Is it time for routine use of the retromolar fiberscope?

ABSTRACT

**Purpose:** This study aimed to determine the effectiveness, safety, and oral intubation time (IT) using a retromolar Bonfils fiberoptic scope compared with a conventional Macintosh laryngoscope.

**Materials and Methods:** Sixty patients (16-60 years old, American Society of Anesthesiology I/II) scheduled for general anesthesia for elective ear-nose-throat and plastic surgery were randomly divided into a Bonfils group (Group B, \( n = 30 \)) and a Macintosh group (Group M, \( n = 30 \)). Exclusion criteria included Mallampati IV, thyromental distance \( \leq 4 \) cm, mouth \( < 4 \) cm, cervical spine problems, body mass index \( > 35 \), sleep apnea, reflux esophagitis, coronary artery disease, intracranial vascular malformation, elevated intracranial pressure, bleeding disorders, allergies to planned drugs, and patient refusal. Mallampati scoring, mouth opening, and thyromental distance were used for airway assessment. The time needed for successful intubation (IT), number of attempts, number of failures, systolic (SBP), diastolic (DBP), mean blood pressure (MBP), heart rate (HR) and Oxygen saturation (\( O_2 \)) and damage to the lips, dentures, and pharyngeal or laryngeal structures were recorded. Continuous variables are presented as mean ± standard deviation and categorical variables are presented as frequency and percentage. Chi-square tests and Student's \( t \)-tests were used to compare the groups. \( P < 0.05 \) was considered statistically significant.

**Results:** The groups were comparable regarding demographic data, preoperative airway parameters, IT, the number of attempts, \( O_2 \), and the incidence of complications (\( P > 0.05 \)). However, Bonfils intubation was associated with more stable HR, SBP, DBP and MBP (\( P < 0.05 \)).

**Conclusion:** The Bonfils fiberoptic scope is comparable to a Macintosh laryngoscope but assures better hemodynamic stability. In difficult cases, the Bonfils scope is a better choice because of its ability to navigate.

**Key words:** Airway; Bonfils; intubation; Macintosh; retromolar

Introduction

Difficult airway mismanagement constitutes the single most important factor in anesthesia-related morbidity and mortality.\(^1\) Causes of difficult airway include congenital, inflammatory, neoplastic, traumatic, endocrine, and cervical spine disorders; extremes of age; obesity; and pregnancy.\(^2\)

Unexpected difficult airway, emergent situations, lack of facilities, and coexisting diseases can worsen a situation, especially if the intubator panics. The situation “cannot intubate, cannot ventilate” is life-threatening and, if not properly managed, can end in brain damage or even death.\(^3\)

Since its design in 1941 by Sir Robert Reynolds Macintosh,
the Macintosh laryngoscope has been widely used for endotracheal intubation. However, other airway devices have been developed to deal with difficult intubation.

Optical stylets have been used for more than 20 years by ear-nose-throat (ENT) surgeons. Anesthesiologists started to use these devices in the mid-1990s in cases with difficult airways. The adult Bonfils scope (Karl Storz GmbH, Tuttlingen, Germany) (Figure 1a and 1b) is formed of fiberoptic fibers in a stainless steel tube. It is a 40-cm-long, semi-rigid optical stylet with an external diameter of 5.0 mm and a fixed anterior tip curvature of 40°. The endotracheal tube is fixed by a cone-shaped adaptor that has a side port. The side port can be used for oxygen insufflation or local anesthetic instillation. The intubator can directly use the scope’s eyepiece or use an attached monitor to visualize the airway. The monitor enables teaching, sharing opinions, and documenting the procedure.

Materials and Methods

This study involved 60 patients (aged 16-60 years old, American Society of Anesthesiology I or II) who were scheduled for elective ENT and plastic surgery at Rumailah Hospital (HMC, Doha, Qatar). The Hamad Medical Corporation Research Committee granted approval (RC/0924/2009) number 8190/08.

Exclusion criteria were as follows: Mallampati IV, thyromental distance (TM distance) ≤4 cm, mouth opening <4 cm, cervical spine problems, body mass index (BMI) >35, sleep apnea, age of <16 or >60 years, reflux esophagitis, a history of coronary artery disease, intracranial vascular malformation, elevated intracranial pressure, bleeding disorders, allergies to any of the planned anesthetic agents, and patient refusal.

During the preoperative visit, patients were classified according to the modified Mallampati test by maximally protruding their tongues from a fully open mouth while sitting upright. The TM distance was measured as a straight line from the thyroid notch to the most anterior part of the chin with the head fully extended. Additionally, age, sex (male/female), height, weight, and BMI were collected for every patient. Finally, the degree of mouth opening and neck mobility were assessed. Both airway management techniques were explained to patients, and written consents were obtained.

All patients received midazolam 0.1 mg/kg and glycopyrrolate 0.2 mg IM 30 min prior to surgery. Before induction of anesthesia, the patients were randomly assigned (using a randomization computer program) to receive either fiberoptic intubation using the Bonfils scope (Group B, n = 30) or Macintosh laryngoscopy (Group M, n = 30).

Anesthesia equipment, drugs, and airway management devices were prepared. The standard monitors were connected including: O₂, HR, SBP, DBP and MBP which were recorded just before intubation. Mask oxygen at 10 L/min was provided for 3 min. Anesthesia was induced with fentanyl 2 mcg/kg, propofol 2 mg/kg, and cisatracurium 0.16 mg/kg. Positive pressure ventilation with 3% sevoflurane in 100% oxygen was provided for 3 min using a face mask and oropharyngeal airway. Bonfils and Macintosh intubation were performed by two experienced anesthesiologists. Each had previously performed at least 50 successful intubations.

In Group B, tracheal intubation was performed using an adult Bonfils retromolar model [Karl Storz-Endoskope, Telepack Pal 20043020; Figure 1]. The Bonfils scope was loaded with a 7.5-mm inner diameter ETT for males and a 7-mm ETT for females. The intubator’s left hand was used to pull the tongue and mandible upward. The Bonfils scope was introduced from the right side of the mouth (behind the last molar teeth), then slid behind the back of the tongue until the uvula was seen. The scope was rotated to direct its tip backward in the midline in order to visualize the epiglottis and laryngeal opening. The scope was then introduced a short distance inside the larynx, and the ETT was detached and pushed (under vision) inside the glottis using a gentle rotating movement. The patient’s head and neck were first kept in a neutral position; if the intubation trial failed, careful head flexion and neck extension were established.

In Group M, tracheal intubation was performed using a standard Macintosh 3 blade with the patient’s head and neck placed in the snifing position according to Horton et al.
Immediately after intubation, the breathing circuit was connected to the ETT. Intubation was considered successful when end-tidal carbon dioxide was detected by capnography during the first three expirations. Both sides of the chest and epigastrium were auscultated to exclude inadvertent endobronchial or esophageal intubation.

Intubation time (IT) in seconds was recorded using a stopwatch; it was measured from the moment that the Bonfils or Macintosh scope was inserted into the oropharynx until end-tidal carbon dioxide detection. $O_2$, HR, SBP, DBP and MBP were measured just after intubation. An intubation attempt was defined as the entire process of instrument insertion and removal in and out of a patient’s pharynx. If there were three failed intubation attempts, other alternatives were used according to a difficult airway algorithm.

Data were recorded on a data collection sheet and included age, sex, BMI, weight, height, mouth opening (cm), TM distance, Mallampati score, the number of trials, IT (until successful intubation), and damage to the lips, dentures, and pharyngeal or laryngeal structures. Changes in HR, $O_2$, SBP, DBP, and MBP before and after intubation were also recorded. All statistic analysis ($t$-test; paired and unpaired, and Chi-square test) were performed using SPSS 14.0 for Windows, SPSS Chicago, IL, USA.

**Results**

Both groups had comparable demographic data and preoperative airway parameters ($P>0.05$), [Table 1].

The Bonfils scope showed a profile of easier intubation in comparison to the Macintosh. There were no significant differences between the groups regarding the time until intubation, the number of trials, or the complication rate [Tables 1 and 2]. However, patients in the Bonfils group showed a significantly more stable hemodynamic response [Figures 2-4 and Tables 2-4].

**Discussion**

Compared to the Macintosh scope, intubation with the Bonfils scope does not require elevation of the epiglottis and consequently results in less stress response. The hemodynamic stability that we observed correlates with the results of a study published by Najafi et al.[$^{10}$]. This characteristic of the Bonfils scope could be beneficial in patients with hypertension and coronary artery disease.

Most airway management devices have a certain fixed, preformed shape that limits their ability to navigate, whereas good navigation ability is a characteristic of flexible fiberoptic scopes and the Bonfils retromolar scope. In this context, navigation means the ability to move in different directions to obtain the best view of the laryngeal opening.[$^{6}$]
A flexible scope can be introduced down the tracheobronchial tree through the oral or nasal route. It should be kept stretched, so that the tip is directed by proximal end control and twisting of the shaft. When entry into the trachea is confirmed, the tip should be straightened before advancement of the ETT. Because they are expensive and have fragile fiberoptic bundles, flexible scopes are usually reserved for difficult airway cases; this decreases learning opportunities for junior anesthesiologists.\textsuperscript{11,12}

During intubation, elevation of the mandible with the intubator’s left hand will move the tongue away from the pharyngeal wall, which helps to open the space available for navigation.\textsuperscript{6,13} Because the Bonfils scope is semi-rigid, it is able to elevate the epiglottis and move soft tissues.\textsuperscript{6}

In this study, because all cases were successfully intubated with both scopes, it is difficult to give an advantage to either in cases of the difficult airway. Also, to avoid additional Macintosh use in the Bonfils group, this study did not include Cormack and Lehane grading, which would have added more time and intubation trials at the expense of patient safety. This could have increased the risk of injury, cardiorespiratory changes, stomach inflation, and aspiration. It is important to note that the view seen during Bonfils intubation, unlike that of the Macintosh scope, is improved through navigation. This means that what is seen through the Bonfils scope cannot be compared to what is seen through the Macintosh laryngoscope.

In previous studies, the Bonfils scope has been successfully used to intubate not only patients with normal airways but also those with difficult airways (expected or unexpected), including cases in which Macintosh intubation had failed. It is also useful in patients with limited neck mobility, cervical spine immobility or injuries, limited mouth opening, protruding incisors, large tongues, and those with a high larynx.\textsuperscript{6} This device can also be helpful for the management of “can’t intubate, can’t ventilate” situations, and it can provide endoscopic guidance during percutaneous tracheostomies.\textsuperscript{14}

Byhahn et al.\textsuperscript{15} used a rigid cervical immobilization collar to simulate difficult intubation and showed that the Bonfils fiberoptic scope was a more efficient tool for tracheal intubation compared with direct laryngoscopy. Abramson et al.\textsuperscript{6} successfully used the Bonfils fiberoptic scope for awake orotracheal intubation in 5 patients with anticipated difficult airways. Finally, Caruselli et al.\textsuperscript{16} demonstrated the successful use of a pediatric Bonfils fibroscope to intubate a small for gestational age newborn.

### Table 1: Demographic data and preoperative airway parameters

|                | Group B: Retromolar mean±SD | Group M: Mac mean±SD | T-test | P-value |
|----------------|-----------------------------|----------------------|--------|---------|
| Age (y)        | 32.73±9.47                  | 38.76±14.99          | 1.90   | 0.06    |
| Sex (male/female) | 17/13                    | 18/12                |        |         |
| Height (m)     | 1.61±0.16                   | 1.67±0.10            | 1.78   | 0.08    |
| Weight (kg)    | 75.94±13.10                 | 78.00±15.27          | 0.059  | 0.42    |
| BMI            | 30.77±13.80                 | 28.11±6.82           | 0.94   | 0.58    |
| TM distance (cm)| 7.08±0.70                  | 6.88±0.62            | 1.15   | 0.35    |
| Mouth open (cm)| 4.66±0.40                  | 4.85±0.50            | 1.55   | 0.141   |
| Mallapatti     | I=82%                       | I=80%                |        |         |
| classification  | II=10%                      | II=12%               |        |         |
| III=6%         | III=8%                      | III=8%               |        |         |
| No of trials   | 1=99%                       | 1=97%                |        |         |
| Injury %       | 2=1%                        | 2=3%                 |        |         |

### Table 2: Comparison between group B and group M

|                | Group B: Retromolar Mean±SD | Group M: Mac Mean±SD | T-test | P-value |
|----------------|-----------------------------|----------------------|--------|---------|
| HR 1           | 79.17±11.86                 | 79.73±15.73          | 0.16   | 0.88    |
| HR 2           | 79.40±11.43                 | 86.77±15.45*         | 2.10   | 0.04    |
| Pao2 1         | 99.17±0.70                  | 99.46±0.68           | 1.68   | 0.10    |
| Pao2 2         | 99.03±0.81                  | 99.17±1.21           | 0.50   | 0.62    |
| SBP 1          | 117.13±13.63                | 123.60±13.51         | 1.85   | 0.07    |
| SBP 2          | 117.70±10.77                | 126.6±11.95*         | 3.04   | 0.004   |
| DBP 1          | 68.40±8.78                  | 73.13±8.61           | 1.97   | 0.054   |
| DBP 2          | 67.23±7.97                  | 73.80±8.89*          | 3.01   | 0.004   |
| MBP 1          | 84.64±9.06                  | 89.96±10.42*         | 2.11   | 0.04    |
| MBP 2          | 84.06±7.84                  | 91.08±9.21*          | 3.18   | 0.002   |
| IT (Sec)       | 25.50±9.94                  | 35.93±11.01*         | 3.85   | 0.003   |

\*(Statistically significant, \(P < 0.05\))

### Table 3: Comparison of readings before and after intubation in Group (M)

|                | Group M: Mac time 1 mean±SD | Group M: Mac time 2 mean±SD | T-test | P-value |
|----------------|-----------------------------|-----------------------------|--------|---------|
| HR             | 79.73±15.73                 | 86.77±15.45*               | 9.70   | .000    |
| Pao2           | 99.47±0.68                  | 99.17±1.21                 | 1.27   | 0.21    |
| SBP            | 123.60±13.51                | 126.6±11.95*               | 2.31   | 0.03    |
| DBP            | 73.13±9.81                  | 73.80±8.89                 | 0.60   | 0.55    |
| MBP            | 89.96±10.42                 | 91.08±9.21                 | 0.60   | 0.55    |

\*(Statistically significant, \(P < 0.05\))

Oxygenation can be achieved through the side channel of the Bonfils fibroscope, but the flow should be limited to 6 L/min. Hemmerling and Bracco\textsuperscript{17} reported a case of cervical and facial surgical emphysema following use of a Bonfils fiberoptic scope with oxygen flow at a rate of 10 L/min; accordingly, they advised others to decrease oxygen flow to 6 L/min.

The Macintosh laryngoscope is not suitable for navigation because it has a fixed blade shape. In cases of the difficult airway, the intubator can only change blade size, adjust the patient’s head and neck position, or use a stylet, bougie, or other...
equipment. In contrast, the Bonfils scope allows navigation among tissues and in different directions, irrespective of variations in anatomy until successful intubation is achieved.

The anesthesiologists involved in this study had all performed more than 50 intubations with the Bonfils scope. We encourage training with this instrument and routine use during endotracheal intubation, which will be helpful in cases of both easy and difficult airways.

A limitation of this study is that expert Bonfils operators performed the intubations; their success should not be extrapolated to those with less experience. However, this can encourage colleagues to build their experience base. Other limitations include the relatively small number of patients and the inclusion of patients undergoing operations on the nose or throat in which it could be difficult to determine whether blood or injuries were related to use of the Bonfils scope versus the surgery. The authors recommend further studies to avoid these limitations.

Awake intubation using local anesthesia, with or without sedation, seems to be easier with the Bonfils scope than with the Macintosh laryngoscope because there is a better view at the screen and recording facility, a less stress response is elicited, and the patient can open his or her mouth to widen the space and facilitate easier navigation. The authors also recommended that further studies which address use of the Bonfils fiberscope versus the surgery. The authors recommend further studies that avoid these limitations.

Awake intubation:

The Bonfils scope should be used routinely like the Macintosh laryngoscope, because it has similar efficacy and is associated with more stable hemodynamics. Because of its unique navigation ability, the Bonfils scope also seems to be more helpful in cases with difficult airways. Anesthesiologists should start to build their experience base with this device by repeated practice.

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**Conflicts of interest**

There are no conflicts of interest.

**References**

1. Benumof JL. Management of the difficult adult airway. With special emphasis on awake tracheal intubation. Anesthesiology 1991;75:1087-110.
2. Practice guidelines for management of the difficult airway. A report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. Anesthesiology 1993;78:597-602.
3. Wong DT, Lai K, Chung FF, Ho RY. Cannot intubate-cannot ventilate and difficult intubation strategies: Results of a Canadian national survey. Anesth Analg 2005;100:1439-46.
4. Burkle CM, Zepeda FA, Bacon DR, Rose SH. A historical perspective on use of the laryngoscope as a tool in anesthesiology. Anesthesiology 2004;100:1003-6.
5. Davis L, Cook-Sather SD, Schreiner MS. Lighted stylet tracheal intubation: A review. Anesth Analg 2000;90:745-56.
6. Abramson SI, Holmes AA, Hagberg CA. Awake insertion of the Bonfils retromolar intubation fiberscope in five patients with anticipated difficult airways. Anesth Analg 2008;106:1215-7.
7. O’Leary AM, Sandison MR, Roberts KW. History of anesthesia; Mallampati revisited: 20 years on. Can J Anaesth 2008;55:250-1.
8. Naguib M, Malabarey T, AlSatli RA, Al Damegh S, Samarkandi AH. Predictive models for difficult laryngoscopy and intubation: A clinical, radiologic and three-dimensional computer imaging study. Can J Anaesth 1999;46:748-59.
9. Horton WA, Fahy L, Charters P. Defining a standard intubating position using “angle finder”. Br J Anaesth 1989;62:6-12.
10. Najafi A, Rahimi E, Shariat Moharari R, Hussain Khan Z. Bonfils fiberscope: Intubating conditions and hemodynamic changes without neuromuscular blockade. Acta Med Iran 2011;49:201-7.
11. Rosenblatt W, Ianus AI, Sukhupragarn W, Fickenscher A, Sasaki C. Preoperative endoscopic airway examination (PPEA) provides superior airway information and may reduce the use of unnecessary awake intubation. Anesth Analg 2011;112:602-7.
12. Stackhouse RA. Fiberoptic airway management. Anesthesiol Clin North America 2002;20:933-51.
13. Rosenblatt WH, Sukhupragarn W. Airway management. In: Barash PG, Cullen BF, Stoelting RK, Cahanal MK, Stock MC, editors. Clinical Anesthesia. 6th ed. Philadelphia: Lippincott William & Wilkins; 2009.
14. Buehner U, Oram J, Elliott S, Mallick A, Bodenham A. Bonfils semirigid endoscope for guidance during percutaneous tracheostomy. Anesthesia 2006;61:665-70.
15. Byhahn C, Nemetz S, Breitkreutz R, Zwisler B, Kaufmann M, Meining M. Brief report: Tracheal intubation using the Bonfils intubation fibrescope or direct laryngoscopy for patients with a simulated difficult airway. Can J Anaesth 2008;55:232-7.
16. Caruselli M, Zannini R, Giretti R, Rocchi G, Camilletti G, Bechi P, et al. Difficult intubation in a small for gestational age newborn by Bonfils fibrescope. Paediatr Anaesth 2008;18:990-1.
17. Hemmerling TM, Braeco D. Subcutaneous cervical and facial emphysema with the use of the Bonfils fibrescope and high-flow oxygen insufflation. Anesth Analg 2008;106:260-2.