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Comparison between ultrasound- and bronchoscopy-guided percutaneous dilational tracheostomy in critically ill patients: A retrospective cohort study

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ABSTRACT

Introduction: Percutaneous dilational tracheostomy (PDT) is routinely performed in the intensive care unit with bronchoscopic guidance. Recently, ultrasound (US) has emerged as a new safety adjunct tool to increase the efficacy of PDT. However, the available data are limited to case series without any control group. Hence, a retrospective cohort study was designed to evaluate the efficacy of US-guided PDT compared with bronchoscopy-guided PDT.

Methods: All patients who were submitted to PDT after the standardization of US-guided PDT technique in our institution were analyzed. Demographic and procedure-related variables, complications, and clinical outcomes were collected and compared in patients undergoing US- or bronchoscopy-guided PDT.

Results: Sixty patients who had been submitted to PDT were studied, including 11 under bronchoscopy guidance and 49 under US guidance. No surgical conversion was necessary in any of the procedures, and bronchoscopy assistance was only required in 1 case in the US group. The procedure length was shorter in the US group than in the bronchoscopy group (12 vs 15 minutes, $P = .028$). None of the patients had any major complications. The minor complication rates were not significantly different between the groups, nor was the probability of breathing without assistance within 28 days, intensive care unit length of stay, or hospital mortality.

Conclusion: Ultrasound-guided PDT is effective, safe, and associated with similar complication rates and clinical outcomes compared with bronchoscopy-guided PDT.

1. Introduction

Percutaneous dilational tracheostomy (PDT) is a common procedure in the intensive care unit (ICU) [1]. Although overall complication rates are low, serious adverse events are still reported [2]. Bronchoscopy guidance has traditionally been used as a safety adjunct, as it helps with the selection of the appropriate site for the tracheal puncture and is used to guide the real-time entrance of the needle into the trachea to avoid posterior wall lesions [3,4].

Recently, ultrasound (US) has emerged as a new tool to assist PDT. The potential advantages of US include the ability to identify the cervical vasculature [5], assist with tube size and length selection [6], help identify the most appropriate location for the tracheal puncture site, and guide needle insertion into the trachea, similar to the technique used in US-guided vascular puncture.

Several studies have demonstrated the value of preprocedure cervical US to improve the safety of PDT [7–9]. In 1999, the first real-time US-guided PDT was described [10], followed by the publication of several reports, including a systematic review [11–14]. However, the available data are limited to case series without any control group. Nevertheless, the reported complication rates are low, suggesting that this method is safe and reliable. Ultrasound-guided PDT was introduced as an alternative technique to bronchoscopy-guided PDT in our institution. Hence, a retrospective cohort study was designed to evaluate the safety and efficacy of US-guided PDT compared with bronchoscopy-guided PDT in critically ill patients.

Abbreviations: PDT, Percutaneous dilational tracheostomy; ICU, Intensive care unit; US, Ultrasound; CNS, Central nervous system; MV, Mechanical Ventilation; CC, Cricoid cartilage; A-M, air-mucosa; CTA, Comet tail artifact; SM, Strap muscle; TG, Thyroid gland.

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2. Methods

This retrospective cohort study conducted in 7 ICUs from Hospital das Clínicas of the University of São Paulo included all patients who were submitted to PDT between July 2013 and December 2013. The analysis of retrospective patient medical record data was approved by the local Ethics and Research Committee and was waived from the requirement to obtain written consent.

In our institution, critical care staff physicians and residents are trained in US and bronchoscopy. Ultrasound-guided PDT was introduced as an alternative to bronchoscopy-guided PDT because the availability of US equipment is greater than that of bronchoscopy equipment in our ICUs.

As part of the training evaluation, intensive care medicine residents participating in PDT have to fill out a standard form with the procedure details, which is attached to the electronic medical records and patient charts. The data were obtained from a medical record analysis.

2.1. Procedures

The procedures are performed according to standardized practices following hospital routines, available in supplemental materials (Fig. 1). Verbal consent for PDT is obtained from the next of kin before the procedure, and PDT is performed as soon as the equipment and the team are available.

2.2. Data collection

The following data were collected: age, sex, weight (in kilograms), height (in centimeters), hospital and ICU admission dates, Simplified Acute Physiologic Score (SAPS) 3 score [15,16], ICU admission diagnosis, reason for orotracheal intubation, reason for tracheostomy, dates of the procedures, guidance method (US or bronchoscopy), *procedure duration* (defined as time elapsed from the skin incision to mechanical ventilator connection to tracheostomy cannula), anatomical difficulties, subjective evaluation of procedure global difficulty [13], procedure-related complications, and clinical outcomes. The clinical outcomes were considered to be the time to *unassisted breathing* (defined as breathing without ventilator assistance for at least 24 hours), days to ICU and hospital discharge, ICU mortality, and hospital mortality.

In the case of US-guided PDT, we evaluated the US duration before the procedure, distance between the skin and second tracheal ring, tracheal transversal diameter at the level of the second tracheal ring, vasculature between the skin and second tracheal ring, and whether there was a change in the planned puncture site after US.

2.3. Procedure-related complications

Complications associated with the tracheostomy procedure were graded as major or minor. Complications were followed up until death or hospital discharge.

Major complications were defined as procedure-related death, cardiac arrest, *hypotension* (defined as systolic blood pressure below 90 mm Hg for more than 5 minutes or any intervention used to increase blood pressure such as fluids or vasopressors), acute hypoxemia (drop in oxygen peripheral saturation below 90% for more than 5 minutes as measured by the pulse oxymeter), loss of airway, tracheal wall injury, false passage cannulation, pneumothorax, tracheostomy cannula obstruction, esophageal injury, tracheoesophageal fistula, accidental decannulation, conversion to surgical tracheostomy, major bleeding (stomal, intratracheal, or tracheovascular fistula) causing hypoxemia and/or requiring emergency transfusion and/or open surgical repair, and tracheostomy-related sepsis (stoma infection as the only identifiable source).

Minor complications included *transient hypotension* (defined as systolic blood pressure below 90 mmHg for less than 5 minutes and no intervention used to increase blood pressure such as fluids or vasopressors); *transient acute hypoxemia* (defined as oxygen peripheral saturation below 90% for less than 5 minutes as measured by the pulse oxymeter); atelectasis; inadvertent cuff puncture; localized minor bleeding, either stomal or intratracheal, which was defined as self-limiting bleeding or bleeding successfully treated with local compression; instillation of topical vasoconstrictive agents;

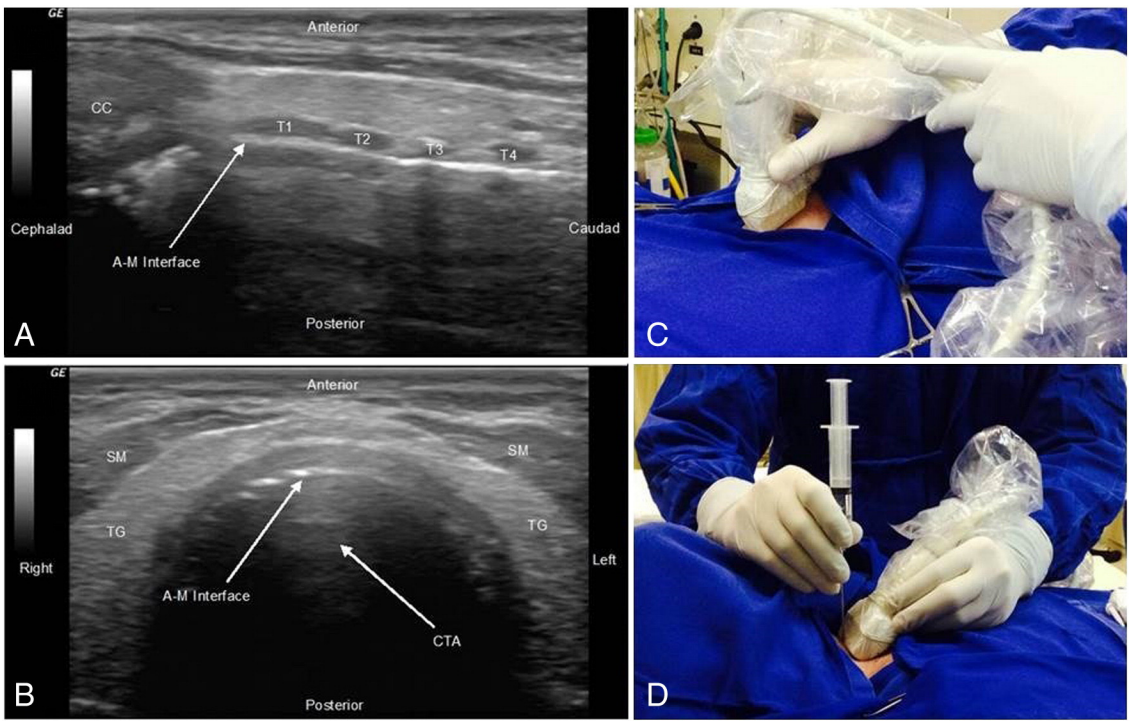

Fig. 1. Ultrasound-guided PDT. A, Left parasagittal scan over the trachea using a linear transducer. The sonogram shows the cricoid cartilage (CC), the tracheal cartilage (T1-T3), and the air-mucosa (A-M) interface. CTA indicates comet tail artifact. B, Transverse scan at the level of the second tracheal ring using a linear transducer placed at the midline. The sonogram shows the trachea, thyroid gland, and strap muscle. Arrowheads indicate the A-M interface; CTA, comet tail artifact; SM, strap muscle; TG, thyroid gland. C, Left parasagittal scan. D, Transverse scan.

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