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# A new simple method for percutaneous tracheostomy: controlled rotating dilation

## A preliminary report

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**Abstract** *Objective:* To describe and introduce a new technique for percutaneous dilational tracheostomy. *Design and setting:* Open, observational clinical trial in patients requiring an elective tracheostomy in two intensive care units of university hospitals. *Patients:* Fifty (25/25) consecutive patients requiring an elective tracheostomy above 18 years of age. *Interventions:* Performance of a percutaneous dilational tracheostomy with a specially designed screw-type dilator, using a thread for the dilation procedure. *Results:* In 50 consecutive patients the new device allowed a quick and safe dilation procedure without any serious bleeding complications or other relevant procedural-related side effects. *Conclusions:* The described new percutaneous dilational tracheostomy device (PercuTwist, Rüsch, Kernen, Germany) represents a single-step method with a high degree of control during dilation. So far, it appears to be a safe, quickly performed procedure with a strikingly low incidence of even small bleeding complications, thus offering an interesting new alternative for the performance of a percutaneous tracheostomy.

**Keywords** Artificial airway · Percutaneous dilational tracheostomy · New method

## Introduction

Tracheostomy, no matter which method chosen, represents one of the most frequently performed surgical procedures on critically ill patients [1]. The obvious tendency towards more frequent performance and earlier timing of tracheostomy has certainly been forced by the availability of different percutaneous dilational tracheostomy (PDT) techniques and their increasingly widespread use. The "classical" technique of PDT using progressive dilators was introduced by Ciaglia and colleagues in 1985 [2]. Currently, four different types of percutaneous tracheostomy techniques are clinically used: the original Ciaglia method (manufactured by Cook and Rüsch); the Ciaglia Blue Rhino technique representing a modification of this "classical" method, while using only one specially curved dilator (manufactured by Cook) [3]; the Portex PDT set (manufactured by Sims Portex) using a specially designed forceps for dilation [4]; and the Fantoni translaryngeal tracheostomy TLT set (manufactured by Mallinckrodt) using a specially designed cannula to pass into and dilate the trachea from its inner lumen outwards to the skin [5]. Many studies have shown that the different percutaneous tracheostomy techniques can be used safely with at least a comparable rate of procedural-related complications as that of open surgical tracheostomy. However, several complications associated with percutaneous tracheostomies have been reported, with the perforation of the posterior tracheal wall being the most serious. Those techniques dilating from the skin towards the lumen of the trachea uniformly use, after the insertion of the guidewire, a first-step dilator allowing thereafter either the introduction of the first or only dilator, or forceps. Difficulties in beginning the procedure and inserting this first-step dilator in some cases brought about the idea of using a dilator with a thread to facilitate the

insertion into the trachea. The first experience was so encouraging that the decision was made to use a single-step dilator with a thread for the whole procedure. Basically, the dilator is designed like a self-tapping screw allowing access to the trachea without the need of pushing the dilation instrument towards the posterior tracheal wall. The technique of "controlled rotating dilation" offers – more than 15 years after the introduction of the "classical" Ciaglia method – an alternative real single-step percutaneous tracheostomy technique. The aim of the present trial was to evaluate the feasibility and safety of this new technique.

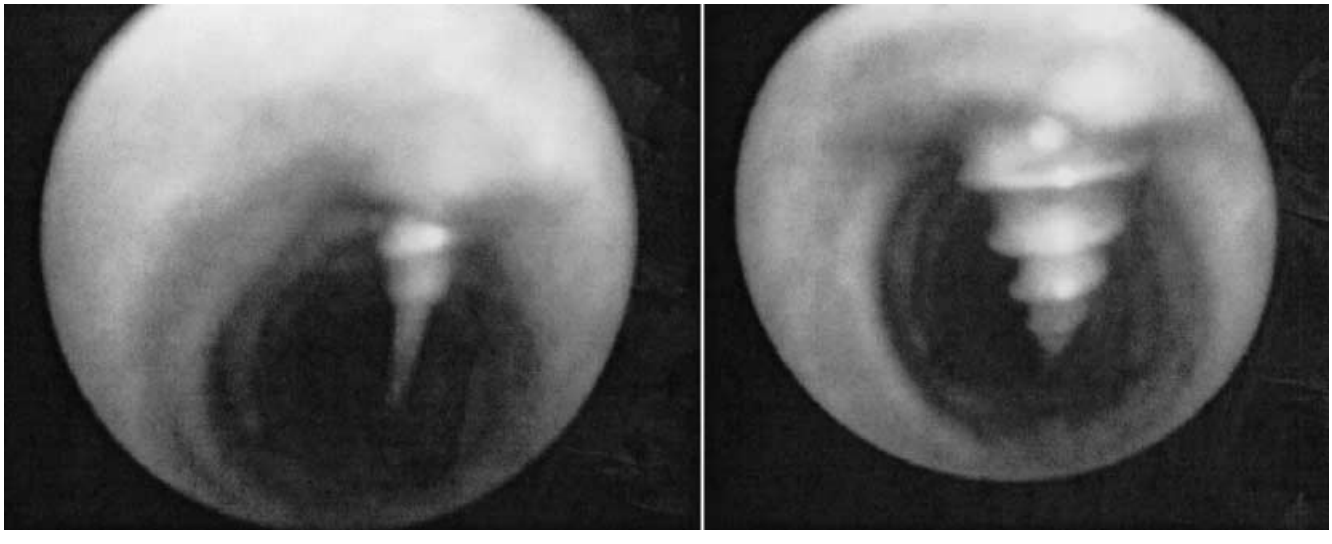
## Material and methods

A total of 50 consecutive patients requiring tracheostomy from two intensive care units in different university hospitals were included in this observational trial during a 5-month period. Patients fulfilling the generally accepted contraindications for the performance of any percutaneous tracheostomy [difficult anatomy of the neck (i.e., no clear identification of the trachea by palpation, previous neck surgery, documented tracheomalacia, extensive thyroid enlargement), irreversible coagulation disorders, difficult or impossible to intubate patients] were excluded. Each center performed 25 of the reported tracheostomies. After consent was obtained (if the patient was unconscious, then from the relatives), the procedure was performed by the same operator in each hospital. All procedures were performed at the ICU bedside under general IV anesthesia and relaxation.

Before starting, $FiO_2$ was increased to 1.0 and controlled positive pressure ventilation was established throughout the procedure. Monitoring of the electrocardiogram, invasive or non-invasive blood pressure and pulse oximetry was routinely used, and $FiO_2$ was reduced after completion of the procedure according to the $SaO_2$ and additional blood gas controls. Patients were positioned to facilitate access to the trachea, mostly with the neck in a neutral position or with the head very slightly reclined by means of a pillow under the shoulders. Fiberoptic guidance and control was used throughout the whole procedure. In one center, the endotracheal tube in place was removed and a laryngeal mask was inserted and held in place during the procedure (center A). In center B, the endotracheal tube in place was drawn back under fiberoptic control to the level directly below the vocal cords and fixed in this position until the tracheostomy cannula was safely in place. Center A used only cannulas with an internal diameter of 8.0 mm (outer diameter 11.7 mm), and center B used only cannulas with an internal diameter of 9.0 mm (outer diameter 12.7 mm). Transillumination was used to facilitate the identification of the puncture side and to identify unexpected larger vessels at the planned place of cannula insertion. After careful surgical disinfection of the skin, the trachea was punctured in the midline without preceding infiltration with any vasoconstrictive local anesthetics. The puncture was performed in each case between the cricoid and first tracheal ring or in one of the intratracheal ring spaces between the first and the third tracheal ring. After successful fiberoptic-controlled puncture of the trachea, the J-guidewire was introduced into trachea and advanced in the direction of the carina. After the removal of the needle, a small vertical skin incision not larger than 8–10 mm skin

**Fig. 1** The screw-type design PercuTwist dilator

**Fig. 2** Endoscopic view of the stepwise-controlled rotating dilation procedure



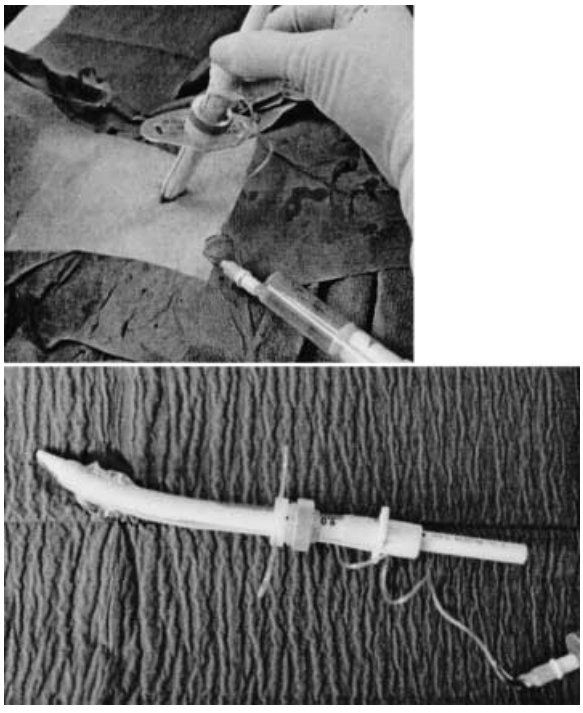


**Fig. 3** Lubricated tracheostomy tube with introducer ready for insertion or introduction of the cannula

was performed. A hydrophilically coated dilation screw, as described above, either suited for the insertion of an 8 mm or 9 mm inner diameter tracheal cannula (PercuTwist, Rüsch, Kernen, Germany) (Fig. 1) was then dropped into water to activate the coating. The PercuTwist instrument has a central inner lumen that allows the guidewire to pass through. Using the guidewire, the dilator was guided towards the skin incision. Under slight pressure the dilator was turned clockwise until the first threads were advanced into the pretracheal tissues.

From that point the instrument was gradually advanced by rotation without pushing, until the tip could be endoscopically identified and then introduced, using Seldinger's technique, twist by twist into the trachea under careful fiberoptic control. The dilating procedure was stopped when the maximum diameter of the dilator could be identified in the trachea (Fig. 2). The instrument was then twisted back and removed and a generously lubricated tracheostomy tube size 8 or 9 with its introducer was advanced into the trachea (Fig. 3). After removal of the introducer and the guidewire, the correct position of the cannula was verified via bronchoscope, and secretions and blood were suctioned before the patient was connected to the ventilator. The removed guidewire was carefully controlled for kinking. The dilating procedure with the new instrument was described by the operators using a scale of I (controlled rotating dilation without any difficulties), II (controlled rotating dilation with some difficulties, but possible), and III (completion of controlled rotating dilation impossible, shift to another percutaneous tracheostomy technique). Bleeding during the procedure (from the incision to the insertion of the cannula) and in a 24-h period was classified as absent or minimal (none or less than one OR sponge and stopping without any intervention), medium (need for special wound dressing and/or vasoconstrictive infiltration) or evident and serious (requiring surgical intervention, such as open ligature, etc.). The insertion of the tracheostomy tube was classified as I (no difficulties), II (minor difficulties), III (very difficult), and IV (controlled insertion impossible) (see Table 1). The incidence of tracheal ring fractures, mucosal lacerations, and lesions of the posterior tracheal wall was carefully evaluated via endoscope. Additionally, bending or kinking of the J-guidewire and other perioperative complications such as oxygen desaturation below an $SaO_2$ of 90% were recorded (see Table 2).

**Table 1** Assessment of the procedure. (*n* number of patients)

| | I | II | III | IV |
|---|---|---|---|---|
| Dilation procedure[a] (*n*) | 44 | 6 | 0 | – |
| Bleeding[b] (*n*) | 48 | 2 | 0 | – |
| Insertion of the tracheostomy tube[c] (*n*) | 46 | 4 | 0 | 0 |

[a] Dilation procedure: I=without difficulties; II=some difficulties but possible; III=impossible
[b] Bleeding: I=absent or minimal; II=medium; III=serious
[c] Insertion of the tracheostomy tube: I=without any difficulties; II=with minor difficulties; III=difficult; IV=controlled insertion impossible

**Table 2** Total number of complications

| Complication | Number |
|---|---|
| Posterior tracheal wall injury | 0 |
| Kinking of the J-guidewire | 8 (5[a]) |
| Laceration of the mucosa | 0 |
| Tracheal ring fracture | 4 |
| Oxygen desaturation ($SaO_2$ below 90%) | 0 |

[a] Number of guidewire kinkings observed during insertion of the tube

## Results

Fifty consecutive adult ICU patients in two different university hospitals were tracheostomized using the new PercuTwist method in a 5-month period. Twenty-five patients were included in each center. Using the classification scale for the performance of the dilation procedure mentioned above (I no difficulties, II some difficulties but possible, and III impossible), the procedure was judged as follows: in center A, I in 23 out of 25, II in 2 out of 25, and III in none of the 25 procedures; in center B, I in 21 out of 25, II in 4 out of 25, and III in none of 25 procedures. In total, 44 procedures were classified as having no problems and six as having some problems, but none serious. None of the performed procedures were classified as being impossible and requiring changing to another tracheostomy technique. In center A, the occurrence of bleeding was judged as absent or minimal in 23 patients, as medium in two patients, and as serious in no patient. In center B, absence of bleeding or minimal bleeding was observed in 25 out of 25 patients. No medium or serious bleeding problems occurred. Bleeding – if present after the initial superficial skin incision – immediately stopped when the first twists had been performed. The insertion of the tracheostomy tube was clas-

sified as I in 25 out of 25 patients in center A, and in center B as I in 21 out of 25 patients and as II in four out of 25 patients. In none of the patients was it impossible to insert the tracheostomy tube in a controlled fashion. In total, four tracheal ring fractures but no mucosal lacerations or lesions of the posterior tracheal wall were observed via endoscopic control. Bending or kinking of the J-guidewire occurred in four out of 25 procedures in center A and B. Other perioperative complications such as oxygen desaturation below an $SaO_2$ of 90% could not be observed.

In summary, in the 50 patients reported, the procedure of controlled rotating dilation could be performed safely and without any major complications.

## Discussion

Percutaneous tracheostomy techniques currently represent the procedure of choice for the performance of a tracheostomy in many intensive care units worldwide [6, 7]. Reasons for their widespread and increasing use might be based on the fact that they offer logistic advantages (with the time from decision-making to performance being the most important one) and that the long-term results in those patients that can be decannulated definitively are at least – from a cosmetic point of view – superior to the conventional open surgical tracheostomy techniques. In addition, many studies have demonstrated at least a comparable rate of perioperative complications and a lower rate of postoperative complications for PDT techniques when compared to conventional open surgical tracheostomy [8, 9, 10, 11]. However, percutaneous tracheostomy techniques might also be associated with serious, even life-threatening complications like airway loss, serious bleeding, pneumothorax, and skin and mediastinal emphysema. Additionally, PDT techniques have their "own" typical complication consisting of an injury to the posterior tracheal wall [8, 12]. Therefore, attempts have been made to reduce the risks associated with the use of the different PDT techniques by developing new methods (such as the Fantoni TLT technique) or by fundamentally modifying established techniques (such as the Blue Rhino technique). The PercuTwist technique offers a new approach to the trachea while simply using the screw principle. The method requires an initial small superficial skin incision, but wide enough to allow the instrument to be rotated without twisting the surrounding skin, and a narrow central stab incision to enable the tip of the screw to enter with its first threads into the pretracheal tissues. After some twists the instrument is screwed into the tissue allowing an even pull during the procedure and therefore giving maximum control. While principally using endoscopy, this fact should significantly reduce the risk of any injury to the posterior tracheal wall during the process of dilation. However, the PercuTwist instrument is a non-flexible, stable screw with sharp threads that can – at least theoretically – easily be advanced into any tissue. Additionally, independent of the patient's anatomy, the screw is long enough to reach the posterior tracheal wall. Therefore, the procedure requires, in our opinion, the imperative use of endoscopic control. A narrowing to the posterior tracheal wall – once identified – can be easily avoided by pulling on the screw during the screwing process. Vertical traction allows the controlled avoidance of an injury to the posterior tracheal wall. However, in contrast to some reports from the literature, the authors are convinced that any percutaneous dilation technique should be performed under bronchoscopic guidance [8, 12].

In the reported series of patients, no serious bleeding problems occurred; interestingly, any bleeding from the initial incision stopped as soon as the instrument was advanced into the pretracheal tissues without re-appearing after the removal of the device or later on. In addition, no serious endotracheal bleeding evidenced by endoscopy could be identified.

While keeping the airway airtight, the procedure allows controlled ventilation without loss of PEEP during dilation. After removal of the dilation instrument, only the short period needed to advance the tracheostomy tube into the trachea and to reconnect the tracheostomy tube to the ventilator opens the airways to atmospheric pressure. Adverse effects on oxygenation as described for "classical" PDT, which is at least partially induced by loss of the PEEP level and repeated airway obstruction by the dilators, are avoided [13]. The tight closure might also reduce the entrance of blood from outside into the tracheal lumen.

Both operators described the process of penetrating the pretracheal tissues and the anterior tracheal wall as easier in elderly patients than in younger ones. Juvenile, firm skin showed a higher tendency to follow the rotating screw. In our experience careful and repeated activation of the hydrophilic coating of the instrument reduces the incidence of these findings. Another interesting finding was that the opening produced by the screw showed almost no tendency towards closure after the removal of the dilation instrument. This is in contrast to the comparable dilation techniques where the opening might close very quickly after removal of the final (or only) dilator.

Initial puncture was performed in each case between the cricoid and first tracheal ring or in one of the intratracheal ring spaces between the first and the third tracheal ring, with the puncture between the intratracheal ring spaces 1–3 being the clearly preferred location. This preference is based on hints from the literature that a puncture between the cricoid and first tracheal ring might be associated with a higher incidence of late tracheal stenosis and direct injury to the cricoid [10].

A kinked guidewire has been described as a sensitive marker for a potential injury to the posterior tracheal

wall [12, 13]. The kinking observed in four guidewires reported in this series never reached 90° in any of the patients. The attempt to advance the first threads into the pretracheal tissues induced guidewire kinking once, thus preventing further penetration of the instrument. Drawing the guidewire a few centimeters back solved the problem in this case. Nevertheless, this observation was counted as kinked guidewire.

It was the intention of this observational study to evaluate feasibility and the occurrence of peri- and postoperative complications with the described new procedure, and not to systematically evaluate endpoints, such as the time needed from puncture of trachea to cannula insertion. However, it should be mentioned that this procedure time did not exceed 5 min in any of the cases described, showing that this technique can at least be performed as quickly as the established techniques [14].

In summary, the new method of controlled rotating dilation could be performed safely and without any serious complications in 50 consecutive patients in two different hospitals. Theoretically, the new procedure offers some potential advantages when compared to other percutaneous dilation techniques. However, the authors are aware of the narrow limits of their non-randomized, observational trial. Therefore, controlled, randomized, and comparative studies will have to show whether the PercuTwist method really represents such a promising new tool as the results from this first report might suggest.

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