Short Communication

Real-time ultrasound guided percutaneous dilatational tracheostomy in critically ill patients: A step towards safety!

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Abstract

There are few reports and observational data that support the safety and efficacy of real-time ultrasound guided (USG) percutaneous dilatational tracheostomy (PDT) when compared with unguided tracheostomy. We performed real-time USG PDT in our intensive care unit (ICU) patients with the aim of providing safe and cost effective point-of-care management. Real-time ultrasonography has the potential advantage of enabling the clinicians to define the needle path by showing displacement of tissues ahead of needle.

Keywords: Bronchoscopes, percutaneous, real-time, tracheostomy, ultrasonography

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Introduction

Percutaneous dilatational tracheostomy (PDT) is a simple, safe, low cost, minimally invasive bedside procedure with several documented advantages over surgical tracheostomy such as less local tissue damage, lower risk of bleeding, wound infection, and mortality.[1,2] PDT is routinely performed with the aid of bronchoscope to further enhance the safety and accuracy of the procedure.[3] Recently, portable ultrasound has been employed for preintubation assessment of upper airway, postintubation verification of endotracheal tube position, and for predicting extubation outcome.[4] Until now, however, there are only a few reports and observational data that support the safety and efficacy of real-time ultrasound guided (USG) PDT.[5-7] We performed real time USG PDT in our intensive care unit (ICU) patients with the aim of acquiring a safe and cost-effective technique for point-of-care management. The objective of this retrospective case series was to report a feasibility study of real time USG PDT where bronchoscopy is unavailable.

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Subjects and Methods

This was a retrospective case series. The study was exempt from review by the Institutional Ethics Committee since it was a retrospective review of medical records. Between July 2012 and February 2013, we (ICU consultants with minimum 3 years of experience of performing PDT) performed real time USG PDT on 12 patients admitted in our 10-bedded level 4 ICU who required prolonged ventilatory support. All patients were hemodynamically stable with normal coagulation profile and were mechanically ventilated with positive end-expiratory pressure (PEEP) less than 10. Patients requiring cervical spine immobilization and those with morbid obesity were excluded. Bronchoscopy was unavailable for PDT, and rather than conducting "blind" PDT, real time USG guided PDT was used. After obtaining written informed consent an ultrasound machine (Esoate™, Esoate Inc. Philipsweg, Netherland, Europe) was used with sterile, 8-3 MHz linear array probe (SL 3323). Imaging mode (2D mode) was set to highest resolution to visualize superficial structures. Pretracheal soft tissue structures were visualized and examined. The insertion point was selected between second and third tracheal rings. The endotracheal tube was withdrawn to subglottic position after cuff deflation under direct laryngoscopic vision. Following local anesthetic infiltration, 2 cm horizontal incision was made over selected point of insertion. Ultrasound probe was placed on the tracheal ring just above the incision to continuously visualize the trachea. We used Griggs forceps technique kits (Smiths Medical, Portex®, London, UK) with tracheotomy tubes (Blue Line Ultra® Portex Tracheostomy Tubes) for performing PDT. To determine the depth of the puncture by cannula, the distance from the probe to the echo of the anterior wall of tracheal wall was measured and subsequently marked on the cannula. Puncture of tracheal cartilage was done with 14 G cannula-on-needle while observing the needle path and tracheal wall insertion by real time sonography. Correct placement was confirmed by aspiration of air in syringe attached to cannula. A J-shaped guide wire was threaded into the trachea and an introducer dilator was then passed over the guide wire to facilitate the stoma formation [Figure 1a]. Subsequently, blunt dilatation was done and Griggs dilatation forceps was advanced over the guide wire under ultrasound guidance [Figure 1b]. An appropriate size tracheostomy tube with obturator was then threaded over the guide wire into the trachea lumen. After tracheal placement of tracheostomy tube, cuff was inflated and proper position confirmed by bilateral expansion of chest with positive pressure ventilation and auscultation of bilateral equal air entry. It was further confirmed by ultrasound intercostal view by observing positive "lung sliding sign".[4] Thereafter, tracheostomy tube was secured with straps and mechanical ventilation was continued.

Patients were monitored for complications such as hypotension, decreased oxygen saturation, bleeding and injury to posterior tracheal wall, atelectasis, or pneumothorax during the observation period (during the procedure and for 1 week postprocedure).

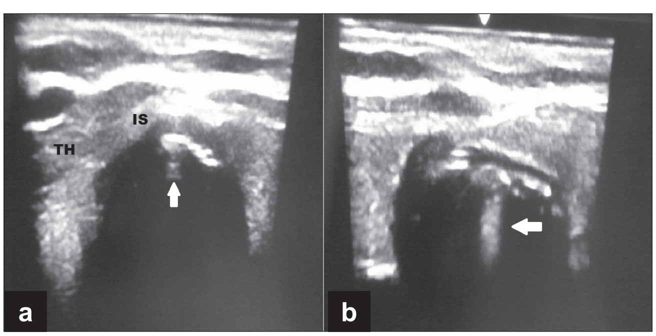

Figure 1: Transverse ultrasonographic view. (a) TH (lateral lobe of thyroid), IS (isthmus); arrow indicating puncture of tracheal cartilage with 14 G cannula. (b) Arrow indicating blunt dilatation with Grigg's dilatation forceps

Results

Out of the 12 patients, four had chronic obstructive pulmonary disease, four were post neurosurgical, two had Guillain-Barré syndrome, and two had adult respiratory distress syndrome, all requiring prolonged ventilatory support. They were aged between 30 and 66 years (median 48 years, interquartile range (IQR) 36-60). None was morbidly obese (median body mass index 22 kg/m^2, IQR 20-25). Four patients (one-third of the study sample) were female.

We successfully performed this procedure in all 12 patients. No complications were observed in any patient during the procedure. Follow-up data on patients were noted from the case files for up to 1 week postprocedure (median 5 days, IQR 4-6), during which no new complications were noticed.

Discussion

Blind PDT procedure had many concerns such as inability to identify correct point of insertion and positioning of tracheostomy tube, false passage, and inadvertent injury to surrounding structures. Bronchoscopic guided PDT had alleviated many such concerns.[3] However, bronchoscopy has the disadvantages of compromising ventilation especially in patients with high levels of PEEP and causing significant hypercarbia with risk of raised intracranial pressure and hence poorly tolerated by patients with head or spinal cord injury.[2,4]

Ultrasonography has several advantages such as being easily available, pain-free, inexpensive, portable, safe, and repeatable.[4] Real-time ultrasonography has the additional advantage of enabling the clinicians to define the needle path by showing displacement of tissues ahead of needle.[5] Acute indentation of anterior tracheal wall with penetration of needle and subsequent straightening could be well-visualized with this technique.[4] We applied the concept of real-time sonography to correctly locate the insertion point, to continuously visualize the needle path till it penetrates the anterior tracheal wall while preventing injury to the posterior tracheal wall and finally to confirm the correct position of the tube by the "lung sliding sign". Though it has been suggested by some that the longitudinal (in-plane) view could help better localization of endotracheal tube position while withdrawing and visualisation of the needle path,[8,9] we preferred the transverse view to prevent associated injury, as the former approach may make viewing of the needle and structures of interest more difficult.[10]

The limitations of this case series include small sample size, retrospective design, absence of comparator group, limited follow-up, and inability to additionally assess with bronchoscopy. The disadvantages of not using bronchoscopy include diminished control of the airway, inability to detect posterior wall injury and ring fractures, decreased ability to perform pulmonary toilet around the procedure, diminished ability to detect false passage of the tube especially if the guidewire is accidentally pulled back too far. A few previous reports used bronchoscopy,[5,9] but not all.[6,7]

However, in developing countries, prohibitive cost of the fiberoptic bronchoscope is a major limitation at many institutions. This case series shows the feasibility of real time ultrasonography - guided PDT where bronchoscopic guidance is unavailable. Because of the absence of a comparator group in this case series, no definitive observations can be made in relation to unguided PDT. However, real time ultrasonography guided PDT holds promise as a cost-effective and safe bedside procedure for larger application in critically ill patients especially in the morbidly obese and in those with cervical spine injury.

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