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Prospective Study of Ultrasound Guided Percutaneous Tracheostomy in Critically ill Patients in Zagazig University Hospitals in Egypt

Khaled Abd ELShakour Mohammed Ali, Abd El Raof Said Mohamed, Alsayed Abdulmageed Alsayed, Sharifa Mohamed Almahdi, Ali Mohamd Ali Hassn Barakat

Department of Otorhinolaryngology, Faculty of Medicine, Zagazig University, Egypt

***Corresponding Author:** Sharifa Mohamed Almahdi, **Email:** sherefalshereef2016@gmail.com

ABSTRACT

Background: Before doing percutaneous tracheostomy (PCT), studies have shown that mapping the neck region with ultrasound (US) is beneficial.

Objective: This study aimed to check the effectiveness of ultrasound guided percutaneous tracheostomy for patients in critical condition.

Patients and Methods: 24 mechanically ventilated patients at the Otorhinolaryngology Department and the Anesthesia and Intensive Care Unit of Zagazig University Hospital who were indicted for elective ultrasonography guided percutaneous tracheostomy in the period from June 2021 to December 2021.

Results: The mean incision length was less than 2 cm and the duration of procedure was 22.08 minutes while the average duration of intubation was 13.25 days.75% of patients had excellent, 12.5% of patients were good, and 12.5% were unsatisfactory, for ease of ultrasonic visualization.

Conclusion: Using ultrasound to guide the percutaneous tracheostomy operation could be an effective and less invasive technique.

Keywords: Percutaneous tracheostomy, Ultrasound, Critically ill.

INTRODUCTION

Patients admitted to the intensive care unit (ICU) may require tracheostomy if ventilatory weaning fails or mechanical ventilation is required for an extended period of time [1, 2]. In this regard, PCT under bronchoscopic supervision was established. Transillumination helps bronchoscopy identify the puncture site, confirm needle position, manage the dilation and placement of tracheostomy tube dilation and positioning. As it stands, the bronchoscopy does not reveal the vascular and thyroid systems in the neck region, and so does not avoid consequences linked to local organ abnormalities [3].

A physical examination may not be able to identify certain anatomical landmarks in obese patients. Obesity-related problems have been documented by many authors. A combination of technological advancement and low invasiveness has led to an increase in the use of ultrasonography (US) in anesthesia and critical care. In obese individuals, this is especially true for treatments like peripheral nerve block, cannulation of arteries, as well as central venous cannulation [4].

A number of studies have shown the benefit of US neck mapping prior to PCT. Even when only anatomical palpation data are used to determine the puncture site, an ultrasound scan will often change that choice [5]. In a neurosurgical ICU, **Rajajee *et al.*** [6] showed that US-guided PCT was feasible.

We aimed at this study for evaluating the efficacy of ultrasound guided percutaneous tracheostomy (USPCT) among patients who are critically ill at Zagazig University Hospital.

PATIENTS AND METHODS

At Otorhinolaryngology Department and Anesthesia and Intensive Care Unit Department, at Zagazig University Hospital, Egypt, this prospective cohort trial was performed during the period from June 2021 to December 2021. This research included 24 critically ill cases who were admitted to Zagazig University Hospital's Intensive Care Unit and for whom U/S guided PCT was indicated.

Ethical approval:

All participants completed informed permission papers (written consents) and submitted them to the Research Ethics Committee at Zagazig University. The study was permitted (ZU-IRB#6785). Ethics guidelines for human experimentation were adhered to in line with the Helsinki Declaration of the World Medical Association.

Inclusion criteria:

Patients with prolonged mechanical ventilation or expected prolonged mechanical ventilation and patients who had difficult weaning from mechanical ventilation, as well as advanced maxillofacial injury patients.

Exclusion Criteria:

Patients below age of 15 years, infection of tracheostomy site, emergency tracheostomy, unidentified anatomic landmarks, coagulation abnormalities (platelet count lower than 80000/mm^3 and an international

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normalized ratio of at least 1.2) and previous surgery at the site or tracheal stenosis.

All patients were subjected to the following:

1. Complete history taking.
2. Complete general and clinical examination including: Mean heart rate before, during and after 10, 20 and 30 minutes of the procedure. Mean arterial blood pressure "MAP" before, during and after 10, 20 and 30 minutes of the procedure. Oxygen saturation before, during and after 10, 20 and 30 minutes of the procedure. End tidal carbon dioxide "$ETCO_2$" before, during and after 10, 20 and 30 minutes of the procedure.
3. **Local examination** of the neck searching for any anatomical difficulties: Palpable thyroid swellings or other palpable neck masses or any palpable pulsating vessels near the site of entry. Short neck. Difficult neck extension (fixed neck). Tracheal deviation. Patient data on admission and during their ICU stay. Diagnosis on admission. Number of days on MV before the decision of tracheostomy. Indications of tracheostomy: Weaning failure, cannot protect the airway, ICU scoring systems on admission [Glasgow coma scale (GCS)] and duration of the procedure.
4. **Selective investigations:** Coagulation profile (prothrombin activity, activated partial thromboplastin time as well as international normalized ratio), arterial blood gases analysis, complete blood count, as well as plain chest X- ray was done before (the most recent one) and one hour after the procedure.
5. **Technique:**
   Ventilator mode and preoxygenation: An oral endotracheal tube was used to manually ventilate each patient. Mandatory ventilation was carried out. Sedation, analgesia and muscle relaxants (Drugs that were administered included propofol (2-2.5mg/kg, IV), fentanyl (25- 100 mcg/dose over 1-2 minutes IV) and atracurium (0.4-0.5mg/kg over one-minute IV).

The vision of the larynx and the difficulty of reintubation were assessed prior to beginning of the operation for all patients who had direct laryngoscopy.

The midline was determined by scanning the trachea along a transverse axis. Cricothyroidotomy kit pre-assembled guidewire of 0.035 was used to put the needle into the patient's trachea for additional tracheostomy guiding. A site below the first tracheal ring, but above the fifth tracheal ring, was chosen for tracheal puncture using sonographic imaging because there was no vascular anatomy. Permission was given for a needle poke into the thyroid isthmus. Intradermal insertion of a 15-G needle was performed perpendicular to the skin's surface using an acoustic shadow and subsequent displacement of tissue layers to assess needle path. There were moments when the needle's indentation of the anterior tracheal wall could be seen. Upon reaching and then barely passing the anterior wall, the needle was paused, with a perceptible change in resistance as the lumen was approached. Once the guidewire had passed through the needle, it was tilted slightly caudally to prevent it from going backwards. The needle was removed once the guidewire was inserted. An endotracheal tube was inserted, and a bronchoscope was inserted through it to see if the guidewire had punctured the trachea's posterior wall. The bronchoscope was then taken out of the patient's body. The proper-sized tracheostomy tube was then inserted into the stoma and fastened in place with an appropriate loading tube. Using auscultation, the tube's position in the trachea was promptly established. During intercostal ultrasound imaging, the visceral pleura can be seen "sliding" over the parietal pleura with a distinct M-mode look.

PDT technique:

horizontal incision 2 inch or finger above suprasternal notch, dissection was performed onto the pretracheal tissue, with the help of inspiration air, the needle's tip was guided caudally into the tracheal lumen, the J-shaped guide was then passed through the guide needle and directed caudally into the distal airways, initial dilatation of trachea and soft tissue was done by short dilator, then removing of the guiding catheter, and guide wire was done. Insertion of Blue Rhino dilator over the guide wire and catheter was done afterwards. Then, we inserted tracheostomy tube over an introducer dilator threaded over the guide wire and catheter and the ventilator circuit was connected to the tracheostomy tube. Finally, tracheostomy cuff was inflated by using cuff pressure manometer.

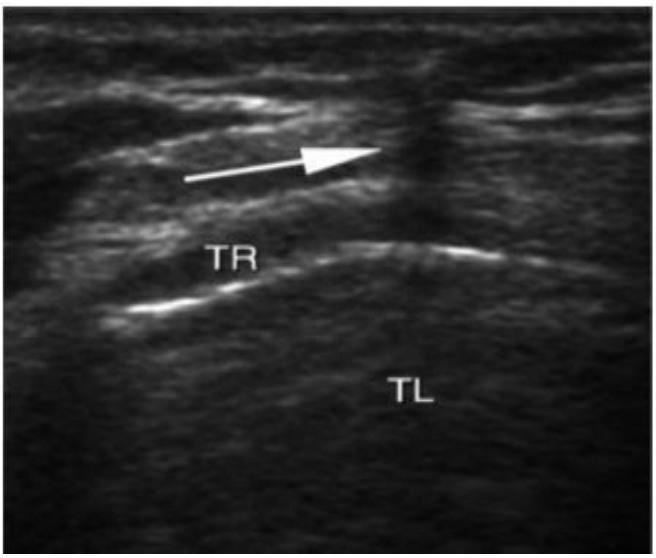

Figure (1): Needle path., TL: Tracheal Lumen, TR: Tracheal ring.

Figure (2): Insertion of tracheostomy tube over an introducer dilatorthreaded over the guide wire and catheter.

Statistical analysis

The collected data were coded, processed and analyzed using the SPSS (Statistical Package for Social Sciences) version 22 for Windows® (IBM SPSS Inc, Chicago, IL, USA). Data were tested for normal distribution using the Shapiro Walk test. Qualitative data were represented as frequencies and relative percentages. Chi square test (χ^2) to calculate difference between two or more groups of qualitative variables. Quantitative data were expressed as mean ± SD (Standard deviation). Independent samples t-test was used to compare between two independent groups of normally distributed variables (parametric data). P value ≤ 0.05 was considered significant.

RESULTS

The patients' average age was 48.08 years, 66.7% of the studied group were male, 50% were working, and 66.7% were married and non-smokers **(Table 1).**

Twenty five percent of patients had no comorbidities, 33.3% of patients were hypertensive, and diabetes was present in 8.3% of patients **(Table 2).**

Diagnosis efficacy of cases are shown in **(Table 3).**

Mean incision length was less than 2 cm and the duration of procedure was 22.08 minutes **(Table 4).**

75% of patients had excellent, 12.5% of patients were good, and 12.5% were unsatisfactory, for ease of ultrasonic visualization **(Table 5).**

Table (1): Age, demographic data, among the studied cases

Parameters		**Patients (n=24)**	
Age (years)		48.08 ± 19.6	
Gender	Female	**N**	8
		%	33.3%
	Male	**N**	16
		%	66.7%
Occupation	Not working	**N**	12
		%	50%
	Working	**N**	12
		%	50%
Maritalstate	Single	**N**	8
		%	33.3%
	Married	**N**	16
		%	66.7%
Smoking	Smoker	**N**	8
		%	33.3%
	Non Smoker	**N**	16
		%	66.7%

Table (2): Comorbidity distribution in the studied group

			Patients (n=24)
Comorbidity	No	N	6
		%	25%
	Hypertension	N	8
		%	33.3%
	Diabetes	N	8
		%	33.3%
	Hypertension & Diabetes	N	2
		%	8.3%

Table (3): Diagnosis of cases included in the study

		Patients (n=24)
Brain tumor	N	2
	%	8.3%
Head trauma basal skull	N	2
	%	8.3%
Poly trauma	N	2
	%	8.3%
Poly trauma with cerebral hemorrhage	N	4
	%	16.7
Prolonged intubation with stroke	N	2
	%	8.3%
Prolonged head trauma	N	2
	%	8.3%
Prolonged intubation with CVA	N	2
	%	8.3%
Prolonged intubation with intra-cerebelar hemorrhage	N	2
	%	8.3%
RTA with brain edema	N	2
	%	8.3%

Table (4): Incision length and procedure duration in the studied group

	Patients (n=24)
Incision length (cm)	Less than 2
Duration of procedure (min)	22.08 ± 3.8

Table (5): Ease of ultrasonic visualization

			Patients (n=24)
Ease of ultrasonic visualization			
	Excellent	N	18
		%	75%
	Good	N	3
		%	12.5%
	Un-satisfactory	N	3
		%	12.5%

DISCUSSION

In the ICU, percutaneous tracheostomy (PT) is a common procedure that is done on the patient's bedside (ICU). PCT has been shown to be a safe and cost-effective alternative to open surgical tracheostomies. During physical therapy, a bronchoscope may be helpful in preventing harm to adjacent tissues, high tube placement, injury to the posterior tracheal wall, and confirmation of endotracheal implantation [(3)]. According to anatomical palpation data, a puncture site may be changed during a US examination [(7)]. Recently, **Rajajee *et al.*** [(6)] in a neurosurgical ICU, US-guided PCT was found to be a viable option.

In the present study, the mean age of patients was 48.08 years, 66.7% of the studied group were male, 50% were working, 66.7% were married and non-smokers. 25% of patients had no comorbidities, 33.3% of patients were hypertensive, 33.3% were diabetic and hypertension and diabetes was present in 8.3% of patients. The diagnosis of cases was different, 16.7% of patients had polytrauma with cerebral hemorrhage, while others had brain tumor, head trauma of basal skull, poly trauma, prolonged intubation with stroke, prolonged head trauma, prolonged intubation with CVA, prolonged intubation with intra-cerebellar hemorrhage and RTA with brain edema with the same percentage (8.3%).

In **Guinot *et al.*** [(4)] Between March 2010 and August 2011, a total of fifty patients were included in the study. Five of the morbidly obese individuals were among the 26 who were obese. The obese group had a median age of 64, whereas the non-obese group had a median age of 58. 50 patients were evaluated and found to have medical issues (such as respiratory failure in COPD, stroke, seizures, abrupt heart failure, and so on), while 23 had undergone medical procedures (such as surgery for cardiac, vascular, or intestinal problems) or suffered from severe trauma.

In **Ravi and Vijay** [(3)] study there was a comparison between BPCT and USPCT. Between March 2012 and December 2013, 74 patients were prospectively enrolled. The total number of obese patients was 26, of which five were classified as morbidly obese. The median ages were 62 years in the Ultrasound assisted percutaneous tracheostomy (USPCT) group. It was found that of the seventy-four individuals studied, 60 had been admitted to the hospital for medical reasons (respiratory failure in C.O.P.D), while 14 had undergone cardiac or intestinal surgery or serious trauma.

Current study showed that, the mean incision length was less than 2 cm and the duration of procedure was 22.08 minutes. This came in agreement with **Guinot *et al.*** [(4)] who found that the median total time of the procedure was 18 minutes. **Ravi and Vijay** [(3)] demonstrated that the median total time for performing USPCT, was 12 min. **Sustić *et al.*** [(8)] revealed that the

US-PDT took an average of 8 minutes to complete. This difference probably was because the operating time was measured starting from the time of puncture of the trachea excluding the time needed for tracheal examination. The difference in time between this study and the other studies may be because of the diverse experiences gained by the tracheostomies operators. The short time of performing the procedure is important in patients with unstable oxygen saturation.

In agreement with our study, pre-PCT US evaluation of the neck region has been found to lower the risk of problems. **Bonde *et al.* [9]** reported that pre-procedural neck ultrasound insured details for 28 consecutive patients during a one-year research period who had PDT performed upon them. In addition, in the study of **Kollig *et al.* [10],** percutaneous tracheostomy was performed on all patients who had undergone preprocedural ultrasonography examination of the neck, 23.6% of patients had to modify the location of their tracheal puncture after an ultrasound examination.

CONCLUSION

Using ultrasound to guide the percutaneous tracheostomy operation could be an effective and less invasive alternative.

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Conflict of interest: Nil.

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