Awake light-aided blind nasal intubation: prototype device

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Background. Limited mouth opening associated with unavailable or ineffective fibreoptic bronchoscope (FOB) is an intubation challenge. A light-aiding device may facilitate the blind nasal intubation.

Methods. Awake blind nasal intubation was planned for 16 elective patients with inaccessible oral route (three children and 13 adults, ASA I–II). Topical anaesthesia for the supraglottis, glottis, and upper trachea was performed using prototype supraglottic topical anaesthesia device and cricothyroid injection of local anaesthesia. Hand-made light-aiding intubation device was used to help blind nasal intubation. Three attempts of blind nasal intubation (60 s each) were allowed, otherwise failure and FOB intubation were considered. During the procedure, heart rate, mean arterial pressure, and arterial oxygen saturation ($S_{pO_2}$) were measured. Temperature created at the bulb surface of the device was measured for 4 min duration, with and without exposing the bulb to oxygen flow of 6 litre min$^{-1}$.

Results. All the patients were successfully intubated except one child. Time to intubate in adults was mean (SD) 52.7 (8.6) s. $S_{pO_2}$ showed significant difference between before and after procedural values. The maximum temperature recorded at the bulb surface was 46.8 (0.4)$^\circ$C and 48.1 (0.8)$^\circ$C with and without oxygen flow, respectively.

Conclusions. The device appeared to be a safe and cost-effective transillumination method for blind nasal intubation in difficult airways.

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Nasal intubation is required when there is poor mouth opening, the oral route is inaccessible, or when facial fractures involve the mandible or maxilla. Inability to use fibreoptic nasal intubation may not be limited to situations of unavailability (lack of equipment, expertise, or experience) but also when there is bleeding or secretions in the airway. While blind nasal intubation may be appropriate, it requires special skill$^1$ and has been facilitated by the transillumination method first described in 1959.$^2$ The objective of this study was to describe the performance of blind nasal intubation facilitated by transillumination using a novel prototype device.

Methods

The present study was performed at Zigzag University Hospital between January 2005 and June 2008. After obtaining Research and Ethics Board approval and informed patients’ (or parental) consent, a limited trial of this prototype device was first performed in patients with anticipated normal airway. The current study was performed with the back-up of different difficult airway management options including fibreoptic intubation and the possibility of performing an emergency tracheostomy.

A hand-made light-aiding intubation device (Fig. 1) was made of a small bulb (12 V, 5 W, Osram, Germany) which was connected to an electrical wire and tightly inserted into a refined cut end of a nasogastric tube (Kawamato Corporation, India) size 12 that measured 115 cm in length. The wire was connected to an electrical adaptor (MOHA ME-300 Multivoltage AC-DC Adaptor, China). The light bulb was transmitted forward and laterally. The flexibility of the light-aiding device is more or less similar to that of the used nasogastric tube. The
nasogastric tube with the bulb fixed at its end was inserted through the suction port of the swivel connector (SIMS Portex Limited, UK) into an endotracheal (ET) tube size 7 mm with the bulb within the ET tube just at its bevelled end. To measure the temperature created at the bulb surface, the temperature probe (Dragger Anesthesia Machine, Primus, Lubeck, Germany) was attached to the top of the bulb and its temperature was recorded every 30 s for 4 min period. The measurements were repeated with flow of oxygen (6 litre min⁻¹) passing through the tracheal tube that was connected to the anaesthesia machine. The bulb temperature measurements were repeated four times.

A prototype supraglottic topical anaesthesia (SGTA) device was used to anaesthetize mucosa of the nasal, nasopharyngeal, and oropharyngeal airway (Patency no. 23733, Academy of Scientific Research and Technology, ARST, Egypt). The device (Fig. 2) consisted of a gauze of cotton surrounding a punctured suction catheter (15–17 cm along its distal part in adult cases) with closed distal tip that allows irrigation of local anaesthetic (LA) into the surrounding cotton by injection through the proximal opening of the catheter. The size of the catheter (usually 14–16 G in adult) and the length surrounded by the cotton gauze would be dependent on patient’s age and body build. The lubricated device, after smooth and gradual nasal insertion through the wider nostril till the hypopharynx with the help of two nasal puffs of xylocaine spray at the start of nasal insertion, would ensure intimate contact between soaked cotton with LA lidocaine 1%/epinephrine 1/200 000 mixture and upper airway mucosal surface with capability to re-inject LA if needed to intensify the LA blockade. In, out, and rotator movements of the SGTA device (3–5 min after insertion) without patient discomfort proved the effectiveness of SGTA, otherwise 5 ml of xylocaine/epinephrine mixture would be injected through the catheter of the inserted SGTA device.

Topical anaesthesia for glottis and upper tracheal mucosa was achieved using the classic cricothyroid topical anaesthesia technique with injection of 4–5 ml of xylocaine 2%/epinephrine mixture at the end of deep breath and after positive air, negative blood aspiration test.³⁴

Sixteen patients, 13 adults and three children (8–11 yr), ASA I–II, were included in the study. The patients had limited or no ability to open the mouth due to locked jaw (n=7), intermaxillary fixation (n=3), previous faciomaxillary surgery (n=3), or recent history of difficult oral intubation (n=3).

All patients were undergoing elective surgery; awake blind nasal intubation was planned and explained to the patients (and care givers in paediatric cases) during the preoperative visit.

They were given atropine 20 µg kg⁻¹ i.m. 1 h before surgery. The adults were given morphine 10 mg i.m. 1 h before surgery and the three children were given a sedative dose of ketamine HCl 0.5 mg kg⁻¹ i.v. immediately before the procedure.⁵⁶

The patient was asked to rest his/her head in a slightly extended position during the procedure to allow maximal visualization of anterior neck of the patient during intubation.⁷ Water-soluble lubricant was applied to the nostril to facilitate entry of the ET tube through the nose after confirming effective SGTA. Through the suction port of a swivel connector, the light-aiding intubation device was inserted into the ET tube to get the bulb just at the bevelled end of the ET tube. The tracheal tube was inserted into the selected anaesthetized nasal cavity and advanced gradually into the nasopharynx and then into the oropharynx as demonstrated by a sudden decrease in resistance to the inserted ET tube.⁷⁸ With the bulb in the nasopharynx, the central room light was put off leaving only the peripheral light on to keep the theatre light dimmed. The bulb was switched on, and the ET tube containing the bulb was
advanced gently towards the trachea using the light glow as a guide. Oxygen was administered during the whole time of the procedure by connecting the anaesthesia machine circuit to the swivel connector with oxygen supply of 6 litre min\(^{-1}\). Feeling resistance with the glow seen at the lateral side of the neck beside the laryngeal prominence indicated that the light-aided ET unit was directed laterally to the lateral pharyngeal wall (pyriform fossa) and stacked there (Fig. 3). The light-aided ET unit was slightly withdrawn and redirected medially to direct the glow towards the thyroid prominence. The operator manipulated the unit, the larynx, or both externally to get a well-defined glow seen in the middle of the anterior neck passing below the thyroid prominence till the glow began to disappear below the sternal notch (Fig. 4), ensuring that the tip of the ET tube was in the trachea (and not oesophagus) approximately half way between vocal cords and carina.\(^9\) The position was confirmed by means of inflation and deflation of the reservoir bag with patient respiration, by chest auscultation, and \(V_{CO_2}\) detection.

A faint glow seen above the thyroid prominence would indicate that the tip of the ET tube was located in the vallecula and to be slightly withdrawn and slowly re-advanced more posterior with the patient’s neck flexed to direct the glow below the thyroid prominence.\(^7\) Three intubation attempts limited to 60 s each (after light bulb on) were allowed for tracheal intubation. If it was impossible to intubate the trachea within these three attempts, failure was considered and fibreoptic intubation was performed.

During the procedure, the time to insert the light-aided ET unit endotracheally after switching the bulb on, number of attempts to intubate, success and failure rate, pre- and post-procedural heart rate (HR), mean arterial pressure (MAP), and \(Sp_{aO_2}\) were measured. Nasal bleeding was considered present when blood could be seen collected at the nose. At the end of surgery and after reversal of neuromuscular blocking agents, all patients were extubated awake using the light-aiding device as tube exchanger if re-intubation was to be required. The data were analysed using paired Student’s \(t\)-test considering \(P<0.05\) as significant (Minitab Statistical Software, Minitab Inc., USA).

**Results**

The age and body weight of the adult patients (seven males and six females), time to intubate, pre and post-procedural HR, MAP, and \(Sp_{aO_2}\) are shown in Table 1.

No nasal bleeding had been reported. However, 12 of 16 SGTA devices were found to be tinged with blood after its extraction from the nose.

Of adults, 11 patients were intubated at the first and two patients at the second attempt; one child was successfully intubated after two attempts and another after three attempts. The third child was intubated using a fibreoptic bronchoscope (FOB) after failure of the allowed three attempts to intubate in spite of getting well-circumscribed anterior neck glow, but from oesophageal placement of the device (Fig. 5). The time required for intubation in the

### Table 1

<table>
<thead>
<tr>
<th>Variables</th>
<th>Statistical data</th>
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<td>Range</td>
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<tr>
<td>Age (yr)</td>
<td>23–73</td>
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<tr>
<td>BW (kg)</td>
<td>55–95</td>
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<tr>
<td>Time to intubate</td>
<td>40–70</td>
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<tr>
<td>HR</td>
<td>75–99</td>
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<tr>
<td>Pre-procedure</td>
<td>70–100</td>
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<td>Post-procedure</td>
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<td>MAP</td>
<td>85.0–110.0</td>
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<td>(Sp_{aO_2})</td>
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<tr>
<td>Pre-procedure</td>
<td>90–100</td>
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<tr>
<td>Post-procedure</td>
<td>97–100</td>
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The highest temperature recorded after 4 min with this hand-made device with O₂ flow (6 litre min⁻¹) passing through the connected anaesthetic circuit was 49°C and 48.1°C as the highest reading and highest mean, respectively, which was less than that reported with the trachlight that reaches 55 (6°C) at the first blink (30 s) and 103 (10°C) after 250 s. The higher temperature with trachlight is related to its brighter bulb that can be used with theatre light in contrast to the present device that requires dim theatre lights, representing a potential disadvantage when dealing with patients with thick neck, and critical patients where low ambient light may not be desirable or not easily achieved. For more safety, the bulb was kept inside the tube just within its bevelled end to avoid direct contact with the mucosa while it is illuminated. Also the light was kept off until the tracheal tube was introduced into the pharynx. The actual contact time between the moving bulb and mucosa, even if it was to occur, would still be <4 min, which adds to the safety of its use. The flow of oxygen (6 litre min⁻¹) passing through the ET, in addition to keeping the patient well oxygenated, helps in keeping the light bulb less warm.

The hand-made light-aiding device used in the study to achieve awake nasal intubation was flexible enough to follow easily the curvature of the nasopharyngeal airway without trauma as that reported with other commercial lightwand devices with stiff stylet. Davis and colleagues recommended that the tip of loaded stylet should remain just inside the tracheal tube and to use a rubber stopper to prevent the tube’s riding up the stylet and exposing the potentially damaging rigid stylet tip to oropharyngeal, laryngeal, or tracheal structures. Favaro and colleagues reported nasal bleeding in 4.35% and 5.3% of their patients (two groups) that could be explained by using the trachlight that has a retractable traumatic stiff stylet for nasotracheal intubation in their study in contrast to the flexible device used in the present study with no reported nasal bleeding. Also there have been two case reports of arytenoid dislocation after lightwand use.

The device used in this study is characteristically long enough (116 cm) to be advanced alone into the trachea and then to thread the ET tube over it, avoiding the hang up of the ET tube at the glottis inlet as reported with the flexible wand of the trachlight after retraction of its stiff stylet. Hung and colleagues reported that after retraction of the internal stiff stylet of the trachlight, the tip of the ET tube occasionally seems to get ‘hung up’ and cannot be readily advanced into the tracheal and may also be dislodged from the glottic opening while withdrawing the lightwand. The lengthy device used in the present study allows the anaesthetist to use it as tube exchanger as well during extubation for rapid easy re-intubation if needed as recommended in such difficult intubation cases.

Passing through a swivel connector, the hand-made light-aiding device allows the anaesthetist to oxygenate the patient all the time during the procedure, one of the

### Discussion

The studied cases were either with limited ability (or inability) to open their mouth or recently postponed cases because of failed oral intubation by senior anaesthetist (>10 yr experience). With unavailable or available but ineffective (presence of upper airway bleeding or secretions) FOB service, awake light-aided blind nasal intubation was considered the most appropriate way to intubate such patients. The author tried to achieve it with the use of a hand-made simple flexible light device.

![Fig 5 ET light-aiding unit shows a well-circumscribed glow (1) in the anterior neck of a child just below the thyroid prominence that proved to be oesophageal and not tracheal (false glow).](https://academic.oup.com/bja/article-abstract/104/2/254/227493)

![Fig 6 The graphic presentation of the heat generated (mean value) at the light bulb of the device fixed at the tip of the ET with and without oxygen flow of 6 litre min⁻¹.](https://academic.oup.com/bja/article-abstract/104/2/254/227493)
differences that has been added to the ASA management of the difficult airway algorithm 2003 compared with that of 1993. Continuous patient’s oxygenation explains the reported statistical, not clinical, significant difference between pre- and post-procedural oxygen saturation in this study. Monitoring the ET CO₂, in addition to the light seen through the anterior neck, would guide the advancement of the ET tube and confirm its tracheal and not oesophageal placement once it is advanced under the sternum with loss of light guidance through the anterior surface of the neck. The ability to match the light-aided ET unit with anaesthesia circuit, at present, is not available with the other illuminating stylet intubating aid including the trachlight device. One of the quoted reasons is that the trachlight has been designed for the bulb to flash on and off after 30 s of being continuously on to remind the intubator that the patient has now been apneic for 30 s and may need reoxygenation.

The studied device being flexible, long, and allowing the anaesthetist to match the ET tube with the breathing circuit can overcome the drawbacks of the available tran-illumination devices such as trachlight that has a stiff traumatic short stylet and is unable to oxygenate or to monitor a patient’s ventilation (ET CO₂) during a difficult intubation process.

The light-aiding intubation device was washed immediately after each use and immersed in a disinfecting solution, glutaraldehyde or 2% iodine containing solutions for 10 or 20 min, respectively, as recommended for disinfecting the FOB. In spite of the tightly inserted bulb in the nasogastric tube and welding to the electric wire, repeated use and disinfection could affect the connections; hence, I ensured that the bulb was fixed tightly within the tube before each use.

Failure to intubate the trachea in one paediatric patient in spite of getting the characteristic glow appearance in the anterior neck may be explained by the high laryngeal position in children and the thin neck in children that allow the appearance of the characteristic glow, despite oesophageal intubation. With high laryngeal position, the nasal ET tube would be more in alignment with the oesophageal axis than the oro-tracheal tube which requires to be directed into the glottis opening using Magill forceps.

In the present study, the author allowed 60 s for every trial and allowed three trials before considering failure in contrast to Inoue and colleagues, who allowed 30 s for each trachlight trial and two unsuccessful trials to consider failure, and Monte and colleagues, who reported median time to intubate 24.5 (22) s in lightwand group. The allowed longer duration in the present study for each trial was related to the limited experience of the author with the device in patients with normal airway beforehand. Also the patients being awake and well oxygenated during the whole procedure encouraged the author to allow three intubation trials instead of two and longer duration for each trial.

In the future, being a non-controlled study, a comparative study with one of the available light-aiding devices, for example trachlight, is warranted for both nasal and oral use. Also, design modification with more light bulb brightness and still limited heat production is required.

In conclusion, the hand-made light-aiding intubation device has proved to be an effective and safe aid for blind nasotracheal intubation in patients with difficult airways. Its use in children may be associated with a false-positive impression of proper tracheal placement, a limitation to be kept in mind.

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