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Percutaneous Dilatational Tracheostomy (PDT): From Shooting in The Dark to Working Under Lights

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1. Abstract

1.1. Introduction: Percutaneous Dilatational Tracheostomy (PDT) is a preferred method for tracheostomy in critically ill patients due to advantages over the surgical tracheostomy. Aim of our study was to know the early complications of PDT, efficacy and safety of airway secured with Either Endo Tracheal Tube (ETT) or laryngeal mask during the procedure and impact of use of bronchoscopy during PDT.

1.2. Patients and Methods: This was a retrospective study. All patients who underwent PDT over a period of 8-years in surgical and trauma intensive care unit were included in the study. Patient's demographic data, method of airway secured during the procedure, type of PDT, perioperative complications, use of bronchoscopy and outcome were recorded. Data was entered in SPSS version 23, to compare the groups' chi square and t-test were used. P value of <0.05 was considered statically significant.

1.3. Results: A total of 342 patients were included in the study. Majority of patients were male (276/80.7%) and had Blue rhino dilatational tracheostomy (252/73.7%). Most of the patient's airway during the PDT was secured by the ETT (316/92.4%). Majority of patients did not have perioperative complications (258/75.4%). There was no significant difference in rate of complication whether airway was secured with ETT or laryngeal mask. When the PDT was performed under vision with bronchoscopy, the rate of perioperative complications was significantly lower (p=0.001).

1.4. Conclusion: PDT is safe to perform with ETT or laryngeal mask. PDT should be done under vision with bronchoscopy.

2. Introduction

Tracheostomy is one of the oldest surgical procedure. In the early 20th century Jackson showed that it is a safe, doable procedure and he put forward guidelines for tracheostomy [1]. Now tracheostomy is a well-practiced conventional or emergency surgical procedure. Tracheostomy can be performed either by traditional surgical way or more recently by percutaneous dilatational technique. Percutaneous dilatational tracheostomy (PDT) is the choice in critically ill patients due to various well described advantages and is frequently performed by the intensivist in the intensive care units [2]. PDT can be performed by various technique namely Ciaglia Blue Rhino, guide wire dilatating forceps, Frontoni's trans-laryngeal tracheostomy, Ciaglia Blue Rhino single dilatation and twist dilatational tracheostomy [2].

PDT can be performed by securing the airway by the endotracheal tube (ETT) or replacing the ETT with laryngeal mask airway. PDT with laryngeal mask decreases the operative time and has a better intraoperative visibility. The available data is smaller and mostly single centered [3]. PDT can be done with or without bronchoscopic guidance, still there are controversies about advantages of using bronchoscopic guidance for tracheostomy and few literatures suggesting PDT can be safely performed without the use of bronchoscopy [4]. There is not much of the literature is available from this region about the complications, use of laryngeal mask or fiber optic bronchoscopy during the PDT. There are two smaller

studies from Qatar, one is describing the forcep dilatation percutaneous tracheostomy [5]. Another basic study describing the simple complications of percutaneous tracheostomy in trauma patients [6].

Aim of the study was to know the various early complications of PDT, compare the rate complication when airway is secured with laryngeal mask or ETT and performance of PDT under bronchoscopy guidance or blind technique.

3. Patients and Methods

After obtaining the approval from the hospital medical research committee, (permission number: 13425/13) all patients who underwent percutaneous dilatational tracheostomy in surgical and trauma intensive care from 2010 to 2018 were included retrospectively into the study. Pediatric patients and patients with distorted neck anatomy were excluded from the present study.

All patients' demographic data, diagnosis, indications for tracheostomy, type of PDT, airway secured by ETT or laryngeal mask, hemodynamic parameters during tracheostomy, peri-tracheostomy complications and patients outcome recorded retrospectively.

3.1. Description of Ciglia PDT Procedure

Patient was sedated and paralyzed, given supine position with a shoulder roll to get optimal neck extension, ETT was pulled up to the vocal cord under vision, ventilatory setting was changed to volume controlled mode and Positive End Expiratory Pressure (PEEP) less than 10 cm of water with fraction of inspired oxygen concentration 1. Local anesthesia 2% lignocaine with adrenaline was injected in between 2nd and 3rd tracheal space then 1 to 2 cm transverse incision was made; subcutaneous tissues were separated. Trachea was located with 14-gauge catheter introducer needle with cannula and saline filled syringe by aspiration of the air. After confirmation of the intra-tracheal positioning of the cannula, needle was withdrawn and through the cannula a J–tipped guide wire was introduced into the tracheal lumen than single Blue Rhino dilator® (Cook) was used to dilate the trachea. Preloaded tracheostomy tube is inserted through the dilated tracheal opening over the guide wire and guidewire stabilizer. Position is confirmed with end tidal carbon dioxide and chest x-ray.

3.2. Description of Forcep PDT Procedure

Trachea is located as described above, then the trachea is dilated over the guidewire with a dilating forcep. Preloaded tracheostomy tube is inserted through the dilated tracheal opening over the guide wire and position is confirmed with end tidal carbon dioxide and chest x-ray.

In patients performed PDT under laryngeal mask, the ETT was removed and inserted an appropriate size laryngeal mask.

Whenever the fibro optic bronchoscope was available, PDT was performed under the guidance of the bronchoscopy lights otherwise PDT was performed blindly.

Any complications from the positioning for tracheostomy to the post-operative 24 hours were recoded retrospectively.

3.3. Statistics

The categorical variables were reported by using number (n) and percentage (%). Continuous variables are reported as Mean ± SD and categorical variables were represented as frequency and percentage. These variables detected as normal by Kolmogorov-Smirnov test. Comparisons between the groups were done by using Chi square test for the categorical variables and t- test for the continuous parameters. Two tail P value ≤0.05 was considered stastically significant.

4. Results

During the study period a total of 342 patients were included in the present study, majority of them were males (276/80.7%). Indian were most frequent to have the PDT. Airway protection was the common indication for PDT (332/97.1%). Two hundred and fifty-two patients (73.7%) had Blue Rhino PDT and 90 patients (26.3%) had Forcep dilatational PDT (Table1). The common post PDT chest x-ray finding was collapse and consolidation (71/20.8%), although there were no post procedure changes in chest x-ray in majority of PDT patients (258/75.8%). In majority of patients the PDT was performed with airway secured by the ETT (316/92.4%). Two hundred and fifty-three patients (74%) required noradrenaline to maintain the hemodynamic during the PDT and 89/26% patients had bradycardia during the PDT (Table1). Majority of patients were on thromboprophylaxis when PDT was performed (324/94.7%). In most of our patients there was no any perioperative complications (202/59.1%). In our patients the mucus plug causing difficulty in the location of the trachea was the major complication (60/17.5%), followed by cuff puncture, guidewire bent and minor bleeding (21/6.1%, 15/4.4% and 11/3.2% respectively). The overall mortality due to primary disease in PDT patient was 67/19.6 % (Table1).

Mean age of our patients was 46 years and PDT was performed on an average day 11 of intubation. On the day of PDT mean hemoglobin was 9 grams/deciliter, activated partial thrombin time (a PTT) was 36.1±7.88 and the mean platelet count was 27±172 per microliters. Our patients had mean and standard deviation (SD) GCS (Glasgow coma scale) of 7.3±3.7, SOFA score 12.98±3.7 and the Mean ± SD injury severity score was 34±4.63 (Table2).

(Table 3) is shows the comparison between PDT performed with airway secured with ETT or laryngeal mask. There was no significant difference in gender, post procedure chest x-ray findings and the complications. There were significantly higher (p=0.002) number of patients had PDT with forceps dilatational, their airway was secured with laryngeal mask whereas in the patients who had Blue rhino PDT, significantly higher number the airway was secured by ETT (p=0.002). The significantly higher number of patients required noradrenaline to maintain their hemodynamics in PDT

performed with airway secured by ETT (P=0.002). In Patients underwent PDT and airway secured with Laryngeal mask had significantly higher incidence of bradycardia in the perioperative period (p=0.002).

(Table 4) is shows the comparison of parameters when the PDT performed under visual guidance with bronchoscopy or performed blindly. Significantly higher number of patients under went PDT with Blue Rhino under bronchoscopic guidance (p=0.001). As far as the complications were concerned, the complications were significantly higher (p=0.027) when the PDT was performed blindly without bronchoscopic guidance.

Table1: Demography, Indications, complications and outcome

Variable		Number(n)	Percentage (%)
Gender	Male	276	80.7
	Female	66	19.3
Nationality	Indian	83	24.3
	Filipino	79	23.1
	Qatari	73	21.3
	Other Arabs	48	14
	Bengali	24	7
	Pakistani	17	5
	Others	17	5
	Airway Protection	332	97.1
Indications	Prolonged ventilation	10	2.9
	Blue rhino	252	73.7
Dilatational technique	Forceps	90	26.3
	None	258	75.4
Post Tracheostomy x-ray findings	Collapse Consolidation	71	20.8
	ARDS (Acute respiratory distress syndrome)	11	3.2
	Pneumothorax	2	0.6
Securing Airway during tracheostomy	Endotracheal tube (ETT)	316	92.4
	Laryngeal mask	26	7.6
Hemodynamics	Required Noradrenaline	253	74
	Developed Bradycardia	89	26
On Thromboprophylaxis	Yes	324	94.7
	No	18	5.3
Complications	None	202	59.1
	Mucus Plug	60	17.5
	Cuff Puncture	21	6.1
	Guidewire bent	15	4.4
	Bleeding	11	3.2
	Hypoxia	8	2.3
	Difficult dilatation	5	1.5
	Extubation During ETT pull	5	1.5
	False Passage	4	1.2
	Others*	4	1.2
Outcome	Survived	275	80.4
	Died	67	19.6

*Others: Subcutaneous emphysema, tracheal fracture, tracheostomy tube dislodgment, tracheoesophageal fistula.

Table 2: Descriptive Parameters

Variable	Value and Standard Deviation
Age (years)	46±17.76
Days of intubation (Days)	11.2±7.8
Haemoglobin (grams per decilitre)	9.0±1.8
INR (International normalizing ratio)	1.1±0.16
aPTT (activated Partial Thromboplastin Time) (Minutes)	36.1±7.88
Platelet (per microliter)	271±172
ISS (injury severity score)	34±4.63
SOFA (Sequential organ failure assessment) Score	12.98±3.7
GCS (Glasgow coma scale)	7.3±3.7

Table 3: Percutaneous dilatational Tracheostomy (PDT) with endotracheal tube verses laryngeal mask

Variable		Endotracheal tube (number /Percentage)	Laryngeal mask (Number/Percentage)	P value
Gender	Male	255/92.4	21/7.6	0.6
	Female	61/92.4	5/7.6	
	Blue Rhino	240/75.9	12/46.2	0.002
Dilatational technique	Forceps	76/24.1	14/53.8	
	None	237/75.0	21/80.8	
Post Tracheostomy x-ray findings	Collapse Consolidation	66/20.8	5/19.2	0.73
	ARDS(Acute respiratory distress syndrome)	11/3.5	0/0	
	Pneumothorax	2/0.6	0/0	
	Required Noradrenaline	241/76.3	12/46.2	
Hemodynamics	Developed Bradycardia	75/23.7	14/53.8	0.002
Use of bronchoscopy	Yes	95/30.1	6/29.5	0.3
	No	225/69.9	20/70.5	
	None	183/57.9	19/73.1	
	Mucus Plug	58/18.4	2/7.7	
	Cuff Puncture	15/4.7	0/0	
Complications	Guidewire bent	18/5.7	3/11.5	0.32
	Bleeding	11/3.5	0/0	
	Hypertension	7/2.2	0/0	
	Hypoxia	6/1.9	2/7.7	
	False Passage	4/1.3	0/0	
	Difficult dilatation	5/1.6	0/0	
	Extubation During ETT pull	5/1.6	0/0	

*Others: Subcutaneous emphysema, tracheal fracture, tracheostomy tube dislodgment, tracheoesophageal fistula.

Table 4: PDT with or without bronchoscopy

Variable		Without bronchoscopy (number /Percentage)	With bronchoscopy (Number/Percentage)	P value
Gender	Male	197/81.7	79/78.2	0.27
	Female	44/18.3	22/21.8	
Dilatational technique	Blue rhino	154/63.9	98/97.0	0.001
	Forceps	87/36.1	3/3.0	
Post Tracheostomy x-ray findings	None	187/73.9	80/79.2	
	Collapse Consolidation	51/22.2	20/19.8	
	ARDS (Acute respiratory distress syndrome)	10/4.1	1/1.0	
	Pneumothorax	2/0.8	0/0	0.32
Hemodynamics	Required Noradrenaline	155/64.3	98/97.0	0.001
	Developed Bradycardia	86/35.7	3/3.0	
Complications	None	135/56.0	67/66.3	0.027
	Mucus Plug	43/17.8	17/16.8	
	Cuff Puncture	10/4.1	5/5.0	
	Guidewire bent	19/7.9	2/2.0	
	Bleeding	9/3.7	2/2.0	
	Hypertension	5/2.1	2/2.0	
	Oxygen desaturation	8/3.3	0/0	
	False Passage	4/1.7	0/0	
	Difficult dilatation	5/2.1	0/0	
	Extubation During ETT pull	1/0.4	4/4.0	
	Others	2/0.8	2/2.0	

*Others: Subcutaneous emphysema, tracheal fracture, tracheostomy tube dislodgment,

5. Discussion

Tracheostomy can be performed by standard surgical procedure (ST) and cutting the tracheal cartilage in the operation theater or it can be well performed bed side in ICU with a smaller skin incision and dilatation of the trachea (PDT).

Now a days PDT is a commonly performed bedside procedure in the intensive care units, there are obvious advantages over the surgical tracheostomy (ST) like fewer overall complications and it takes less time and no need to book the operation theater [7]. The early complications in the perioperative period reported to be hemorrhage, false passage, difficulty in tracheostomy tube placement, hypoxia, hypotension, pneumothorax and death [8]. Durbin also described that the most frequent periprocedural complication are hemorrhage, difficult tube insertion, subcutaneous emphysema, hypoxia, hypertension and pneumothorax in the descending order [8]. In our study the common perioperative complications were mucus plug causing difficulty in tracheal location, and cuff puncture causing difficulties in ventilation. Whereas it was rare to have hemorrhage, difficulty in tube placement and false passage.

Sonti et al reported that performing PDT by replacing the ETT with a laryngeal mask to secure the airway is safe and decreases the need of muscle relaxants [9]. Our study also demonstrated that PDT safely performed with airway secured with the laryngeal mask, as there was no difference in complication rate whether airway was secured with laryngeal mask or endotracheal tube (ETT).

Romero de Tejada et al reported that the use of bronchoscopy during the PDT reduces the duration of procedure, morbidity and detects intraoperative complications missed by blindly performed PDT approach [10]. In contrast Lima reported in their prospective study that the percutaneous dilatational tracheostomy is safe and practical procedure without use of bronchoscopy [11]. Taha et al in their randomized clinical trial concluded that no superior advantages of using bronchoscopy during the PDT [12]. Whereas our study is demonstrated that there was a significantly higher rate of complications during the perioperative period if PDT is blindly performed without visualization with the lights of bronchoscopy.

6. Conclusion

PDT is a safe intensive care unit procedure. Mucus plug can cause difficulties in tracheal location. PDT is safe in airway secured with laryngeal mask or ETT. Most frequent post PDT imaging

abnormality was collapse and consolidation. PDT can be safely performed in patients on thromboprophylaxis. PDT should be performed under bronchoscopic guidance to avoid and document the peri-procedure complications.

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