# Technical Report

# Light-guided retrograde intubation

Orlando R. Hung MD FRCPC,
Mohammad Al-Qatari MB BS

**Purpose:** Transillumination of the soft tissues using a lightwand (Trachlight™) can guide the endotracheal tube (ETT) into the glottis to facilitate the retrograde intubation. This study evaluated the effectiveness and safety of this intubating technique for patients with cervical spine instability.

**Methods:** After obtaining institutional approval and informed consent, 27 patients were studied. Light-guided retrograde intubation was performed either awake, or under general anaesthesia. Following cricothyroid membrane puncture using a #18 *iv* catheter, an epidural catheter was advanced cephalad into the oropharynx. While pulling the epidural catheter taut, the ETT, with the Trachlight™ in place, was advanced into the glottis. When the tip of the ETT entered the glottis, a bright glow was seen in the anterior neck. The number of attempts, failures, complications, the times required to puncture the cricothyroid membrane, insert the epidural catheter, and insert the ETT into the trachea were recorded.

**Results:** In all patients, the tracheas were successfully intubated. The mean (± sd) time to perform cricothyroid puncture, insert the epidural catheter, and place the ETT into the trachea were 66.1 ± 56.2, 74.0 ± 25.2, and 72.8 ± 42.5 sec respectively. The average total-time for this light-guided retrograde intubating technique was 205.8 ± 78.3 sec. Apart from minor bleeding at the cricothyroid membrane puncture site, there were no major complications.

**Conclusion:** In a small number of patients, we have shown that light-guided retrograde intubation is effective and safe for patients with cervical spine instability. This simple and inexpensive technique may prove to be a valuable adjunct in the management of difficult airways.

**Objectif :** La transillumination des tissus mous avec un guide lumineux (Trachlight™) permet de diriger le tube endotrachéal (TET) dans l'orifice glottique et facilite ainsi l'intubation rétrograde. Cette étude évalue l'efficacité et innocuité de cette technique d'intubation chez des patients à colonne cervicale instable.

**Méthodes :** Après l'obtention de l'approbation des instances appropriées et d'un consentement éclairé, 27 patients ont été étudiés. L'intubation rétrograde avec un guide lumineux a été réalisée soit à l'état vigile, soit sous anesthésie générale. Une fois la membrane cricothyroïdienne perforée avec une canule intraveineuse 18G, un cathéter épidural a été avancé dans l'oropharynx en direction céphalique. Le TET avec le Trachlight™ en place a été enfilé sur le cathéter maintenu sous tension et poussé vers la glotte. Quand l'extrémité du cathéter a pénétré dans l'orifice glottique, une lueur intense a fait son apparition à la région cervicale antérieure. On a enregistré le nombre de tentatives, d'échecs, de complications, le temps requis pour la perforation de la membrane cricothyroïdienne et pour l'insertion du cathéter épidural et l'introduction du TET dans la trachée.

**Résultats :** L'intubation trachéale a réussi chez tous les patients. Les temps moyens (±ÉT) requis pour la perforation cricothyroïdienne, l'insertion du cathéter épidural et la mise en place du TET dans la trachée étaient respectivement de 66 ± 52,2, 74,0 ± 25,2 et de 72,8 ± 42,5 s. Au total, cette intubation rétrograde a duré en moyenne de 205,8 ± 78,3 s. À l'exception d'un léger saignement au site de la ponction cricothyroïdienne, il n'y a pas eu de complications majeures.

**Conclusion :** Nous avons démontré l'efficacité et l'innocuité de l'intubation rétrograde avec un guide lumineux chez un petit nombre de patients à colonne cervicale instable. Cette technique simple et peu coûteuse pourrait nous aider à gérer efficacement les voies aériennes difficiles.

From the Departments of Anaesthesia and Pharmacology, Dalhousie University Halifax, Nova Scotia, Canada.
*Address correspondence to*: Dr. Orlando Hung, Department of Anaesthesia, Queen Elizabeth II Health Sciences Centre, Victoria General Hospital, Halifax, Nova Scotia, Canada B3H 2Y9; E-mail: hungorla@is.dal.ca; Phone: 902-473-7767; Fax: 902-423-9454.
*Accepted for publication May 9, 1997.*

IN 1960, Butler and Cirillo reported the first retrograde intubation in surgical patients through an existing tracheostomy opening.[1] The technique was subsequently modified by Waters who performed a cricothyroid membrane puncture using a Tuohy needle.[2] Waters inserted an epidural catheter through the Tuohy needle to advance cephalad so that the catheter was brought out through the mouth. An endotracheal tube (ETT) was then threaded over the epidural catheter. While pulling both ends of the catheter taut, the ETT was guided into the trachea. After the ETT entered the trachea, the catheter was pulled out through the oral cavity.

The placement of the light bulb of a lightwand at the tip of the endotracheal tube (ETT) during retrograde intubation can potentially guide tube advancement, as a bright circumscribed glow can be readily seen in the anterior neck when the tip of the ETT enters the glottic opening, thus improving the success rate of the technique.

The goal of the study was to evaluate the effectiveness and safety of light-guided retrograde intubation by using a lighted-stylet for patients with cervical spine fractures and instability.

## Methods

After obtaining the approval of the institutional review board, patients with a history of cervical spine fracture and instability who were scheduled for elective surgery were recruited into the study. Exclusion criteria were uncooperative patients, patients requiring an emergency surgical procedure or patients who had a history of gastro-oesophageal reflux or coagulopathy. All patients were informed of the use of the light-guided retrograde intubating technique for the placement of an endotracheal tube (ETT) into the trachea. An alternative technique using a fibreoptic bronchoscope would be used if the retrograde intubating technique was unsuccessful. All patients were given a choice of two anaesthetic techniques for intubation: (a) awake under topical anaesthesia; (b) asleep under general anaesthesia. All patients were informed of the advantages and risks of each of the intubating techniques. An informed consent was obtained from all patients. With the assistance of either another staff anaesthetist or an anaesthesia resident, all intubations were performed by one of the authors who are experienced in the use of the Trachlight™ and retrograde intubation.

### *The technique of retrograde intubation using the lighted-stylet*

#### (1) EQUIPMENT

The equipment necessary for light-guided retrograde intubation is listed in Table I. Although the Trachlight™, a newly designed lighted stylet,[3] was used in this study, it should be emphasized that any lighted-stylet with adequate flexibility and length might also be suitable. The Trachlight™ consists of three parts: a reusable handle, a flexible wand, and a stiff removable stylet. The wand consists of a plastic shaft with a bright light bulb affixed at the distal end. With the removal of the stiff internal stylet of the Trachlight™, the wand becomes flexible. The pliability of the wand and ETT facilitates its insertion into the trachea during intubation. Lubrication of the flexible wand using a water soluble lubricant will facilitate the retraction of the wand from the ETT following intubation.

#### (2) PATIENT PREPARATION

For those patients who were awake for tracheal intubation, topical anaesthesia was achieved.[4] After gargling 30 ml lidocaine 2–4%, additional anaesthesia of the upper airway was achieved by nebulizing 15 ml tetracaine 0.45% with epinephrine via a DeVilbiss atomizer. Additional laryngeal anaesthesia was produced by transtracheal injection of 4 ml lidocaine 2% through the #18 *iv* catheter following the cricothyroid membrane puncture. Sedation was achieved with judicious doses of midazolam and/or propofol *iv* during intubation, as described previously.[4]

Patients who chose general anaesthesia for tracheal intubation were denitrogenated for five minutes prior to induction of anaesthesia. Anaesthesia was induced with 1.5–2.5 $mg \cdot kg^{-1}$ propofol *iv*. After loss of consciousness, manual ventilation was provided via a face

TABLE I Equipment necessary to facilitate light-guided retrograde intubation

| *Equipment* | *Function* |
|---|---|
| #18 gauge needle | for skin puncture to facilitate cricothyroid membrane puncture |
| #18 intravenous catheter (Jelco™) and 5 ml syringe | cricothyroid membrane puncture and aspiration of free air |
| Trachlight™ (with the internal stylet removed) | transillumination of the soft tissues of the neck |
| #18 epidural catheter | to guide the ETT into the trachea |
| Magill forceps and a laryngoscope | to retrieve the epidural catheter from the oral cavity |
| 4 × 4 gauze | to hold the tongue forward during intubation |
| water-soluble lubricant | to facilitate the removal of the wand from the ETT following intubation |

mask. If ventilation was difficult, the patient was awakened and retrograde intubation was then carried out awake under topical anaesthesia. If ventilation was adequate, a muscle relaxant (1–1.5 $mg \cdot kg^{-1}$ succinylcholine or 0.1 $mg \cdot kg^{-1}$ vecuronium *iv*) was administered. Tracheal intubation was then carried out using the light-guided retrograde technique.

### (3) LIGHT-GUIDED RETROGRADE INTUBATION

Since there was no cervical spine manipulation during the light-guided retrograde intubation, no attempts were made to immobilize the cervical spine during intubation. However, tracheal intubation in patients with halo-jacket or skull-traction tongs was performed with the immobilization devices in place.

A cricothyroid membrane puncture was performed using a #18 gauge *iv* catheter over needle (Jelco™, Critikon, Tampa, FL) in the midline with a 450 cephalad angle. The *iv* catheter was less traumatic and substantially easier to use than a Tuohy needle. After confirmation of tracheal placement of the *iv* catheter by the aspiration of free air, a #18 gauge epidural catheter (Concord Portex, Keene, New Hampshire) was inserted through the *iv* catheter and advanced cephalad into the oropharynx. The epidural catheter was readily retrieved from the mouth using the Magill forceps and laryngoscope. The *iv* catheter was removed from the neck. The epidural catheter was then inserted into the ETT. The pliable Trachlight™, with the internal stylet removed, was then inserted into the endotracheal tube alongside the epidural catheter until the light bulb was positioned close to the tip of the ETT. The epidural catheter was passed through the clamp on the handle of the Trachlight™ (Figure 1). The tip of the ETT was lubricated to facilitate its entry into the glottic opening. The tongue of the patient was then gently pulled forward by an assistant to elevate the epiglottis and provide a clear glottic passage. While pulling the epidural catheter taut from both ends, the ETT and Trachlight™ assembly was inserted into the oropharynx. When the tip of the ETT entered the glottic opening, a bright circumscribed glow was readily seen in the anterior neck, slightly below the thyroid prominence (Figure 2). While relaxing the tension of the epidural catheter at the distal end, the ETT was advanced gently into the trachea. The Trachlight™ was then removed from the ETT. Following confirmation of intratracheal placement of ETT using end-tidal $CO_2$, the epidural catheter was removed through the mouth. A gentle examination was made of the oropharynx using a laryngoscope to identify any mucosal bleeding, soft tissue or dental injury. A video camera was used to record the intubation procedure so that the intubation time could be determined.

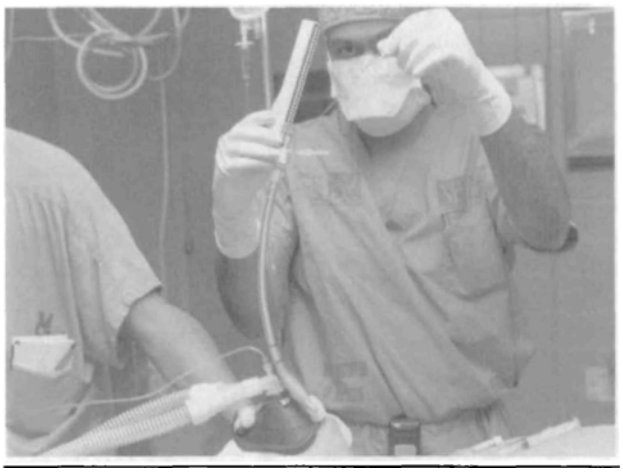

FIGURE 1 The pliable Trachlight™, with the internal stylet removed, was inserted alongside with the epidural catheter into the endotracheal tube. The epidural catheter was passed through the clamp on the handle of the Trachlight™ (arrow).

FIGURE 2 While pulling both ends of the epidural catheter taut, the endotracheal tube together with the lightwand was advanced gently into the glottis. When the tip of the endotracheal tube entered the glottic opening, a bright circumscribed glow could be seen in the anterior neck just below the thyroid prominence (arrow). While relaxing the tension at the distal end of the epidural catheter, the endotracheal tube together with lightwand could advance further down into the trachea.

An attempt was considered when the ETT-TL assembly was advanced over the epidural catheter into the glottis. When the attempt was unsuccessful, the ETT-TL was removed from the oropharynx so that manual ventilation could be resumed. Three attempts were permitted, with ventilation with 100% oxygen

interposed. If light-guided retrograde intubation was unsuccessful, an alternative approach, such as awake fibreoptic intubation, would be used. The number of attempts, failures, and times required to puncture the cricothyroid membrane, insert the epidural catheter (from the time the epidural catheter was inserted into the *iv* catheter to the time the epidural catheter was retrieved from the oral cavity), and insert the ETT (from the time the ETT-TL assembly entered the oral cavity to the time the Trachlight was removed from the ETT) were recorded. Following extubation, the presence of sore throat was assessed and recorded prior to discharge from the Post Anaesthetic Care Unit.

## Results

Twenty-seven patients (19 male, 8 female) were studied (Table II). Most of the patients studied had a cervical spinal fracture (66.7%). The cervical spines of 15 of these patients were immobilized either with skull-traction tongs (n = 8) or with a halo-jacket (n = 7). The remaining patients had instability of the cervical spine due to either rheumatoid arthritis (29.6%), or malignancy (3.7%) involving the spine. In the majority of patients intubation was performed under general anaesthesia (74.1%). None of the patients had difficulties in mechanical ventilation following induction of anaesthesia and thus none required awake fibreoptic intubating technique. Tracheal intubation of all the patients as successful using this light-guided retrograde technique with the majority completed after one attempt (81%). Tracheal intubation of the remaining patients (19%) was successful after two attempts. The mean (± sd) times to perform the cricothyroid membrane puncture, insert the epidural catheter, and place the ETT into the trachea were 66.1 ± 56.2, 74.0 ± 25.2, and 72.8 ± 42.5 sec respectively. The average total-time to intubation with this technique was 205.8 ± 78.3 sec. Apart from minor bleeding at the cricothyroid membrane puncture site, there were no complications during the light-guided retrograde intubation. None of the patients had new neurological deficits following intubation and surgery. Occasionally, dimming the room lights or shading the anterior neck was necessary in obese patients, or patients who had thick necks with suboptimal transillumination of the neck soft tissues (four patients, 15%) (Table III).

TABLE II Demographic data

| | *Mean ± sd* | *Range* |
|---|---|---|
| Number of patients | 27 | – |
| Gender (male/female) | 19/8 | – |
| Age (yr) | 46.0 ± 16.5 | 18–85 |
| Weight (kg) | 76.0 ± 16.1 | 51–126 |
| Height (cm) | 173.0 ± 8.9 | 154–186 |
| Cervical spine pathology (fractures/rheumatoid arthritis/ metastatic cancer) | (18/8/1) | – |

## Discussion

In a small number of patients, we have shown that light-guided retrograde intubation is a simple, effective, and safe technique of tracheal intubation for patients with cervical spine fractures and instability. As described in our previous study which utilized the lightwand to intubate the trachea of patients with difficult airways, following proper preparation and patient selection, this technique can be done safely either with the patients awake, under topical anaesthesia and sedation, or under general anaesthesia.

Modifications of the retrograde intubating technique have been developed over the past two decades to improve its effectiveness. Bourke suggested that the epidural catheter should be inserted through the "Murphy's" eye of the endotracheal tube.[5] Others have suggested the use of a guide wire,[6] subcricoid punc-

TABLE III Results and complications of light-guided retrograde intubation.

| | *Mean ± sd* | *Range* |
|---|---|---|
| Anaesthesia technique (General Anaesthesia/Topical Anaesthesia) | 20/7 | – |
| Time to perform cricothyroid membrane puncture (sec) | 66.1 ± 56.2 | 7–204 |
| Time required to insert the epidural catheter (sec) | 74.0 ± 25.2 | 34–149 |
| Time to insert the ETT (sec) | 72.8 ± 42.5 | 21–152 |
| Total time required for the retrograde intubation (sec) | 205.8 ± 78.3 | 91–422 |
| 1 intubating attempt (n) | 22 | – |
| 2 intubating attempts (n) | 5 | – |
| 3 or more intubating attempts (n) | 0 | – |
| Failure (n) | 0 | – |
| Minor mucosal bleed (n) | 12 | – |
| Sore throat (n) | 8 | – |

ture,[7] pulling rather than guided technique,[8] and a multilumen catheter guide[9] to improve the success rate of the technique. Although these modifications are useful, they do not overcome the difficulty of determining the location of the tip of the ETT during intubation. In some situations, the epidural catheter or the guide wire is removed while the tip of the ETT is "caught up" against the epiglottis, vallecula or anterior commissure.[10] This problem can be avoided easily using transillumination, by placing the light bulb of a lightwand at the tip of the ETT during retrograde intubation. Although a limited number of patients were involved in this study, our data suggest that this light-guided technique is highly effective with no failures.

Retrograde intubation using a guide wire together with a fibrescope has also been shown to be effective as the tip of the ETT can be guided into the glottis under vision.[11] However, the fibrescope is expensive and the retrograde passage of the guide wire through the working channel of the bronchoscope can potentially damage the internal lining of the channel.[12] In addition, the use of a fibrescope requires special training and skill. Visualization of the laryngeal structures through a fibrescope can be difficult in the presence of blood and secretions. However, under these circumstances, retrograde intubation can be effectively performed using transillumination of the soft tissues of the neck from the bright light at the tip of the bronchoscope.[13]

While the use of a guide wire has been shown to facilitate retrograde intubation, we preferred to use an epidural catheter. The #18 gauge epidural catheter is relatively inexpensive and is readily available in most operating rooms. In addition, the flexible epidural catheter can bend easily during intubation and permit the ETT to advance deeply into the trachea past the puncture site at the cricothyroid membrane. Furthermore, the flexible epidural catheter easily fits between the connector of the ETT and the anaesthetic circuit without the use of a special bronchoscopy adaptor, to permit mechanical ventilation, oxygenation, and confirmation of the tube placement into the trachea using end-tidal $CO_2$ prior to the removal of the epidural catheter. Although there are reports that the epidural catheter is prone to "kinking" and is difficult to retrieve from the oropharynx,[10] we did not encounter any difficulties with the epidural catheter in this study.

While light-guided retrograde intubation is an effective intubating technique, it has some potential complications. Although rare, complications, such as bleeding (puncture site, and peritracheal haematoma), subcutaneous emphysema, pneumothorax, pneumomediastinum, and trigeminal nerve trauma have been reported with retrograde intubation.[10] While our study involved a limited number of patients, there were no complications during the study, apart from slight bleeding at the cricothyroid membrane puncture site. It should be emphasized that, compared with the Tuohy needle, the use of a #18 gauge *iv* catheter has made the cricothyroid membrane puncture substantially easier to perform and less traumatic. Using transillumination as a guide, the tip of the ETT can be located easily during intubation, and allows gentle retraction and redirection of the tube toward the glottis, thus minimizing the risk of serious complications as described in other studies.[10] Since light-guided retrograde intubation is a blind technique, it should be avoided in patients with abnormalities of the upper airway. These include patients with tumours, polyps, retropharyngeal abscess and other local infections. In addition, this intubating technique should not be used in patients with coagulopathy.

Although tracheal intubation using a fibrescope or a lighted-stylet alone can be highly effective for patients with difficult airways, they can be difficult to use in patients with a long, "floppy" epiglottis.[14–15] These techniques can be particularly problematic when the epiglottis is in contact with the posterior pharyngeal wall, making it difficult to advance underneath the epiglottis.[14-15] Under these circumstances, the epidural catheter can elevate the epiglottis and guide the tip of ETT into the trachea during the light-guided retrograde technique. Since no intubating technique can be applied to all patients with difficult airways, it should be emphasized that the choice of an intubating technique must rely solely on the patient's acceptance, the intubator's experience and the available resources.

In summary, in a limited number of patients, the light-guided retrograde intubating technique has been shown to be an effective and safe procedure to secure the airway of patients with cervical spine instability either awake under topical anaesthesia or under general anaesthesia. This simple and inexpensive intubating technique may prove to be a valuable adjunct in the management of difficult airways.

## References

1 *Butler FS, Circillo AA.* Retrograde tracheal intubation. Anesth Analg 1960; 39: 333–8.

2 *Waters DJ.* Guided blind endotracheal intubation. For patients with deformities of the upper airway. Anaesthesia 1963; 18: 158–62.

3 *Hung OR, Stewart RD.* Lightwand intubation: I – A new lightwand device. Can J Anaesth 1995; 42: 820–5.

4 *Hung OR, Pytka S, Morris I, Murphy M, Stewart RD.* Lightwand intubation: II – Clinical trial of a new lightwand for tracheal intubation in patients with difficult airways. Can J Anaesth 1995; 42: 826–30.

5 *Bourke D, Levesque PR.* Modification of retrograde guide for endotracheal intubation. Anesth Analg 1974; 53: 1013–4.
6 *Gerenstein RI.* J-wire facilitates translaryngeal guided intubation (Letter). Anesthesiology 1992; 76: 1059.
7 *Shantha TR.* Retrograde intubation using the subcricoid region. Br J Anaesth 1992; 68: 109–12.
8 *Abou-Madi MN, Trop D.* Pulling versus guiding: a modification of retrograde guided intubation. Can J Anaesth 1989; 36: 336–9.
9 *Dhara SS.* Retrograde intubation – a facilitated approach. Br J Anaesth 1992; 69: 631–3.
10 *Sanchez TF.* Retrograde intubation. Anesthesiology Clinics of North America 1995; 13: 439–76.
11 *Carlson CA, Perkins HM.* Solving a difficult intubation (Letter). Anesthesiology 1986; 64: 537.
12 *Ovassapian A, Mesnick PS.* The art of fiberoptic intubation. Anesthesiology Clinics of North America 1995; 13: 391–409.
13 *Skinner AC.* Glottic illumination by fiberscope (Letter). Anaesthesia 1983; 38: 1100–1.
14 *Hung OR, Pytka S, Morris I, et al.* Clinical trial of a new lightwand device (Trachlight) to intubate the trachea. Anesthesiology 1995; 83: 509–14.
15 *Ovassapian A, Yelich SJ, Dykes MHM, Brunner EA.* Fiberoptic nasotracheal intubation – incidence and causes of failure. Anesth Analg 1983; 62: 692–5.

**Acknowledgements**
The authors gratefully acknowledge the technical assistance of Mr. Joseph O'Leary from the Audio-Visual Department at the Queen Elizabeth II Health Sciences Centre, Victoria General Hospital, Halifax, Nova Scotia.