An alternative technique to identify the tracheal lumen during percutaneous tracheostomy with the acoustic puncture assist device

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Abstract. A crucial step in performing successful percutaneous dilatational tracheostomy is the correct introduction of the needle and guide wire into the trachea. We describe an alternative technique, in which an acoustic signal is used as guidance to confirm correct tracheal needle placement.

Introduction
Currently percutaneous dilatational tracheostomy (PDT) technique is accepted as the method of choice in performing elective tracheostomy in mechanically ventilated patients in the intensive care unit (ICU) [1]. Although the complication rate is low, life-threatening events have been reported [1-4]. One serious adverse event may be dislocation of the needle and guide wire, creating a false route.

The Acoustic Puncture Assist Device (APAD) has been used to identify the epidural space guided by an acoustic and visible signal. Using the “loss of resistance” technique, this method integrates pressure monitoring by an acoustic and visible signal and allows the identification of hollow cavities in the human body by means of an acoustic signal, thus replacing the conventional loss of resistance technique [8-10].

In this case report we describe the Acoustic Puncture Assist Device as an alternative technique to verify correct placement of the needle and guide wire in the tracheal lumen during the PDT.

Case report and method
A previously healthy 80-year-old woman was admitted to ICU because of respiratory insufficiency. An elective percutaneous tracheostomy was performed in order to facilitate the weaning process.

During the procedure, mechanical ventilation was maintained and invasive blood pressure, heart rate, respiratory rate, and oxygen saturation were monitored. Anaesthesia consisted of continuous infusion of fentanyl and midazolam, for relaxation rocuronium was administered. Under aseptic conditions, with the patient in the supine position and the neck mildly hyperextended, the pretracheal area was infiltrated with lidocaine with epinephrine. The cuff of the endotracheal tube was deflated and under guidance of direct laryngoscopy the tube was withdrawn to facilitate the procedure.

A 14 G needle with cannula was flushed with saline and theAPAD was attached to the needle with a 120 cm length of polyvinyl chloride tubing (Fig 1). The infusion pump (rate set at 100ml/h), the sound amplifier and the instrumentation recorder of the APAD were activated. The system was tested by kinking the extension tube, which led to a clearly audible rise in tone pitch and a clear upward deflection in the pressure register. The needle was inserted at a constant speed, under guidance of the acoustic signal and the palpating fingers of the operator, through the cutis toward the midline of the trachea at the level of the second or the third tracheal ring. Initially, there was a clear rise in tone pitch and after a sudden drop in tone the needle advancement was stopped and the pressure register was studied. The pressure registration has some typical characteristics (Fig 2). The first pressure peak is the test signal. The second starts on the introduction of the 14G needle, reaching its maximum whilst passing through the sub mucosa. On entering the tracheal lumen, a rapid decrease in pressure to zero was registered. The whole procedure took only a few seconds and was easy to perform. The total amount of water infused during the procedure was 2 to 3 ml. After disconnection of the APAD from the needle, we tried to insert the cannula; however this was unsuccessful at the first attempt. The tip of the 14 G needle is bevelled and sharp. As the needle tip enters in the tracheal lumen, immediately a change in tone and pressure is noticed. At the second attempt, the needle was inserted 1-2 mm deeper in the trachea before withdrawing the needle and leaving the cannula inside the tracheal lumen.

After localization of the tracheal lumen, a Portex® percutaneous dilation tracheostomy kit, a single-stage dilator with Blue Line Ultra® tracheotomy tube and introducer (Smiths, Hythe, Kent, UK ) with size 9.0 mm internal diameter was used without any complication. Afterwards, end tidal capnography assured the correct position of the tube in the tracheal lumen. Chest radiography routinely performed after the procedure showed no abnormalities related to the procedure. During the ICU stay no complications were recorded which could be related to the PDT.

Discussion
At present bronchoscopy and end tidal capnography are recommended during the PDT insertion procedure [4-5]. The most important reason is the bronchoscopic visualization and confirmation that the puncture is performed at the correct site, i.e. the midline of the anterior wall of the trachea between the first and third tracheal rings. A number of studies have shown that bronchoscopy can result
in compromised mechanical ventilation leading to reduced tidal volume, with hypventilation and hypercarbia in some patients [6-7]. There is an added risk of damage to the bronchoscope by the introducing needle. Although capnography detects CO2 when the tip of the needle is in the trachea, needle insertion remains blind if not combined with bronchoscopy. Known shortcomings of end tidal capnography are problems of needle obstruction due to tissue fragments, thick tracheobronchial secretions or blood [4].

In our patient we used the APAD to guide the placement of the needle in the tracheal lumen. The whole procedure took only a few seconds and is easy to perform. During the procedure continuous airway control is guaranteed and obstruction of the needle is unlikely because of the continuous flow (100 ml/hr). The use of the APAD technique enables us to register and document the correct position of the needle in the tracheal lumen. The auditory signal is also a useful tool in confirmation the correct needle position. Nevertheless, the tracheal puncture with the APAD is also a blind technique and in particular in difficult necks there is no guarantee that the puncture will be in the midline.

We carefully conclude from this care report that APAD might be a useful tool in the PDT insertion procedure. The results of this case report encourage us to proceed further with a prospective study to compare the APAD with the golden standard, the bronchoscopy.

References