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. 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

How to cite this article: Ziyaeifard M, Azarfarin R. Introducing a new instrument “Downpipe endotracheal tube” for improving the safety of percutaneous dilatational tracheostomy. J Res Med Sci 2020;25:16.
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, 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
to subglot 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 ever 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.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Dochi H, Nojima M, Matsumura M, Cammack I, Furuta Y. Effect of early tracheostomy in mechanically ventilated patients. Laryngoscope Investig Otolarngol 2019;4:292-9.

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     | Yes    | 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 |        |        |        |        |        |        |        |        |
| SpO₂ (%)    | 97     | 98     | 96     | 96     | 90     | 90     | 95     | 96     |
| EtCO₂ (mmHg)| 40     | 40     | 40     | 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     |

|             | Case 1 | Case 2 | Case 3 | Case 4 | Case 5 | Case 6 | Case 7 | Case 8 |
|-------------|--------|--------|--------|--------|--------|--------|--------|--------|
| End of procedure |        |        |        |        |        |        |        |        |
| SpO₂ (%)    | 100    | 100    | 99     | 99     | 88     | 95     | 99     | 100    |
| EtCO₂ (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
2. Westphal K, Byhahn C, Rinne T, Wilke HJ, Wimmer-Greinecker G, Lischke V. Tracheostomy in cardiosurgical patients: Surgical tracheostomy versus ciaglia and fantoni methods. Ann Thorac Surg 1999;68:486-92.

3. Jacobs S, Al Rasheed AM, Abdulsamat W, Al Barrak A, Al Omer NF, Tjan D, et al. Effects of a simple protocol on infective complications in intensive care unit patients undergoing percutaneous dilatational tracheostomy. Respir Care 2003;48:29-37.

4. Durbin CG Jr. Bacteremia, infection, and antibiotic choices. Respir Care 2003;48:22-3.

5. Durbin CG Jr. Techniques for performing tracheostomy. Respir Care 2005;50:488-96.

6. Oberwalder M, Weis H, Nehoda H, Kafka-Ritsch R, Bonatti H, Prommegger R, et al. Videobronchoscopic guidance makes percutaneous dilatational tracheostomy safer. Surg Endosc 2004;18:839-42.

7. Fisher L, Duane D, Lafreniere L, Read D. Percutaneous dilational tracheostomy: A safer technique of airway management using a microlaryngeal tube. Anaesthesia 2002;57:253-5.

8. Ziyaeifard M, Azarfarin R, Massoumi G. A comparison of intraocular pressure and hemodynamic responses to insertion of laryngeal mask airway or endotracheal tube using anesthesia with propofol and remifentanil in cataract surgery. J Res Med Sci 2012;17:503-7.

9. Ziyaeifard M, Totonchi Z. Real-time ultrasound guided the new standard technique for percutaneous dilatational tracheostomy (PDT). Anesth Pain Med 2015;5:e24653.