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# Between the devil and the deep red sea: Airway trauma during introducer-guided difficult intubation

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ABSTRACT

A 46-year-old woman was scheduled for total thyroidectomy and had modified Mallampati class III airway. After anaesthesia was induced, laryngoscopy revealed Cormack–Lehane grade 3a view of the vocal cords with external laryngeal manipulation. A Portex single-use tracheal tube introducer was first introduced up to 27 cm mark, after eliciting the tracheal click and hold-up signs. A Portex tracheal tube size 7 mm ID was railroaded over the introducer with some difficulty because of resistance, necessitating anticlockwise rotatory movements to slide the tube in, and the cuff was inflated. After intubation, there was a gush of blood through the tracheal tube. Correct placement was confirmed with capnography, and peak airway pressure was 32 $cmH_2O$. Repeated suctioning was performed through the tracheal tube, and the bleeding subsided gradually. On withdrawal, the tip of the introducer was found to have blood stain. A check bronchoscopy revealed soft tissue trauma at the carina. The patient was ventilated again, and airway pressure dropped to 19 $cmH_2O$. Her intra- and post-operative courses were uneventful. She was discharged 3 days after the operation without any further sequelae. While single-use introducers are useful in cases of difficult intubation, their use has been associated with airway trauma. We review the current use of single-use introducers and provide recommendations to minimise the associated trauma.


## 1. Introduction

Difficult tracheal intubation is an infrequent occurrence during anaesthesia-related airway management, but it occurs in 1.5%–8% of patients with seemingly normal airways [1]. To facilitate tube placement in the trachea, airway management guidelines advise the use of a stylet or a tracheal tube introducer (also known as a bougie) in cases of unanticipated difficulty [2]. An introducer is most often used when laryngoscopy reveals a poor view of the vocal cords (Cormack–Lehane [CL] grades 3 and above). A recent study involving patients undergoing emergency endotracheal intubation found the introducer to have a higher first-attempt intubation success rate than endotracheal tube + stylet [3]. Traumatic complications associated with introducers are rare but serious [4]. Many studies have found (single-use) introducers to be inexpensive [5] (~14 USD), portable, and easy to use and have a high success rate.

Two signs are considered important to confirm correct introducer placement: (1) the click sign—the introducer is correctly introduced intra-tracheally when a click sensation is felt as the tip slides over the tracheal cartilages, and (2) the distal hold-up sign—resistance felt at 25–40 cm as the tip hits the carina or a small bronchus. For most types of introducers, one or both of these vital signs should be elicited before railroading a tracheal tube over the introducer into the trachea [6].

We report a case of an unanticipated difficult intubation during elective thyroidectomy, where a single-use introducer led to soft tissue injury, which led to a gush of blood from the tracheal tube, but gradually subsided after suctioning with no ventilation problems intra-operatively. In addition, we review the current status of single-use introducers and provide evidence-based recommendations for their use in difficult intubation.

## 2. Case report

A 46-year-old woman with papillary carcinoma of the right thyroid lobe was scheduled for elective total thyroidectomy. Computed tomography (CT) scan showed tracheal compression and deviation to the left side, with no evidence of tracheal tumour infiltration.

She had a physical health status of American Society of Anesthesiologists (ASA) class 1 and was a non-smoker, with a height of

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160 cm, weight 73 kg (body mass index: 28.5), and no previous surgical history. Preoperative airway examination revealed no predictive signs of difficult intubation (mouth opening > 5 cm, dentition and thyromental distance normal, modified Mallampati class 2, neck circumference 40 cm).

After preoxygenating the patient with open cuff silicone face mask (Ambu) for 3 min with 100% O2 at 6 L/min, general anaesthesia was induced with fentanyl (2 μg/kg), propofol (2 mg/kg), and atracurium (0.5 mg/kg) after confirming mask ventilation. Laryngoscopy revealed a CL grade 3a under external laryngeal manipulation.

As per the protocol of our department, tracheal intubation was facilitated using the Portex™ 15-Fr 600-mm coudé tip single-use introducer (Smiths Medical, Hythe, UK), which was inserted easily between the vocal cords into the trachea up to 27 cm mark; both the click sign and the distal hold-up sign were used to confirm proper placement. Portex™ tracheal tube size 7-mm ID (Smiths Medical) was railroaded over the introducer with some difficulty because of resistance at the glottic opening. This necessitated forced anticlockwise rotatory movement to slide the tube inside the trachea [2,7]. After the tracheal tube was placed in the trachea, we removed the introducer.

As soon as we connected the tube to the breathing system to ventilate the patient's lungs, there was a gush of blood from the tracheal tube (Fig. 1). Correct tracheal tube placement was confirmed by end-tidal capnography, equal chest movements, and bilateral air entry into the lungs on auscultation. Peak airway pressure was 32 $cmH_2O$.

Endotracheal suction through the tracheal tube was performed repeatedly, and the bleeding gradually stopped. Throughout this event, the patient's transcutaneous O2 saturation (SPO2) remained >95% with no abnormalities on auscultation. On withdrawal, the tip of the introducer was found to have blood stain (Fig. 2).

Finally, a fibreoptic bronchoscopy to get a better picture of what happened and to rule out possible bleeding from tumour infiltration revealed only soft tissue trauma at the carina (27 cm). After that, airway pressure dropped to 19 $cmH_2O$ during ventilation of the patient's lungs and no further intraoperative ventilation problems or bleeding occurred. The patient's intra- and post-operative course was uneventful; immediate post-operative chest X-ray revealed no abnormalities. She was successfully extubated on the table and transported to the ward after the operation. Post-operative SpO2 was always above 95%. The patient was discharged from the hospital 3 days after the operation without any further sequelae.

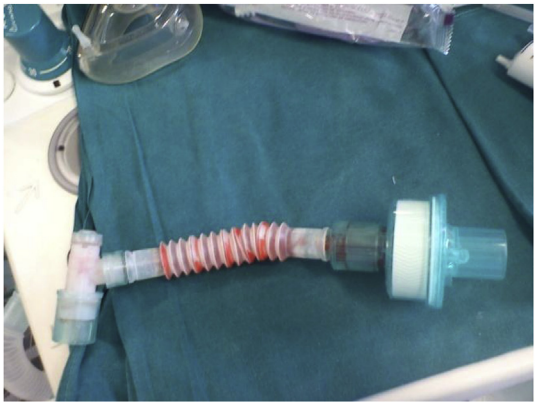

**Fig. 1.** Gush of blood through the catheter mount.

**Fig. 2.** Blood stain on the tip of the introducer on withdrawal.

## 3. Discussion

Introducers are commonplace in the anaesthesiology departments, and injuries due to their use are rare compared to the magnitude of their use worldwide. In our patient, the most probable explanation for the trauma was direct mechanical injury at the carinal level caused by inserting the introducer tip too distally and with probably too much force into the trachea during railroading and rotation of the tracheal tube. Fortunately, the complication resolved spontaneously; however, such incidents have been associated with severe pulmonary haemorrhage, pneumothorax, and hemothorax [4].

There are many factors that affect the success of an introducer in terms of trauma and efficacy, e.g., Cormack–Lehane grade, use of videolaryngoscopy, type of introducer used, experience of the intubator, eliciting the hold-up sign, etc. Use of an introducer in poorer views—grade 3 or higher—is complicated. All India Difficult Airway Association 2016 guidelines [2] and Difficult Airway Society (DAS) 2015 guidelines [7] recommend the use of a gum elastic bougie or a pre-shaped bougie/stylet to facilitate tracheal intubation in case of a grade 3a view on direct laryngoscopy and do not recommend blind insertion in grade 3b or 4 as it can lead to trauma. Studies have found introducers to be less traumatic and have higher first-attempt success rates than stylets [3,11].

Use of videolaryngoscopy for difficult intubation is very well recognised. The DAS 2015 guidelines [7] note that especially recommend using it for difficult intubation, especially combined with a gum elastic bougie because of its plasticity. While it is generally thought that its use might increase intubation time, studies [8] have found that their combined use reduces the intubation time taken by less-experienced anaesthesiologists and might thus be useful for other clinicians and paramedics in emergencies.

The distal hold-up sign is used to check the entry of the introducer in a small bronchus, but its use has been associated with lung trauma, airway perforation, as well as bronchospasm, particularly with single-use introducers [5,7]. This is because railroading the tracheal tube is sometimes difficult and necessitates placing force on the introducer, which already abuts against the bronchial wall. Thus, eliciting this sign is not recommended. As a solution, Paul et al. [9] described a traffic-light bougie, with green (0–21 cm) indicating a safe depth for introducer insertion, yellow (21–26 cm) indicating possible contact with the carina, and the rest (26 cm to the end) being red. They coded red starting from 26 cm because they found a high risk of carinal damage if an introducer is advanced beyond this point. Consider the distal hold-up sign is sometimes elicited as far as 40 cm, this concept prevents the

introducer from being inserted too far and obviates reliance on this sign.

Whether Portex tracheal tube or Frova intubating introducer is better for difficult intubation is controversial. Single-use introducers are generally not considered as they tend to be too rigid. Also, they have been criticised for not being extensively evaluated in human studies and extrapolation of results from manikin studies [5]. The Portex single-use introducer is rigid and less effective than the Eschmann introducer, whereas Frova has been found to be as effective but with a significant potential for trauma to the airway [10]. However, a recent trial found the Portex introducer to be non-significantly superior to Frova intubating introducer when used with video laryngoscopy [11].

Based on the guidelines, recent studies, and our clinical experience, we recommend the following possible approaches to circumvent these complications:

1. Advance the introducer and tracheal tube as gently as possible.
2. Use of other introducers like the Frova introducer which do not need eliciting any of the signs for correct introduction.
3. Avoid the hold-up sign or, if used, retract the tracheal introducer a few centimetres after the distal hold-up sign before railroading the tracheal tube over the introducer [12]. Alternatively, use a traffic-light bougie [8].
4. Use of only the click sign to ascertain the position of the introducer. The click sign is apparent in adults and older children if the introducer is correctly placed in the trachea. However, the ability to reliably feel the tracheal rings has been disputed [13].
5. A CT scan done pre-operatively can also be used to measure the distance to the carina, and thus guide the depth the introducer can go in.
6. Improve the tracheal tube's angle of insertion over the introducer by moving soft tissues out of the way with the laryngoscope; using a videolaryngoscope helps visualise of the ease with which the tube may slide in and determine which manoeuvre might be helpful in case of difficulty. In this case, however, the tip should be introduced in the oropharynx only under direct vision [7].
7. Minimise the risk of introducer migration by having an assistant 'stabilise' the introducer while advancing the tracheal tube into the trachea.
8. Limit the number of tracheal intubation attempts; the guidelines recommended a maximum of two [2] or three [7] attempts.
9. Introducers with a metal core should not be used as they can cause more harm to the tracheobronchial mucosa [14].
10. If an injury is suspected after intubation, a diagnosis can be made with tracheobronchoscopy, followed by a chest CT scan if needed.

It is important to prevent the blood from flowing distally in order to avoid aspiration of the blood if the continuous bleeding persists. In such a scenario, the area is infiltrated with topical adrenaline-soaked gauge pieces. Submucosal adrenaline can also be attempted. In severe cases, lung separation by a bronchial blocker or double lumen tube can be attempted until the bleeder is controlled. However, the possibility of increasing further bleeding due to stimulation of the bleeding lesion due to the large external diameter of the double lumen tube should not be ignored.

The best is to prevent such infraglottic airway injuries and bleed by an introducer during difficult intubation. Unfortunately, current airway management guidelines provide very little guidance on such events.

In conclusion, the learning point and our take-home message from this case are the following: based on the potential for harm and until newer and safer introducers are available, the hold-up sign should not be elicited if an introducer is being used to indicate proper depth of the introducer.

## Conflict of interest statement

The authors declare that they have no conflicts of interests associated with this manuscript.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tacc.2019.04.001.

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