tension.[14]

recently, technical progress and low invasiveness have meant that (US) is increasingly used as a tool to aid PDT by allowing visualization of the airway anatomy with clear delineation of the thyroid, cricoid and tracheal cartilages. This enable entry at the chosen level in the trachea. Subsequently, confirming the level of guide wire entry on the long axis view by counting downwards from the cricoid cartilage.

Gobatto AL et al [15] reported that using US as a guide for performing PDT may be safely and effectively if used by skilled ICU physicians. Also Chacko J et al[16] also reported that real time us guided PDT enable precise insertion of the introducer needle at the desired level of the trachea, in median position. US guidance may be equally safe even without bronchoscopic guidance.

For these reasons, a comparison between ultrasound guided PDT, bronchoscopic guided, and using both techniques together was done in a randomized controlled trial involving three groups of patients who were comparable in age & sex.

No significant difference between the three groups as regards number of punctures was found, most of the cases

Table-1. Comparison between the three studied groups according to patient criteria

	Group I (n=25)	Group II (n=25)	Group III (n=25)	p
Sex				
Male	16 (64%)	14 (56%)	12 (48%)	**0.522**
Female	9 (36%)	11 (44%)	13 (52%)	
Age (years)	52.04 ± 15.15	50.0 ± 14.94	55.24 ± 13.15	**0.437**
Indication				
Ischemic stroke	7 (28%)	9 (36%)	5 (20%)	**0.821**
TBI	6 (24%)	4 (16%)	8 (32%)	
Respiratory failure	4 (16%)	4 (16%)	3 (12%)	
ICHge	3 (12%)	2 (8%)	5 (20%)	
Maxillofacial injury	1 (4%)	0 (0%)	1 (4%)	
Post arrest	4 (16%)	6 (24%)	3 (12%)	

Qualitative data were described using number and percent and was compared using Chi square or Monte Carlo. Quantitative data was expressed as Mean ± SD and compared using F- ANOVA test. ICHge: Intracerebral Hemorrhage. TBI: Traumatic brain injury.

Table-2. Comparison between the three studied groups according to different parameters

	Group I (n=25)	Group II (n=25)	Group III (n=25)	p
Number of puncture				
1	24 (96%)	22 (88%)	24 (96%)	
2	1 (4%)	1 (4%)	1 (4%)	**0.668**
3	0 (0%)	2 (8 %)	0 (0%)	
Insertion time	4.32 ± 1.18	4.79 ± 1.33	4.86 ± 0.97	**0.221**
Total time	6.15 ± 1.48	6.99 ±1.55	13.78[@$] ± 2.4	**<0.001[*]**

Qualitative data were described using number and percent and was compared using Chi square or Monte Carlo. Quantitative data was expressed as Mean ± SD and compared using F- ANOVA test.
**: Statistically significant at p ≤ 0.05; @: Statistically significant with group I; $: Statistically significant with group II*

Table-3. Comparison between the three studied groups according to complications

	Group I (n=25)	Group II (n=25)	Group III (n=25)	p
Hypoxemia	4 (16%)	1 (4%)	3 (12%)	**0.522**
Minor bleeding	3 (12%)	1 (4%)	2 (8%)	**0.865**
False passage	0 (0%)	1 (4%)	0 (0%)	**1.000**
Pneumothorax	0 (0%)	1 (4%)	0 (0%)	**1.000**

Qualitative data were described using number and percent and was compared using Chi square or Monte.

were done using single puncture but only one case in each group (4%) needed two punctures and 2 cases (8%) in US group needed three punctures. This may be due to using flexible bronchoscopy can trans illuminate the chosen site before needle insertion. Chacko J et al[16] also reported no statistically significance between US and bronchoscopic groups as regard numbers of punctures.

As regards the insertion time, no significant difference was found between the three groups however the total time is markedly prolonged in group III; this was expected because of using US first for assessment of the neck anatomy before starting PDT with bronchoscopic guidance.

In group I, total time was 6.15 ± 1.48minutes while in group II the mean was 6.99 ±1.55minutes and it was 13.78 ± 2.34 minutes in group III. By reviewing the literatures, Ambesh et al[7]reported 6.5 minutes in blind PDT, bronchoscopic guided PDT required 21.5±4.90 minutes.[17] In comparison, Añón et al[18] reported 17.3±1.9 minutes for bronchoscopic PDT, while, Sustić and colleagues[19] reported that the average time required to perform US-PDT was 8 minutes. Variability in time between the present study and the previous ones may be due to different experiences gained by the operators from doing more tracheostomies. In our department total number of patients in need for intubation was 1160 per year, 10% of them were candidate for tracheostomy, airway management working team in our department is dedicated to perform this work. also it was reported that blind tracheostomy using Griggs techniques was performed in 1.46±0.31minutes during emergency situation in failed airway[20]. The short time of performing the procedure is important in patients with unstable oxygen saturation.

Chacko J et al[16] reported that the total procedural time was significantly shorter in the US only group but as regard needle to wire time it was no significant difference between the groups. In comparison, Ravi PR et al[21] reported a longer duration in the bronchoscopic technique.

On comparison between the three 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 minutes immediately preoperatively to prevent the intraoperative desaturation especially in those prone to rapid desaturation such as respiratory failure and severe chest infection patients. Postoperatively, 100% oxygen was again applied for 10-15 minutes for all patients. Ravi PR et al[21] experienced no statistically significant difference between US and bronchoscopic groups as regard desaturation during the procedure.

This is against what reported in CHACKO J. et al[16] that hypoxic episode was significantly less frequently in the ultrasound-only group this may be due to large diameter of the bronchoscope used in their study and the long time needed to accomplish the procedure. No episodes of hypercapnia were recorded in our study.

Bleeding occurred in 3 patients (12%) in bronchoscopic group versus one patient (4%) in US group versus 2 patients (8%) in group III. In all cases bleeding was negligible and required only than good suctioning or brief compression with no statistically significant difference between the groups. Gobatto AL et al[15] experienced minor bleeding in 6.7% in US group versus 8.6% in bronchoscopic group. J. CHACKO et al[16] also documented that no significance difference between both groups as regards bleeding either during or after the procedure.

Gobatto ALN et al[22] also experienced no difference between US and bronchoscopic groups as regard either major or minor bleeding. These variable results may be due to unavailability of a standard categorization of amount of bleeding, making the matter judged by personal experience.

Misplacement of the tracheostomy tube by false passage into paratracheal tissues was encountered in only one case (4%) in US group and non in other groups, which lead subsequently to pneumothorax, it was resolved simply by intercostal tube insertion which was removed within two days.

CONCLUSION

US-guided PDT and bronchoscopic-guided PDT are effective, safe and associated with similar complication rate and clinical outcome but using both techniques together as guide for PDT may increase the duration of the procedure without any effect on the complications and clinical outcome.

Conflict of Interests

Authors declare that there is no conflict of interests regarding the publication of this paper.

References

[1]. Freeman BD, Morris PE. Tracheostomy practice in adults with acute respiratory failure. Crit Care Med. 2012;40(10):2890-6.

[2]. Dennis BM, Eckert MJ, Gunter OL, Morris JA, Jr., May AK. Safety of bedside percutaneous tracheostomy in the critically ill: evaluation of more than 3,000 procedures. Journal of the American College of Surgeons. 2013;216(4):858-65; discussion 65-7.

[3]. Kost KM. Endoscopic percutaneous dilatational tracheotomy: a prospective evaluation of 500 consecutive cases. Laryngoscope. 2005;115(10 Pt 2):1-30.

[4]. Ultrasound-guided percutaneous dilational tracheostomy versus bronchoscopy-guided percutaneous dilational tracheostomy in critically ill patients (TRACHUS): a randomized noninferiority controlled trial. Intensive Care Medicine. 2016;42(3):342-51.

[5]. Hardee PS, Ng SY, Cashman M. Ultrasound imaging in the preoperative estimation of the size of tracheostomy tube required in specialised operations in children. The British journal of oral & maxillofacial surgery. 2003;41(5):312-6.

[6]. Mitra S, Kapoor D, Srivastava M, Sandhu H. Real-time ultrasound guided percutaneous dilatational tracheostomy in critically ill patients: A step towards safety! Indian Journal of Critical Care Medicine : Peer-reviewed, Official Publication of Indian Society of Critical Care Medicine. 2013;17(6):367-9.

[7]. Ambesh SP, Pandey CK, Srivastava S, Agarwal A, Singh DK. Percutaneous tracheostomy with single dilatation technique: a prospective, randomized comparison of Ciaglia blue rhino versus Griggs' guidewire dilating forceps. Anesth Analg. 2002;95(6):1739-45, table of contents.

[8]. Fikkers BG, Staatsen M, Lardenoije SGGF, van den Hoogen FJA, van der Hoeven JG. Comparison of two percutaneous tracheostomy techniques, guide wire dilating forceps and Ciaglia Blue Rhino: a sequential cohort study. Critical Care. 2004;8(5):R299-R305.

[9]. Romero CM, Cornejo RA, Ruiz MH, Galvez LR, Llanos OP, Tobar EA, et al. Fiberoptic bronchoscopy-assisted percutaneous tracheostomy is safe in obese critically ill patients: a prospective and comparative study. J Crit Care. 2009;24(4):494-500.

[10]. McCormick B, Manara AR. Mortality from percutaneous dilatational tracheostomy. A report of three cases. Anaesthesia. 2005;60(5):490-5.

[11]. van Heurn LW, Theunissen PH, Ramsay G, Brink PR. Pathologic changes of the trachea after percutaneous dilatational tracheotomy. Chest. 1996;109(6):1466-9.

[12]. Walz MK, Schmidt U. Tracheal lesion caused by percutaneous dilatational tracheostomy--a clinico-pathological study. Intensive Care Med. 1999;25(1):102-5.

[13]. Reilly PM, Anderson HL, 3rd, Sing RF, Schwab CW, Bartlett RH. Occult hypercarbia. An unrecognized phenomenon during percutaneous endoscopic tracheostomy. Chest. 1995;107(6):1760-3.

[14]. Al-Ansari MA, Hijazi MH. Clinical review: percutaneous dilatational tracheostomy. Crit Care. 2006;10(1):202.

[15]. Gobatto AL, Besen BA, Tierno PF, Mendes PV, Cadamuro F, Joelsons D, et al. Ultrasound-guided percutaneous dilational tracheostomy versus bronchoscopy-guided percutaneous dilational tracheostomy in critically ill patients (TRACHUS): a randomized noninferiority controlled trial. Intensive Care Med. 2016;42(3):342-51.

[16]. Chacko J, Gagan B, Kumar U, Mundlapudi B. Real-time ultrasound guided percutaneous dilatational tracheostomy with and without bronchoscopic control: an observational study. Minerva anestesiologica. 2015;81(2):166-74.

[17]. Gonzalez I, Bonner S. Routine chest radiographs after endoscopically guided percutaneous dilatational tracheostomy. Chest. 2004;125(3):1173-4.
[18]. Anon JM, Gomez V, Escuela MP, De Paz V, Solana LF, De La Casa RM, et al. Percutaneous tracheostomy: comparison of Ciaglia and Griggs techniques. Crit Care. 2000;4(2):124-8.
[19]. Sustic A, Krstulovic B, Eskinja N, Zelic M, Ledic D, Turina D. Surgical tracheostomy versus percutaneous dilational tracheostomy in patients with anterior cervical spine fixation: preliminary report. Spine. 2002;27(17):1942-5; discussion 5.
[20]. Beshey B, Helmy T, Asaad H, Ibrahim E. Emeregency percutaneous tracheotomy in failed intubation. European Respiratory Journal. 2013;42(Suppl 57).
[21]. Ravi PR, Vijay MN. Real time ultrasound-guided percutaneous tracheostomy: Is it a better option than bronchoscopic guided percutaneous tracheostomy? Medical Journal, Armed Forces India. 2015;71(2):158-64.
[22]. Gobatto ALN, Besen BAMP, Tierno PFGMM, Mendes PV, Cadamuro F, Joelsons D, et al. Comparison between ultrasound- and bronchoscopy-guided percutaneous dilational tracheostomy in critically ill patients: A retrospective cohort study. Journal of Critical Care. 2015;30(1):220.e13-.e17.