

Fibre-optic Aided Bougie (FAB) for Simulated Difficult Tracheal Intubation[†]

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Abstract

Introduction: Difficult intubation remains a key problem and the value of the gum elastic bougie as a first approach is well recognised. **Materials and Methods:** A fine fibre-optic endoscope (Rapiscopescope, Cook Critical Care) was used in 50 patients to verify placement of a custom-designed hollow plastic bougie prior to “rail-roading” a tracheal tube. Following induction and muscle relaxation, direct laryngoscopy was performed after two-minutes of assisted ventilation. The laryngoscope blade was lowered to simulate difficult intubation and the bougie passed behind the epiglottis. The position of the introducer bougie was then checked using the Rapiscopescope. Following correct bronchoscopic identification of the tracheobronchial anatomy, a tracheal tube was then “rail-roaded” following withdrawal of the scope. **Results:** All patients were successfully intubated following identification of the bronchial tree by the Rapiscopescope: three on the second attempt and the rest on the first. Mean (SD, range) time to successful bronchoscopic confirmation of correct placement of the bougie was 38 s (9.1 s, 19 to 60 s). All bronchoscopic assisted intubation were subsequently confirmed by capnography after tracheal tube insertion. Mean (SD, range) time to successful intubation was 106 s (14 s, 52 to 132 s). **Conclusion:** The fibre-optic assisted bougie (FAB) offers a promising technique in patients who may be difficult to intubate but who can be ventilated. Further developments are required to achieve a faster intubation time but oxygenation may be achieved by jetting down the hollow bougie.

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Introduction

Difficult intubation remains a key problem¹ and the value of a flexible introducer (gum elastic or wire) as a first approach is well recognised in the UK and USA.² It is the simplest method, effective for all grade 2 laryngoscopies, where at least the arytenoids are visible and most grade 3 laryngoscopies, where the epiglottis can be seen but no part of the glottis. Macintosh devised the method³ and also invented the Oxford tube⁴ for use with an introducer.

However, the main drawback of an introducer is that it remains a “blind” procedure—correct placement can only be determined once the tracheal tube is “rail-roaded” and end-tidal CO₂ detected. Oesophageal intubation is a well-known complication. It is usually detected clinically and by absence of a capnogram after tracheal tube placement. This entails the risk of hypoxaemia and regurgitation-aspiration of gastric contents. One of the most reliable ways of ensuring correct tracheal tube positioning is to see the tube pass between the vocal cords at laryngoscopy. This explains

the widespread popularity of the fibre-optic bronchoscope for awake intubation when difficulty is anticipated.⁵

Materials

With the recent availability of the fine fibre-optic endoscope (Rapiscopescope, Cook Critical Care, Bloomington, USA), we now have the means of verifying the placement of a home-designed modified plastic bougie prior to “rail-roading” the tracheal tube (Fig. 1). The plastic bougie is hollow with an internal diameter (4 mm); this allows passage of the Rapiscopescope or a flexible wire. The plastic bougie is adapted to mimic the curve of a gum elastic bougie. The length of the bougie is 2 cm less than that of the Rapiscopescope optical fibre (40 cm). The proximal end of the bougie allows the connection of a luer lock connector for jetting oxygen from a Sanders injector or high frequency ventilation. Hence the potential hypoxaemia which may result following a “Magill-type” tracheal tube becoming impacted at the cords following rail-roading can be alleviated

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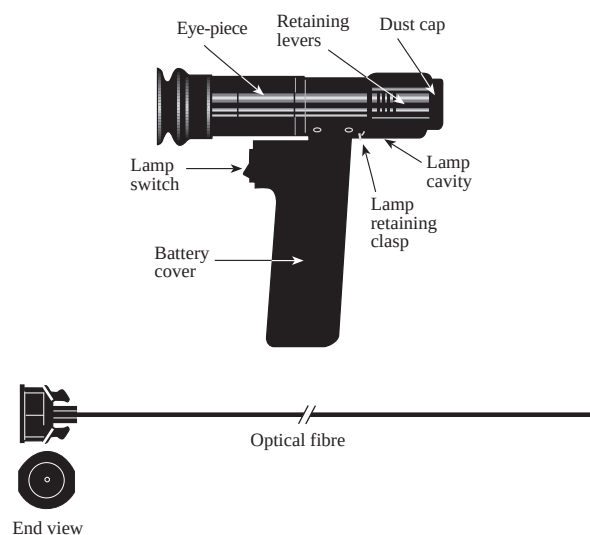


Fig. 1a. The Rapiscope (Cook Critical Care, Bloomington, USA) incorporating an optical fibre (40 cm) attached to a hand-held light source.

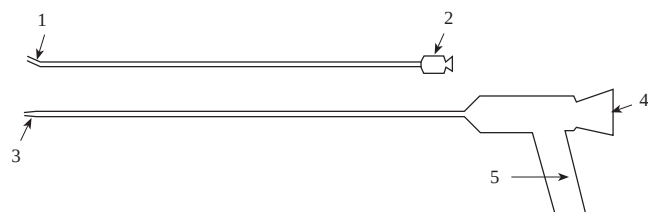


Fig. 1b. Hollow plastic bougie (1: distal tip, 2: Luer lock proximal connector) and Rapiscope (3: distal tip of optical fibre, 4: eye-piece, 5: battery cover of hand-piece).

by oxygenation down the hollow bougie. The hazard of regurgitation with oesophageal ventilation is also potentially avoided.

Patients and Methods

Following ethical committee approval and informed consent, 50 patients (ASA 1-3) requiring tracheal intubation for elective surgical procedures were recruited to the study. Excluded were patients with history of oesophageal reflux and anticipated difficulty in assisted ventilation. The airway was assessed and graded using the Mallampati score. After premedication with oral midazolam 7.5 mg one hour pre-operatively, anaesthesia was induced using thiopentone 3 mg/kg, fentanyl 1 µg/kg and maintained using 2% isoflurane in oxygen following muscle relaxation with atracurium 0.5 mg/kg. Following assisted ventilation for two minutes, direct laryngoscopy was performed (by CJW assisted by at least one co-investigator) and the view of the larynx graded according to the method of Cormack and Lehane.⁶ To simulate a difficult intubation, the laryngoscope blade was then lowered until the epiglottis obscured the cords.⁶ The bougie was then passed behind the epiglottis. The position of the bougie was ascertained using the Rapiscope passed

within the hollow bougie to protrude beyond the tip. A view of the tracheobronchial tree confirms correct placement. In case of failure to identify the tracheobronchial tree, the bougie was removed and following further ventilation, the procedure was repeated up to a maximum of 3 attempts. Following correct bronchoscopic identification of the tracheobronchial tree, the Rapiscope was removed from the hollow bougie and the tracheal tube “rail-roaded” over it. The correct positioning of the tracheal tube was then verified clinically and using capnometry. Demographic characteristics, Mallampati scores, laryngoscopy grades and the number of intubation attempts were noted. The time (seconds) from direct laryngoscopy to correct fibre-optic identification of the tracheobronchial tree as well as the time to correct placement of the tracheal tube were recorded.

Results

All 50 patients (age range 14 to 81 years) were successfully intubated following identification of the bronchial tree using the Rapiscope: three on the second attempt and the rest on the first (Table I). Mallampati and Cormack & Lehane scores in those requiring two attempts were both 1 in 1 patient and 2, each in the other 2 patients (Table II). Mean (SD, range) time to successful bronchoscopic confirmation of correct placement of the bougie was 38 s (9.1 s, 19 to 60 s). All bronchoscopic assisted intubation were subsequently confirmed by capnography after tracheal tube insertion. Mean (SD, range) time to successful intubation was 106 s (14 s, 52 to 132 s). All patients with laryngoscopy grades 3 were intubated on the first attempt. There were insufficient numbers of patients to perform significant statistical analysis of the relationship between Mallampati scores and the number of intubation attempts or time taken for intubation. There were no instances of hypoxaemia requiring the use of jet ventilation.

Discussion

The ability to achieve a 100% success rate in simulated difficult tracheal intubation (94% on the first attempt) with the modified bougie confirms the known usefulness of the technique.² The mean time of 38 s to fibreoptic identification of correct tracheal tube position is well within the safe limits for preoxygenated patients. However, the mean time

TABLE I: PATIENT DEMOGRAPHICS {MEAN (SD) [RANGE]}

Age (y)	43.3 (16.8) [14-81]
Weight (kg)	61.5 (11.7) [39-89]
Height (cm)	163.9 (3.8) [157-170]
Sex (M:F)	22:28
ASA (1:2)	30:20
Mallampati score (1:2:3)	37:10:3
Cormack & Lehane larynx grade (1:2:3)	39:5:6

TABLE II: MALLAMPATI AND CORMACK & LEHANE SCORES, NUMBER OF ATTEMPTS AT INTUBATION AND TIMES TO SUCCESSFUL VISUALISATION OF THE BRONCHIAL TREE AND TRACHEAL INTUBATION (s)

Mallampati Score	Number of patients	Number of patients requiring 1:2 attempts	Time to visualisation [mean (SD) s]	Time to successful intubation [mean (SD) s]
1	37	36:1	37 (12)	101 (13)
2	10	8:2	46.5(14)	112 (16)
3	3	3:0	52 (11)	102 (15)
Laryngoscopy Grade				
1	39	38:1	39 (11)	105 (12)
2	5	3:2	47 (9)	120 (12)
3	6	6:0	43.8(10)	111 (9)

to successful intubation of 106 s is longer than would be desirable. This is because the current length of the Rapiscope (40 cm) precludes the use of a standard length bougie. Hence, following fibre-optic identification of tracheo-bronchial anatomy, the hollow bougie needs to be withdrawn to allow a cut tracheal tube to be “rail-roaded” into position. This introduces the risk of inadvertently allowing the bougie to slip out if care is not taken. Incidentally a longer version of the Rapiscope optical fibre has subsequently been introduced by the manufacturer since the completion of this study. This may allow faster intubation time as there will not be a need to withdraw the bougie before rail-roading the tracheal tube into position.

The ultimate comparison needs to be made in a randomised study comparing the conventional technique of using the traditional bougie and the FAB, both in terms of success rate as well as speed. Further developments are in the pipeline using video technology and colour-charge coupled devices to optimise image quality,^{7,8} although the FAB retains the advantage of simplicity.

The exact place of the fibre-optic bougie or similar device in the anaesthetist’s armamentarium when faced

with difficult intubation remains as yet unresolved.^{9,10} One possible development could be to supplement the stylet or traditional bougie before reaching for the intubating bronchoscope in the unexpected difficult intubation case where oxygenation and ventilation are not yet compromised.

In summary, in this preliminary investigation, the fibre-optic assisted bougie (FAB) has been found to be satisfactory in its intended use; further developments in terms of increased length and use of a softer material need to be investigated. However, the capacity to jet oxygen down the hollow bougie allows more time for intubation in the “cannot intubate but can ventilate situation”.

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