

## Case Report

# Application of a new tracheal inducer to therapeutic flexible bronchoscopy for airway management: a case report

Chunlan Lin, Yaohua Yu, Qinghua Wu, Shenxian Lin

*Department of Anesthesiology, The First Hospital of Putian, Teaching Hospital of Fujian Medical University, Putian 351100, Fujian, P.R. China*

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**Abstract:** The ventilation methods during therapeutic flexible bronchoscopy vary among anesthesiologists and institutions, but each method has its own pitfalls. Therefore, improvement of the airway equipment is important. Here, we present a case in which a new tracheal inducer (Safe Easy Endotracheal Kit-flexible, SEEK<sup>flex</sup>) was applied in bronchoscopic balloon dilation under general anesthesia for airway management. This technology utilizes a flexible bronchoscope to reveal the glottis for tracheal placement of the SEEK<sup>flex</sup> to allow subglottic jet ventilation, illustrating the prominent function of performing SEEK<sup>flex</sup>-guided tracheal intubation in case of rapid sequence intubation. The SEEK<sup>flex</sup> can be easily inserted into the trachea transnasally without the aid of other devices, without significant kink and displacement during the jet ventilation. The SEEK<sup>flex</sup> could provide good airway control by facilitating sufficient ventilation, optimizing surgical access and guiding tracheal intubation when necessary.

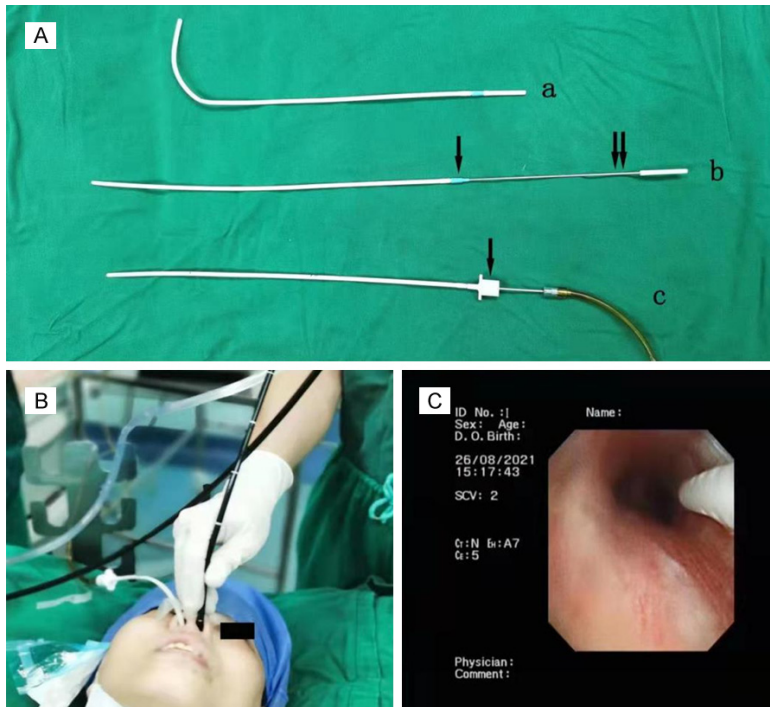
**Keywords:** Therapeutic flexible bronchoscopy, nasotracheal placement of SEEK<sup>flex</sup>, SEEK<sup>flex</sup>-guided tracheal intubation, subglottic jet ventilation, airway management

## Introduction

The therapeutic application of flexible bronchoscopy is expanding in both frequency and complexity [1]. The methods of ventilation and choices of airway device during flexible bronchoscopy vary among anesthesiologists and institutions, and each method has specific limitations [2, 3]. Subglottic high-frequency jet ventilation via a small catheter is frequently used to maximize visualization during flexible bronchoscopy. However, it provides less airway control during hemorrhage events than endotracheal tubes, which protect and selectively ventilate the non-bleeding lung. However, most jet catheters also have disadvantages. For example, nasotracheal intubation with a jet catheter is limited in that it is advanced along the posterior pharyngeal wall towards the esophagus, instead of the laryngeal inlet. A commonly used method to overcome this shortcoming is to railroad a jet catheter over a guidewire into the trachea using the Seldinger technique. However, this process is cumbersome and time-consuming

because of the short procedures. Thus, airway equipment needs to be continuously improved to allow simple and convenient airway control.

A new malleable tracheal inducer (Safe Easy Endotracheal Kit-flexible, SEEK<sup>flex</sup>) containing an accessory adapter, a smooth polyvinyl chloride (PVC) outer catheter and a malleable steel inner guide core, similar to an intubating stylet, has recently become available. The outer PVC catheter and the inner guide core are connected by a blue connector, which is located on the latter and cannot be removed. After removing the inner guide core, the outer PVC catheter can be connected with the anesthetic circle through its accessory adapter. The distal end of the outer PVC catheter has four rows of side holes and three holes at the top. The SEEK<sup>flex</sup> was originally designed for extubation and reintubation in patients with critical COVID-19 [4], but it has not yet been applied for therapeutic flexible bronchoscopy. Given that SEEK<sup>flex</sup> has a narrow catheter and facilitates intubation, here we



**Figure 1.** A. Use of the tracheal inducer: (a) The distal 6 cm portion of the inducer is angulated approximately 90° in advance. (b) The inducer acts as a guide for intubation when the inner guide core (pointed out by two arrows) is reconnected and locked by a blue connector (pointed out by an arrow). (c) The inducer is connected to the jet ventilator as a jet catheter through an adapter (indicated by the arrow). B. The patient during the procedure. C. The inducer is observed using flexible bronchoscopy.

present a novel application of SEEK<sup>flex</sup> in bronchoscopic balloon dilation (BBD) under general anesthesia for airway management. In this operation, a flexible bronchoscope was utilized to reveal the glottis for tracheal placement of the SEEK<sup>flex</sup> without any accessory tools, followed by subglottic jet ventilation, which illustrated the prominent function of performing SEEK<sup>flex</sup>-guided tracheal intubation in cases of rapid sequence intubation.

### Case presentation

A 43-year-old woman (158 cm, 56 kg, Body Mass Index 22.4) with a right middle lobar bronchial stenosis was scheduled to undergo BBD. We applied SEEK<sup>flex</sup> as a subglottic jet catheter for airway management during BBD after this novel application was agreed to by the patient. The distal 6 cm portion of the SEEK<sup>flex</sup> was angulated approximately 90° in advance. Pre-oxygenation for 3 min was followed by the induction of anesthesia through target-controlled infusion of propofol and remifentanyl

with an initial effect-site concentration of 3 µg/ml and 2.5 µg/L, respectively. After induction of anesthesia, a flexible bronchoscope was inserted into the left nare and positioned 4 cm above the vocal cord, and the glottis and vocal cord were revealed. Subsequently, the reshaped SEEK<sup>flex</sup> was inserted and advanced at a sharp angle through the right nare and nasopharynx, and then passed through the vocal cord into the trachea under the direct vision of a flexible bronchoscope. After the SEEK<sup>flex</sup> was inserted through the vocal cord, the inner guide core was removed, and the SEEK<sup>flex</sup> was advanced continually until it reached 3 cm above the carina in the view of the flexible bronchoscope. Finally, the matching adapter was placed at the outer end of the SEEK<sup>flex</sup> and connected to the jet ventilator (Figure 1A). Ventilation was started with a frequency

of 60 min<sup>-1</sup> at an I:E ratio of 1:2 under a driving pressure of 0.2 MPa. After observing considerable chest rise, we secured the SEEK<sup>flex</sup> next to the nose. During ventilation, no significant kink was observed at the end of the SEEK<sup>flex</sup> under the view of a flexible bronchoscope. Then a procedure was performed (Figure 1B and 1C). Anesthesia was maintained by infusion of propofol and remifentanyl, and the procedure was continued for 30 min. During the procedure, pulse oxygen saturation (SpO<sub>2</sub>) was from 96% to 98%, partial pressure of carbon dioxide in the artery (PaCO<sub>2</sub>) was maintained between 44 and 56 mmHg, and the patient neither coughed nor moved. After the procedure, a nasopharyngeal airway was introduced to allow the egress of air, and the patient awakened within 5 minutes. She tolerated the SEEK<sup>flex</sup> well, without cough or dysphoria. After the jet ventilation was stopped, the adapter was removed from the jet ventilator and connected to the anesthesia machine, which continued to supply oxygen to the patient via SEEK<sup>flex</sup>. The SEEK<sup>flex</sup> device was removed when the patient was fully awake. No adverse

effects, such as pneumothorax, hemoptysis or subcutaneous emphysema, were observed.

### Discussion

In this case, we found that the SEEK<sup>flex</sup> could be easily inserted transnasally into the trachea under the view of a flexible bronchoscope. This is attributed to its small outer diameter and plasticity, in combination with its inner guide core. The PVC catheter, with a 4.0 mm internal diameter and a 4.2 mm outer diameter, is thin, and hence, easy to maneuver. Because the inner guide core is semi-rigid and can be adjusted to various shapes, the bending angle of SEEK<sup>flex</sup> can be adjusted to comply with the curve of the nasopharynx, and the SEEK<sup>flex</sup> tip can be easily turned towards the glottis after passing through the nasopharyngeal passage. Operation using a semi-rigid curved inner guide core facilitates the advancement of the SEEK<sup>flex</sup> without the aid of other devices such as Magill forceps or a guidewire, which makes it unique among other jet catheters [5, 6]. Furthermore, the SEEK<sup>flex</sup> facilitates subglottic jet ventilation. After the inner guide core is removed, the SEEK<sup>flex</sup> can be soft enough to regain its original shape rapidly, which cannot maintain any other shapes when bended. We observed that it neither kinked nor displaced significantly during the jet ventilation. Also, there was no airway injury during the placement or the ventilation. Unlike other self-made devices [7], the PVC catheter, with a Shore A hardness of 77, is quite solid, so it cannot be easily compressed by the bronchoscope during the procedure.

Moreover, the SEEK<sup>flex</sup> could function as a guide for intubation. Considering the risk of severe hypoxemia or great airway bleeding during therapeutic flexible bronchoscopy, emergent rapid sequence intubation may be needed. If necessary, the tracheal tube could be intubated easily under the guidance of SEEK<sup>flex</sup> in these urgent situations. Flexible bronchoscope-guided intubation is also feasible, but may fail because the flexible bronchoscope tip is soiled by secretions or blood, which also limits the applicability of video-assisted laryngoscopes. This method is undoubtedly an important guarantee for the safety of ventilation. In addition, the SEEK<sup>flex</sup> can be used to deliver oxygen to patients with spontaneous ventilation. Spontaneous breathing may recover at any time due to general anesthesia without muscle relaxation. If so, oxygen supplementation can

be provided through the SEEK<sup>flex</sup>, which can be connected to the anesthetic circuit through a matching adapter. Because the patient tolerated the SEEK<sup>flex</sup> well without cough and was able to talk with the catheter in the trachea, the SEEK<sup>flex</sup> could continue providing oxygen until the patient was completely awake.

Other intubating introducers such as the Fronva, which is a hollow blue tube with a J-angle at its distal tip [8], can also be used for subglottic technique. However, it is unavailable in our hospital, and we have no experience in using it. Moreover, although the Fronva (with 4.6 mm outer diameter) is only 0.4 mm wider than the SEEK<sup>flex</sup>, the SEEK<sup>flex</sup>, whose outer catheter is white without a curved tip, seems much thinner and less obtrusive, providing a better view for the bronchoscope. The length of the Fronva is 70 cm, while the SEEK<sup>flex</sup> is 43 cm long, which is stretchable and seems easier to handle. Another issue is the significant cost difference. The SEEK<sup>flex</sup> is intended for one-time use, so it is much cheaper than the Fronva. A suit of SEEK<sup>flex</sup> costs around \$15.00, while the Fronva, including two types of adapters, costs about \$78.00. Also, there has not been any literature about the application of the Fronva for therapeutic flexible bronchoscopy, so the performance of the Fronva in this technology is uncertain and needs to be future studied.

In this case report, we demonstrated a potential novel application of the SEEK<sup>flex</sup> for airway management in BBD, finding it to be feasible and effective. As the SEEK<sup>flex</sup> can be performed easily without muscle relaxation under the view of a flexible bronchoscope and can facilitate intubation if necessary, it may be of great benefit in advanced diagnostic bronchoscopy, such as electromagnetic navigation bronchoscopy, endobronchial ultrasound and virtual bronchoscopy, or in short therapeutic flexible bronchoscopy, such as stent placement, BBD and resection of intratracheal tumor, both of which require deep sedation or general anesthesia, with short recovery time and no muscle relaxation during anesthesia. However, as our experience with the novel SEEK<sup>flex</sup> device is limited, further research is needed to evaluate its safety and effectiveness. However, this report indicates that SEEK<sup>flex</sup> should be considered as a new alternative airway equipment for airway management during therapeutic flexible bronchoscopy.

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## Disclosure of conflict of interest

None.

**Address correspondence to:** Dr. Yaohua Yu, Department of Anesthesiology, The First Hospital of Putian, Teaching Hospital of Fujian Medical University, No. 449 Nanmen West Road, Putian 351100, Fujian, P.R. China. E-mail: yyh.8@163.com

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