

Introducing a new instrument “Downpipe endotracheal tube” for improving the safety of percutaneous dilatational tracheostomy

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Background: Percutaneous dilatational tracheostomy (PDT) is the most commonly used minimally invasive procedure in patients with prolonged mechanical ventilation. However, during the procedure withdrawal, the endotracheal tube (ET) may cause substantial gas leak and sometimes the airway could be lost, and the patient exposed to severe hypoxemia. In order to prevent hypoxemia during ET withdrawal and needle stuck in ET during PDT and also for performing the procedure more safe and easy. **Material and Methods:** In this study, we introduce a new instrument “downpipe endotracheal tube” that has been registered as a patent and examined it in eight patients to confirm practical advantage of this tube. **Results:** These patients were five female and three male, with a mean weight of 71.7 kg and the mean age of 65.12 years. The cause of tracheostomy was difficult weaning from mechanical ventilation. **Conclusion:** The procedure was safe in all cases. We did not find any complications during the procedure.

Key words: Airway management, patient safety, tracheostomy

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INTRODUCTION

Prolonged mechanical ventilation is frequent in patients after cardiac surgery or after major cardiac and cerebrovascular events. In these patients, elective tracheostomy is a choice for better airway management. There are different techniques for tracheostomy including conventional or surgical tracheostomy, translaryngeal tracheostomy, and minimally invasive percutaneous dilatational tracheostomy (PDT).^[1,2] PDT is minimal invasive in comparison to ST. PDT is usually performed under local or general anesthesia with neck extension and a sterile field. The needle usually placed in the second and third membranes of the trachea, and guide wire is passed through it, and after proper dilatation, favorite size tracheostomy tube is placed.^[3-5]

It is necessary to withdraw the endotracheal tube (ET) until its tip just in the larynx below the vocal cord. Pulling back of ET may cause substantial gas leak, and sometimes the airway could be lost, and the patient exposed to severe hypoxemia, especially those with underlying respiratory disease. In some situations, anesthesiologist has to do laryngoscopy for several times that result in soft-tissue injury in the pharynx and larynx.^[6] Considering the above complications, we introduce a new instrument “downpipe endotracheal tube” (DET) and examined it in eight patients to confirm practical advantage of this tube.

MATERIALS AND METHODS

The research proposal was approved by the institutional ethics committee. We performed the PDT procedure using “DET” in eight patients who had prolonged intubation after cardiac surgery. The cause of tracheostomy was

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difficult weaning from mechanical ventilation. Usually, during the standard tracheostomy (PDT) procedure, two skilled persons are needed to cooperate: one operator for withdrawing ET and the second person introduces the needle and then tracheostomy tube. In order to avoid hypoxemia during ET withdrawal or needle stuck in ET during PDT, we performed tracheostomy by replacing standard ET with DET [Figures 1-3]. The material of this tube is the same as other ETs. Thus, regarding to unroofed tube in 7 cm end of this new instrument, there is no concern about needle stuck while the airway is remained open and secured. Furthermore,

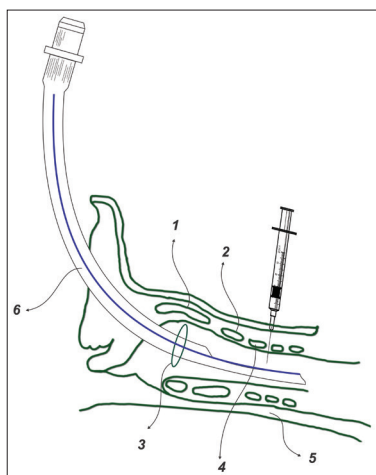


Figure 1: Schematic illustration downpipe tube in the patient's tracheal. (1. Thyroid cartilage, 2. Cricoid cartilage, 3. Vocal cord, 4. First cartilage, 5. Esophagus, 6. Tracheal tube)

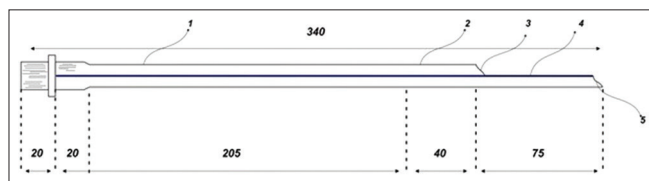


Figure 2: Downpipe endotracheal tube; (1) Body of tube outside mouth (2) Body of tube inside mouth. (3) Bevel of the tube (4) Body of the tube placed inside the trachea. (5) Bevel of end of the tube. Dimensions are provided in mm

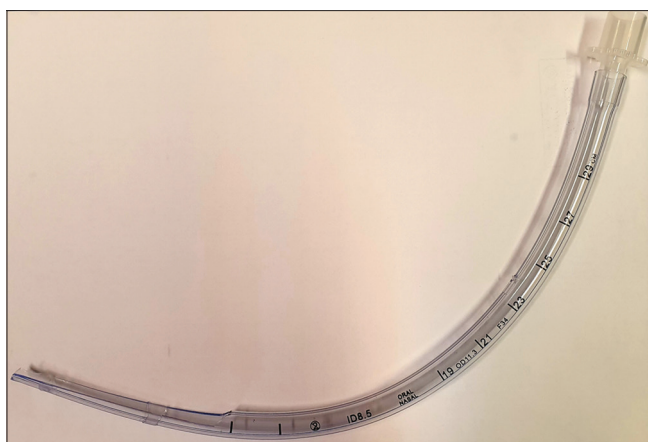


Figure 3: Downpipe tube

with maintaining back part (downpipe part of the DET), the needle stick of the posterior trachea is prevented. Internal diameter tube sizes were 8–8.5 for female and 8.5–9.0 mm for male patients. Tube fixed in 21 cm from incisor tooth in female and on 22 cm in male patient. Overall, 7 cm of tube end (distal part) is unroofed and is down shaped. Downpipe tube is placed in the trachea, and we confirmed its proper placement with fiber-optic bronchoscopy if needed.

Using DET, there was no need to withdraw the tube during inserting the needle and passing guide wire and dilator. Thus, during all times of the PDT procedure, patient oxygenation remained unchanged, and the anesthesiologist performs the procedure with more confidence. The likelihood of puncturing this part if needle stuck may be a concern; however, needle stuck could be occurred rarely in experienced hand, and it can be checked with fiber-optic bronchoscopy in case of needle stuck.

In these eight patients who underwent the PDT procedure using "DET," there was no difficulty in placement of DET, and also there was no need for fiber-optic bronchoscopy-guided DET placement. In these eight patients, the needle did not stuck in DET, and tracheostomy has been done without DET withdrawal and chest expansion, and oxygenation was acceptable. Our method of acting PDT is Ciaglia technique. PDT is usually done under local or general anesthesia and neck extension in a sterile field, and the needle usually placed in the second and third membranes of the trachea, and guide wire is passed through it, and after proper dilatation, favorite size tracheostomy tube is placed. We did not have any airway losing or need for a second hand (aid). To rule out no posterior wall damage, if the needle is stuck with a pipe, it is usually associated with resistance and may be passed through the pipe and damaged. However, we could check with fiber-optic bronchoscopy and rule out of injury. There was not any complication during the procedure including bleeding, subcutaneous emphysema, pneumothorax, esophagus injury, and tracheal injury.

RESULTS

These patients were five female and three male, and their mean weight was 71.7 kg, and the mean age of the patients was 65.12 years [Table 1]. The patients' clinical data including arterial blood gas are summarized in Table 2. All the data regarding arterial oxygen saturation, end-tidal CO₂, systolic and diastolic blood pressures, and heart rate were within the normal range [Table 2].

DISCUSSION

There are several approaches and techniques in PDT. The most common method is pulling back of the tracheal tube

Table 1: Demographic variables of the studied patients

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8
Age (year)	63	66	66	63	78	53	67	65
Sex (male/female)	Female	Female	Male	Male	Female	Female	Female	Male
Weight (kg)	70	72	60	87	70	75	65	75
Consciousness level (GCS)	5	11	15	11	10	10	14	15
Short neck	No	Yes	No	Yes	No	No	Yes	Yes
Endotracheal tube size (mm)	7.5	8	8	8.5	7	7	8	8.5

GCS=Glasgow coma scale

Table 2: Clinical characteristics of the patients, during percutaneous dilatational tracheostomy

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8
Before the procedure								
SpO ₂ (%)	97	98	96	96	90	90	95	96
EtCO ₂ (mmHg)	40	37	38	45	40	42	44	53
SBP (mmHg)	144	110	90	100	130	120	130	140
DBP (mmHg)	77	75	70	61	85	80	85	90
HR (bpm)	65	100	85	95	100	90	95	98
End of procedure								
SpO ₂ (%)	100	100	99	99	88	95	99	100
EtCO ₂ (mmHg)	40	40	40	44	40	40	45	48
SBP (mmHg)	120	120	100	110	135	120	130	125
DBP (mmHg)	75	80	75	80	85	82	85	90
HR (bpm)	70	100	90	100	105	94	85	88
Air leakage through DET	A	A	No	No	A	No	A	A
Procedure time (min)	30	35	25	25	30	35	40	40

DET=Downpipe endotracheal tube; EtCO₂=End-tidal CO₂; SBP=Systolic blood pressure; DBP=Diastolic blood pressure; HR=Heart rate; A=Acceptable

to subglott for passing guide wire to the trachea and then tracheostomy tube. However, withdrawal may be not sufficient and needle stuck or ET cuff puncture occurs. On the other hand, more pull backing of ET may cause severe air leak or unexpected extubation and partial or complete loss of ventilation. Most of patients are vulnerable to severe hypoxemia or even cardiorespiratory arrest. Needle stuck in the ET may cause the removal of guide wire more difficult, and the operator should repeat the procedure another time.^[7,8]

It has been recommended that the ET should be withdrawn into the pharynx under direct laryngoscopy, until the tip of ET to be in the trachea. Other approaches of managing the airway during percutaneous tracheostomy have been defined including the use of the laryngeal mask airway, combitube, a tracheal ventilation catheter, and microlaryngeal tube.^[6,8] However, none of these methods guarantees a secure airway, especially if use real-time ultrasound or fiber-optic bronchoscopy.^[8,9] The advantage of our procedure using the "DET" is that ventilation is maintained throughout the PDT procedure, and the clinician can be assured that adequate ventilation is established, and the tracheostomy tube has been placed within the lumen of the trachea. There is no need to pull back the tracheal tube during inserting the needle and passing guide wire and dilator, and there is no risk of needle stuck.

CONCLUSION

In the abovementioned patients who underwent PDT procedure using DET, the procedure was safe and easy, and our tracheostomy team was satisfied. We did not face any complications during the procedure. We also recommend combining this with the fiberoptic bronchoscopy (FOB) for the possibility of puncture and the location of the tube end.

Acknowledgments

Using DET that has been registered as a patent with title "Endotracheal tube for oxygenation and guiding during percutaneous dilatational tracheostomy" no. 98555 in the National Registration and Documentation Office in Iran. Ethic code Number: IR.RHC.REC.1397.076.

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Conflicts of interest

There are no conflicts of interest.

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