# Equipment

# Light-guided tracheal puncture for percutaneous tracheostomy

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**Purpose:** To determine the effectiveness of lightwand-guided tracheal puncture for percutaneous tracheostomy.

**Methods:** The desired puncture site was marked on the skin of the anterior neck. A lightwand (Trachlight) was inserted into the patient's endotracheal tube (ETT), so that the number indicator on the lightwand matched the number indicator of the ETT of the patient. At this position, the light bulb of the lightwand was exactly placed at the tip of the endotracheal tube. With the lightwand turned on, the lightwand together with the endotracheal tube (ETT-LW) was slowly withdrawn from the trachea until a bright glow in the anterior neck could be seen 1 cm above the marked puncture site. At this position, the tip of the ETT was 1 cm above the puncture site.

**Results:** Percutaneous tracheostomy via a light-guided tracheal puncture was performed on 11 neurosurgical patients. The withdrawal of the endotracheal tube to a location above the puncture was accomplished easily with the lightwand. All percutaneous tracheostomies performed were successful, with ease and without any complications.

The procedure time was 17.8 ± 5.3 min. Mechanical ventilation was not interrupted during the whole procedure.

**Conclusion:** The lightwand guided intratracheal puncture for percutaneous tracheostomy is a simple, effective, and safe procedure. This technique can avoid the risk of puncturing the endotracheal tube and/or cuff, thus allowing adequate ventilation and oxygenation during the percutaneous tracheostomy. Furthermore, this technique is inexpensive and minimizes the risk of damaging equipment like the fibreoptic bronchoscope.

**Objectif :** Déterminer l'efficacité d'une ponction trachéale sous guidage lumineux pour réaliser une trachéotomie percutanée.

**Méthode :** Le site de la ponction a été marqué sur la peau de la face antérieure du cou. Une tige lumineuse (Trachlight) a été insérée dans le tube endotrachéal (TET) de manière que le nombre indicateur sur la tige corresponde à celui du TET du patient. Dans cette position, l'ampoule de la tige lumineuse se trouvait exactement à la pointe du TET. Le guide allumé a été, avec le TET, lentement retiré de la trachée jusqu'à ce qu'une transillumination maximale soit observé sur la face antérieure du cou, 1 cm au-dessus du site de ponction marqué. La pointe du TET était alors à 1 cm au-dessus du site de ponction.

**Résultats :** La trachéotomie percutanée, à l'aide d'une ponction trachéale sous guidage lumineux, a été réalisée chez 11 patients de neurochirurgie. Le positionnement du TET sous le point de ponction s'est fait facilement avec le guide lumineux. Toutes les trachéotomies percutanées ont été réussies avec facilité et sans complications. Le temps moyen requis a été de 17,8 ± 5,3 min. La ventilation mécanique a été maintenue pendant l'intervention.

**Conclusion :** La trachéotomie réalisée grâce à la ponction trachéale sous guidage lumineux est une mesure simple, efficace et sécuritaire. La technique peut éviter de percer le tube endotrachéal et/ou le ballonnet, ce qui assure une ventilation et une oxygénation adéquates pendant la trachéotomie percutanée. De plus, c'est une technique peu coûteuse qui réduit le risque d'endommager l'équipement comme le fibroscope bronchique.

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IN 1985, Ciaglia described the technique of subcricoid percutaneous tracheostomy.[1] This technique became popular given its simplicity with minimal instrumentation, safety and feasibility to perform in the ICU environment.[2–4] While this technique is effective and safe, it has some complications. These include puncturing the cuff and transfixing the endotracheal tube (ETT) during the transtracheal needle insertion, inserting the guide wire through the Murphy's eye, or accidental extubation while withdrawing the endotracheal tube during the procedure leading to loss of the airway.[5–9] Although using the fingertip to palpate the trachea and endotracheal tube is a useful technique to locate the tip of the endotracheal tube during the procedure, it is unreliable, particularly in a patient with a short and thick neck. The use of a fibreoptic bronchoscope may be helpful.[10–14] However, it is an expensive tool which is not readily available in some centres. The goal of this report is to describe a simple, effective, safe, and inexpensive technique to overcome some of these limitations of percutaneous tracheostomy.

## Methods

Eleven, consecutive, mechanically ventilated patients in the Intensive Care Unit (ICU) requiring elective tracheostomy during the study period were recruited. Informed consent was obtained from the families of all study patients. The first six light-guided percutaneous tracheostomies were done in the operating room. Since the procedure was shown to be effective and safe and did not require the assistance of any nursing staff, the remaining five procedures were done in the ICU. All patients fasted for four to six hours before the procedure. Oxygen saturation, ECG, and arterial blood pressure were monitored continuously during the procedure. Anesthesia was provided with 0.02-0.5 $mg \cdot kg^{-1}$ midazolam, 1.5-3.0 $\mu g \cdot kg^{-1}$ fentanyl and a continuous infusion of 50-150 $\mu g \cdot kg^{-1} \cdot min^{-1}$ of propofol until patients were suitably anesthetized. Rocuronium (0.5-1.0 $mg \cdot kg^{-1}$) was used to provide neuromuscular block during the procedure.

Ciaglia percutaneous tracheostomy kit (Cook Inc, Bloomington, IN 47402, USA) was used to perform the tracheostomy. All percutaneous tracheostomies were performed by the neurosurgeon (BMA), who had experience with both the percutaneous tracheotomy and the standard open tracheostomy prior to the study. A lightwand (Trachlight™, Laerdal Medical Inc., Wappingers Falls, New York) was used for the transillumination of the neck soft tissues.[15] The Trachlight™ consists of three parts: a reusable handle, a flexible wand, and a stiff retractable stylet. The retractable stylet is enclosed within the wand. The advantage of using the Trachlight™ over other commercially available lightwands was the pliability of the wand when the internal stylet was removed. In addition, while placing the lightwand into the ETT, the number indicators on the wand of the Trachlight can be positioned at the number indicators on the ETT. This usually requires the ETT to be cut to fit the lightwand. At this position, the light bulb of the Trachlight will be at the tip of the ETT. Transillumination using this setup allows the determination of the tip of the ETT during percutaneous puncture of the trachea.

Under sterile conditions, the desired percutaneous puncture site was identified and marked on the skin at the level of the interval between the first and the second tracheal rings or the space between the cricoid cartilage and the first ring (Figure). Through a bronchoscopy connector (Portex Fiberoptic Bronchoscope Swivel Adaptor, SIMS Portex Inc., Keene, NH), the Trachlight without the internal stiff wire was inserted into the ETT of the patient such that ventilation and oxygenation could be maintained while withdrawing the ETT. The number indicator on the lightwand was positioned to match the number indicator of the ETT. This step involved cutting the ETT at 26 cm mark to fit the lightwand. The cuff of the ETT was deflated. With the lightwand turned on, the lightwand together with the endotracheal tube (ETT-LW) was slowly withdrawn from the trachea until a bright glow in the anterior neck from the transillumination of the lightwand could be seen 1 cm above the marked puncture site (Figure). At this position, the tip of the ETT was 1 cm above the puncture site. It should be emphasized that the ETT must be secured properly at this position to prevent advancement or further withdrawal during the percutaneous tracheostomy procedure. With the tip of the ETT at this position, the cuff of the ETT was reinflated where mechanical ventilation could be easily provided while the tracheal puncture was made using a modified percutaneous tracheostomy technique as described by Ciaglial. The absence of air leak confirmed the balloon integrity. The skin and underlying tissue were infiltrated with lidocaine 2% with epinephrine (1:100,000) as a vasoconstrictor to minimize bleeding at the site of the incision. A 1 cm vertical was made halfway between the thyroid cartilage and the suprasternal notch. The soft tissue of the neck including the thyroid gland isthmus and the trachea were identified. With the isthmus of the thyroid gland pushing downward, the trachea was punctured between the second and third tracheal ring by a 16 gauge intravenous catheter attached to 5 ml syringe filled with Xylocaine 1%. Following the tracheal puncture, as confirmed by the aspiration of free air, the

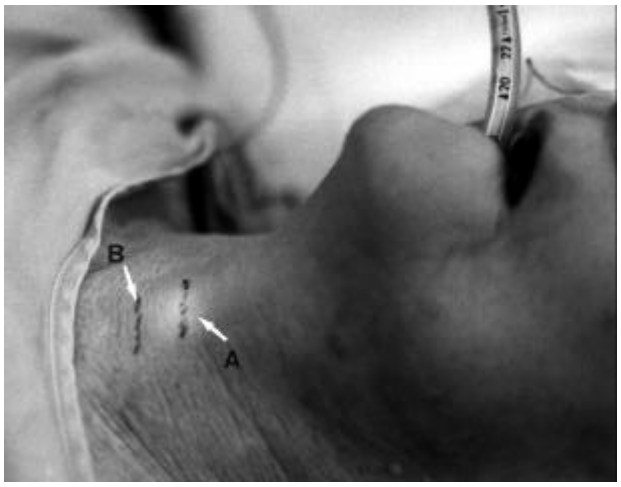


FIGURE Transillumination of the soft tissues of the anterior neck of a patient. With the lightwand placed inside the endotracheal tube (ETT) so that the lightbulb of the lightwand is placed at the tip of the ETT, the ETT was withdrawn slowly so that the light glow (A) is about 1 cm above the space between the first and second tracheal rings (B). At this position, the tip of the ETT is about 1 cm above the site of puncture (B).

intravenous catheter was further advanced 0.5 cm to ensure that the plastic cannula was in the trachea. After the removal of the needle, l ml of lidocaine was injected into the trachea through the cannula. A flexible J guide wire was inserted through the cannula caudally 6-8 cm beyond the tip of the cannula. The intravenous cannula was then removed, leaving the guide wire in place. A #8 Fr Teflon catheter was then inserted over the guide wire. This was followed by the insertion of a series of dilators from #12 Fr to #36 Fr. Finally, a #8 Shiley tracheostomy tube fitted snugly over a well lubricated #28 Fr dilator was inserted over the guide wire. After the insertion of the tracheostomy tube, the proper placement was confirmed with end-tidal $CO_2$.

The time to perform the percutaneous tracheostomy was defined as the time from the initial skin incision to the time when tracheal placement was confirmed. All patients had chest x-rays performed immediately following tracheostomy. Complications and adverse events arising during and following the procedure were also recorded. The anesthesiologist was joined at times by a resident for teaching purposes.

## Results

Lightwand guided percutaneous tracheostomy was performed successfully in 11 neurosurgical patients. Five of these patients had an unstable cervical spine injury and the percutaneous tracheostomy was performed on the rotating bed. The remainder had severe brain damage due to subarachnoid hemorrhage (three patients) and head injury (three patients). All percutaneous tracheostomies were performed on the patient's bed with no difficulties. Although dimming of the ambient light was necessary in four patients, transillumination of the soft tissues of the neck using the lightwand was easy. The mean time to perform this procedure was 17.8 ± 5.3 min, which is shorter than was recorded in previous reports.[16] There was no damage to the ETT or the cuff, and mechanical ventilation was provided without difficulty during the procedure. Oxygenation saturation was maintained above 95% and no major alteration of the hemodynamic parameters was observed. Apart from minor bleeding from the tracheal puncture and dilation, this lightguided technique was easy to perform with no complications encountered during or following the procedure.

## Discussion

Lightwand-guided percutaneous tracheostomy is an effective and safe alternative technique to the conventional surgical approach. It can be performed quickly and with minimal complications.[16] This technique allows an accurate withdrawal of the ETT to avoid the risk of damaging the ETT during percutaneous puncture of the trachea. The lightwand (Trachlight™) is an inexpensive device. It is simple to use and thus presents an attractive alternative to the more sophisticated instruments, such as fibreoptic bronchoscope. Since lightwand-guided percutaneous tracheostomy can be performed with fewer instruments, it would be particularly suitable for patients in the ICU setting.

Although this lightwand-guided percutaneous tracheostomy is a simple and effective technique, it has limitations. Since this is a relatively "blind" technique, it should be used with great caution in patients with coagulopathy when homeostasis should be controlled surgically using the conventional surgical technique. Furthermore, since this light-guided technique uses the principle of transillumination of the soft tissue of the neck, its use should be avoided in patients where transillumination would be difficult or impossible, for example, in patients who are grossly obese or who have a short or "thick neck".

In our opinion, the most difficult part of the procedure was the insertion of the tracheostomy tube into the trachea. In a few of the study patients, substantial resistance was encountered during the insertion. This could be due to the different shape of the dilator (round) and the lumen of the tracheostomy tube (oval). The small gap between the dilator and the tracheostomy tube con-

siderably increased the resistance of the tracheostomy tube on entering the trachea. However, generous lubrication and a steady rotating pressure can overcome this resistance. A well lubricated #28 Fr dilator fitted snugly through the tracheostomy tube would ensure a smooth and easy advancement over the guide wire.

Since percutaneous tracheostomy is a simple technique and can be performed safely in the ICU, it can be a cost-effective alternative to the standard open tracheostomy. In a study with 183 patients, McHenry *et al.* had shown that percutaneous tracheostomy required considerably less time to perform compared to the standard open tracheostomy (21 ± 6 min for percutaneous tracheostomy *vs* 46 ± 21 min for open standard tracheostomy).[16] Although in this study, we did not include a control group to evaluate the time required to perform the percutaneous tracheostomy, the time to perform the light-guided percutaneous tracheostomy was 17.8 ± 5.3 min. The time is slightly shorter than the time reported to perform the percutaneous tracheostomy by McHenry *et al.*

Although we did not use this light-guided technique for a conventional open tracheostomy, it is conceivable that this simple technique will also allow the accurate withdrawal of the tip of the ETT above the surgical tracheostomy site. Similarly, this lightwand-guided technique will likely minimize the risk of damaging the ETT or the cuff and allow adequate oxygenation and ventilation during the surgical tracheostomy.

In summary, in a small series of patients, we have demonstrated that a lightguided percutaneous tracheostomy using a lightwand is an effective and safe technique to withdraw the endotracheal tube accurately prior to tracheal puncture.

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