Research Article

Percutaneous dilatational tracheostomy: Griggs guide wire dilating forceps technique versus ULTRA-perc single-stage dilator – A prospective randomized study

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Abstract

Percutaneous dilatational tracheostomy (PDT) is a frequently performed surgical procedure on critically ill patients. This study was designed to compare its two methods: Griggs guide wire dilating forceps (GWDF) technique and the ULTRA-perc single-stage dilator technique. **Materials and Methods:** Thirty Intensive Care Unit (ICU) patients on prolonged mechanical ventilation and requiring tracheostomy were included in our prospective randomized study. The first group (GP-GWDF) underwent PDT by the GWDF technique and the second group by the ULTRA-perc technique (GP-UP). Time for the procedure and early and late procedural complications were recorded and compared in between the two groups. **Results:** Time taken for tracheostomy was 11.68 ± 6.48 min for GP-GWDF and 13.93 ± 11.54 min for GP-UP (*P*-value 0.486). Desaturation was noted in two patients in GP-GWDF versus five in GP-UP (*P*-value = 0.195). Hypercapnea and rise in peak airway pressure occurred in one patient in GP-GWDF versus two in GP-UP (*P*-value = 0.543). Loss of airway was recorded in two patients in GP-UP and in none in GP-GWDF (*P*-value = 0.143). Subcutaneous emphysema, pneumothorax and pneumomediastinum occurred in one patient in GP-UP. No major complications were observed in GP-GWDF (*P*-value = 0.309). Hoarseness of voice was noted in one patient in each group (*P*-value = 0.659). **Conclusion:** Both the techniques seem to be equally reliable for carrying out PDT at bedside in the ICU.

Keywords: Intensive care, percutaneous, tracheostomy

Introduction

Tracheostomy is one of the most frequently performed surgical procedures on critically ill patients in an Intensive Care Unit (ICU). Currently, in ICUs, most tracheostomies are performed percutaneously.[1]

There are many techniques described in the literature to carry out percutaneous dilatational tracheostomy (PDT).[2-8] There have been many studies conducted by different investigators comparing the different techniques of percutaneous tracheostomy.[9-12]

There was only one study by Patel *et al.*[13] done on porcine model and mannequins for ULTRA perc; therefore, we decided to compare the ULTRA perc technique with the Griggs guide wire dilating forceps (GWDF) technique, which was already being done in our institute.

The aim of study was to compare the two different methods of percutaneous tracheostomy: GWDF technique with the ULTRA-perc single-stage dilator technique with respect to their duration of procedure, ease of the technique and complications, both procedural and late.

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Materials and Methods

This was a prospective randomized comparison trial. The study was done at the All India Institute of Medical Sciences, New Delhi, Anesthesia Department ICU, which dealt mainly with postoperative surgical and respiratory illnesses. Thirty critically ill patients (15 in each group), who required tracheostomy, were included in this study after getting approval from the ethics committee of the institute and written informed consent from the patients or next of kin.

The sample size was calculated depending on the number of percutaneous tracheostomies done in our institute and by also statistically analyzing the power of the study.

Exclusion criteria were: oxygen requirement greater than 0.8 fraction of inspired oxygen (FiO_2) or greater than 10 cm of water positive end expiratory pressure (PEEP), potential or diagnosed lesion in the cervical spine, uncorrected coagulopathy, anatomical distortion of the trachea or preexisting tracheomalacia, nonpalpable or very low cricoid cartilage, previous neck surgery, goitre or large thyroid mass, gross cervical obesity, infection involving the operative site, nonintubated patients, emergency surgical airway management and pediatric patients.

After fulfilment of the inclusion criteria, the patients were randomized by the envelope method to undergo percutaneous tracheostomy by either the ULTRA-perc or the GWDF technique. Routine monitors were attached.

All tracheostomies were performed at the bedside in the ICU by the faculty of the institute of more than 10 years of experience and under general intravenous anesthesia.

In the ULTRA-perc technique, the patients were placed in the supine position with moderately extended neck. The endotracheal tube was withdrawn under bronchoscopic visual control to bring the tip of the endotracheal tube immediately below the vocal cords. In this place, the cuff was reinflated. Under all aseptic precautions and after landmark identification, 3–5 mL of 2% of lignocaine with adrenaline (1:2,00,000) was used for subcutaneous infiltration. After making a 1.5–2 cm transverse skin incision, blunt dissection of pretracheal tissues was performed by using hemostats to expose the pretracheal fascia. The anterior trachea was then palpated and punctured with a 14 G cannula-on-needle in a posterior caudal direction. Tracheal entry

of needle was confirmed by aspiration of air into the saline-filled syringe. After successful placement of the tracheal cannula, a J-tip guidewire was passed through the cannula into the tracheal lumen. The guidewire introducer and the cannula were then withdrawn leaving the guidewire *in situ*. A well-lubricated initial dilator was passed over the guidewire into the trachea to start the stoma formation and was later removed. A guiding catheter was advanced over the guidewire in the direction of the arrow mark until the safety ridge. The proximal end of the guiding catheter was aligned over the proximal band mark of the guidewire to determine the correct depth of insertion. A White Rhino (ULTRA-perc) dilator was passed over the guidewire and the guiding catheter up to the appropriate skin marking (i.e., marking of 38F external diameter). The safety stop of the guiding catheter was at the skin level and the proximal mark of the guidewire on the tip of the guiding catheter. Finally, the tracheostomy tube was loaded over an appropriate and well-lubricated introducer and was introduced into the tracheal stoma. The introducer, guidewire and the guiding catheter were then removed, leaving the tracheostomy tube *in situ*.

In the GWDF method, just like the ULTRA-perc technique, guidewire placement was completed in the same manner. The initial dilator was then passed over the guidewire to start the stoma formation and was later removed. The dilating forceps with its jaws closed was advanced over the guidewire till a resistance was felt. Then, the forceps was opened to allow dilation of soft pretracheal tissues. The forceps was then reapplied to the guidewire and advanced until the jaws pass into the tracheal lumen. Free movement of the guidewire through the closed jaws of the GWDF was ensured. The handles of the forceps were then raised to align the jaws in the long axis of the trachea. One-step dilatation of the anterior wall of the trachea was achieved by using two-handed opening of the forceps to allow the subsequent passage of the tracheostomy tube of the desired size. After formation of the stoma, the GWDF was removed leaving the guidewire *in situ*. A cuffed tracheostomy with its specially designed obturator was advanced over the tracheal guidewire and inserted through the tracheal stoma. The obturator and guidewire were then removed.

Correct placement of the tracheostomy tube was confirmed by chest auscultation for air entry, capnography, oximetry, bronchoscopic visualization and ventilation of lungs was resumed through the tracheostomy tube. Chest X-ray was taken to look for tracheostomy tube position, pneumothorax, pneumomediastinum, atelectasis and other changes.

Flexible fiberoptic bronchoscopy was performed to look for tracheal wall/ mucosal injuries, fracture of cricoid/ tracheal rings and extent of stoma dilatation.

The following variables were observed and recorded: age, sex, body mass index if possible (using records at time of admission), Acute Physiology and Chronic Health eEvaluation II (APACHE II) score, baseline FiO_2, number of days on mechanical ventilation prior to tracheostomy, time taken for tracheostomy (was defined as local infiltration to connection of the breathing circuit to tracheostomy tube and confirmation of the tube placement by auscultation and rise of the chest), ease of the technique, peak airway pressure before, during and after the procedure and complications – procedural, early and late. Survivors were interviewed in person or by telephone or letters sent to them 6–10 weeks after decannulation, and were enquired about any late complications.

The statistical analysis between the various parameters in the two groups was done using the Statistical Package for the Social Sciences (SPSS) software version 10.0 for windows and Epi info version 6.04d. Age of the patient, number of days with translaryngeal intubation and baseline FiO_2 were compared between the two groups using Student's t-test. Sex of the patient was compared using the chi square test. APACHE II scores between the two groups were compared with the Mann Whitney test. Tracheostomy time was compared using the T-test. Success rate, adequacy of dilatation and procedural and late complications were compared using chi square test.

For this study, a P-value of less than 0.05 was considered statistically significant.

Results

A total of 30 ICU patients (15 in each group) on prolonged mechanical ventilation and requiring tracheostomy were included in our prospective study. None of the patients were excluded from our study.

There were no statistically significant differences between the two groups with regard to demographic data, namely age in years, sex of the patients, APACHE II scores, number of days with translaryngeal intubation prior to tracheostomy, number of survivors among the patients who underwent tracheostomy and baseline FiO_2 values [Table 1].

Success rate in performing the percutaneous tracheostomy was 100% in both the groups. Fourteen patients (93.33%) in the GWDF group and 13 patients (86.67%) in the ULTRA-perc group underwent percutaneous tracheostomy in the first attempt. In one patient (6.67%) in the ULTRA-perc group, it was done in the second attempt; in another patient (6.67%), it was done in the third attempt. In the GWDF group, only one patient dilatation was found to be difficult, and it was done in three attempts. These values were not statistically significant.

Time for the procedure was 11.68 ± 6.48 min in the GWDF group and for the ULTRA-perc group, it was 13.93 ± 11.54 min. These values were not significant statistically (P-value = 0.486).

Stoma was adequately dilated in all the patients in both the groups. There was no incidence of overdilatation and near-total transection in any patient.

Procedural complications

In the GWDF group, desaturation below 90% SPO_2 was noted in two patients. An increase in end tidal CO_2, rise in peak airway pressure and difficult dilatation were encountered in one patient only. None of the patients in the GWDF group had any other complications.

In the ULTRA-perc group, major complications, namely pneumothorax, pneumomediastinum, subcutaneous emphysema, false passage, hypotension, hypertension and loss of airway, were noted in a single patient. Desaturation was seen in five patients and hypercapnea, rise in peak airway pressure, difficulty in dilatation and loss of airway were encountered in two patients each.

None of the patients in either group had significant bleeding during the procedure.

Table 1: Demographics

	GP-GWDF (%)	GP-UP (%)	P-value
Age in years, mean ± SD	48.67 ± 17.61	54.4 ± 19.02	0.564
Sex, male:female	9:6	9:6	NS
APACHE II score, median (range)	18 (0–32)	15 (1–30)	NS
Translaryngeal intubation, mean ± SD	14.73 ± 4.59	15.7 ± 5.52	0.118
Number of survivors (%)	4 (23.33)	4 (23.33)	NS
Baseline FiO_2, median (range)	0.4 (0.28–0.8)	0.4 (0.28–0.8)	NS

NS = Nonsignificant, SD = Standard deviation, APACHE II = Acute Physiological and Chronic Health Evaluation II, FiO2 = Fraction of inspired oxygen

These complications, when compared between the groups, were statistically not significant [Table 2].

Follow-up

Follow-up was done up to 6–10 weeks in patients who survived to discharge. During follow-up, among the late complications, hoarseness of voice was noticed in only two (one from each group) Out of Seven patients, who survived to discharge (*P*-value = 0.659). No other late complications were noted in any of the patient.

Discussion

Elective tracheostomy in patients on long-term ventilatory support is a widely accepted procedure in the ICU. With the advent of the Seldinger guidewire technique,[14] PDT has almost replaced the surgical tracheostomy in critically ill patients. Experiences with dilatational technique have generally been favorable, with claims that, in comparison with the conventional method, they are safer, easier and quicker to perform at the bedside and are associated with fewer complications. However, Dulguerov *et al.*,[15] in his meta analysis of tracheostomy trials, observed that perioperative complications were more frequent with the percutaneous technique (10% vs. 3%) whereas the postoperative complications occur more often with the surgical tracheostomy (10% vs. 7%). Various studies have been carried out to compare different methods of percutaneous tracheostomy and their complications. In humans, till date, no study is available that compared the recently available ULTRA-perc with other methods of percutaneous tracheostomy, although many studies have been performed using the Ciaglia Blue Rhino technique, which has got many similarities with ULTRA-perc. The only study using ULTRA-perc, as found in the literature, has been done by Patel *et al.*,[13] which was performed on mannequin and porcine airway models. They compared the Cook Blue Rhino and the portex ULTRA-perc in the laboratory. Therefore, this study was designed to compare the ULTRA-perc technique with GWDF, which was being routinely performed in our ICU to look for the procedural ease of ULTRA-perc and compare the procedural and late complications of both techniques.

In our study, time for the procedure was comparable in both the groups. The time for the procedure was 11.68 ± 6.48 min in the GWDF group, whereas it was 13.93 ± 11.54 min (*P*-value = 0.486) in the ULTRA-perc group. The time taken for the PDT and insertion by GWDF technique was 6.5 ± 4.5 min in the study by Ambesh[11] *et al.* For Patel *et al.*,[13] the time taken was 51 (range 49–58) s in mannequins and 60.3 (range 51–75) s in the porcine airway model with the ULTRA-perc technique. The higher time for the procedure could be attributed to the time wasted for the arrangements during the dilatation, learning curve of the percutaneous tracheostomy for many operators and because of the long time lapsed for managing the complications in two patients (one in each group). When these two patients were excluded from the calculations, the time taken for the procedure was 10.9 ± 5.57 min for GWDF and 11.4 ± 6.01 min for ULTRA-perc. These timings are comparable to that found in few studies.[14,16]

During the formation of tracheal stoma, there are three important factors that come into play: patient factors,

Table 2: Procedural complications

Complications	GP-GWDF (in number of patients, *n* = 15)	GP-UP (in number of patients, *n* = 15)	*P*-value
Bleeding	Minimal in all patients	Minimal in all patients	-
Desaturation	2	5	0.195
Hypercapnea	1	2	0.543
Rise in peak airway pressure	1	2	0.543
Arrythmias	0	0	-
Difficulty in dilatation	1	2	0.543
Esophageal perforation	0	0	-
False passage	0	1*	0.309
Hypotension	0	1*	0.309
Hypertension	0	1*	0.309
Loss of airway	0	2	0.143
Reintubation	0	1*	0.309
Pneumothorax	0	1*	0.309
Pneumomediastinum	0	1*	0.309
Subcutaneous emphysema	0	1*	0.309
Atelectesis	0	0	-
Tracheal lesion on FOB - anterior	0	0	-
Tracheal lesion on FOB - posterior	0	0	-
Tracheal injury	0	0	-
Technique-related morbidity	0	1*	0.309

*All these complications were noted in the same patient

instrument factors and operator factors. The body mass index, thickness of soft tissues overlying the trachea, site of proposed tracheostomy, calcification of tracheal cartilage rings and prolonged duration of translaryngeal intubation making the tracheal tissues soft and fragile, which may affect the dilatation kinetics of the tracheal stoma. Overenthusiastic attempts at dilatation may result in overdilatation or occult subtotal transection of the trachea and excessive bleeding. Nates *et al*.[17] have postulated that excessive bleeding and the other surgical complication during the dilatational tracheostomy are caused by uncontrolled dilatation of the trachea. In our study, dilatation was found to be adequate in 100% of the patients.

In their study, Ambesh *et al*.[11] reported overdilatation of tracheal stoma in seven of 30 patients in the GWDF group. None of the 30 patients in the CBR group had overdilated trachea.

Complications arising from percutaneous tracheostomy can be intraoperative, perioperative or postoperative. Commonly reported complications include the creation of false tract, laceration of the posterior tracheal wall and uncontrollable bleeding. These complications are potentially fatal.

Hemorrhage from percutaneous tracheostomy is caused by bleeding from the inferior thyroid veins, anterior jugular veins or the thyroid gland itself. Because this is not an open surgical approach, bleeding from injury to these vessels is not rare. Because the bleeding is venous, it is usually easily managed and rarely requires further intervention.

Procedural complications
The complication rates were higher in the ULTRA-perc group than in the GWDF group, which were not statistically significant but were significant clinically.

Among the major complications, pneumothorax, pneumomediastinum, subcutaneous emphysema and significant bradycardia up to 10 beats/min developed in one patient in the ULTRA-perc group. No evidence of tracheal wall injury was found even on repeated bronchoscopy. The pneumothorax that occurred in this case could have been caused either by a false passage formation or by rupture of emphysematous bullae as a result of an increase in peak airway pressure and/or air trapping. The dynamic hyperinflation of lungs and air trapped in the thorax and mediastinum could be implicated in decreasing the venous return and thereby causing hemodynamic compromise in the form of hypotension, bradycardia and near cardiac arrest.

A similar case of pneumothorax was reported by Ambesh *et al*.[11] The patient was an 80-year old who developed pneumothorax after the CBR dilatation and did not exhibit any injury to trachea on repeated bronchoscopy.

With regard to oxygenation, both GWDF and ULTRA-perc did not affect oxygen saturation in a significant manner, although it appeared to be clinically significant, as five patients in ULTRA-perc group and two patients in the GWDF group developed short periods of intraoperative oxygen desaturation. Transient desaturation in these patients may be attributed to the difficulty encountered in dilatation (one patient in GWDF; two in ULTRA-perc) requiring more than one attempt, higher FIO_2 requirement in some patients, size and shape of the white rhino dilator and relative inexperience with the ULTRA-perc technique. Probably, more number of patients needs to be studied to find a significant level.

No incidence of anterior or posterior tracheal lesion was reported in any of the groups in our study. Kinking of the needle, guidewire, guiding catheter or dilator against the tracheal wall is the major cause of anterior or posterior tracheal injury, whereas tracheal cartilage/ring fracture has been attributed to the rapid one-step dilatation. These complications in our study were significantly lower when compared with the study by Ambesh *et al*.[10] (30%) and Byhahn *et al*.[11] (25–36%) in the CBR method. Edward and Williams[18] have also shown that the CBR technique is associated with tracheal cartilage fracture. Reasons for the lower complication rates in our study could be the presence of expert guidance all the time during the procedure, utmost care taken during the procedure and continuous bronchoscopic visualisation during the procedure.

Another reason for not detecting tracheal lesion and ring fracture in our study could be the use of bronchoscope only for their detection. No pathological study was done, as it was not feasible in the patients we studied mostly because of refusal of relatives for the autopsy. Byhahn *et al*.[10] have found bronchoscope to be not so sensitive as compared with pathological studies for detecting the incidence of damage to the tracheal ring. Laryngotracheoscopy can also be used for identifying the pathology. It provides a morphological and functional examination of the airway and is

an accurate and efficient technique to document laryngotracheal lesions.

Late complications

Two patients (one from each group) developed hoarseness of voice. A confounding factor, longer mean duration of the translaryngeal intubation (14.73 ± 4.59 days for GP-GWDF and 15.7 ± 5.52 days for GP-UP), could be the most important cause of the voice problems. No other late complications were recorded. Our results are comparable to the study by Anon *et al.*[12] and Ambesh *et al.*[11] In the study by Anon *et al.*, no late complications were reported in the patients undergoing CBR. Three of 26 patients in the GWDF group presented with mild symptoms of voice changes. However, laryngotracheoscopic examination failed to reveal morphology or functional alteration in the trachea or vocal cords. Ambesh *et al.*[11] reported a change in voice in three of 30 patients 8 weeks after decannulation following CBR. No other complication was reported.

Some patients might develop asymptomatic tracheal stenosis, which cannot be detected on endoscopic examination. Additional diagnostic tests such as computed tomography, magnetic resonance imaging scans or forced oscillation technique need to be performed to know its actual incidence.

Limitations of our study were learning curve for the ULTRA-perc technique and inability to perform pathological studies, computed tomography, magnetic resonance imaging and laryngotracheoscopy during the follow-up.

We conclude that the GWDF and ULTRA-perc (white rhino) techniques of tracheostomy seem to be equally reliable for carrying out PDT at the bedside in an ICU setup. Although the ULTRA-perc technique was associated with a case of major complication, this technique was comparable to the GWDF technique with regard to the procedural time and early and late complications. Expert guidance, utmost care and bronchoscopic visualisation during the procedure help in reducing the complication rates significantly. Late complications are rare with PDT.

References

1. Simpson TP, Day CJ, Jewkes CF, Manara AR. The impact of percutaneous tracheostomy on intensive care unit practice and training. Anaesthesia 1999;54:186-9.
2. Ciaglia P, Firsching R, Syniec C. Elective percutaneous dilatational tracheostomy. Chest 1985;87:715-9.
3. Fantoni A, Ripamonti D, Lesmo A, Zanoni CI. Translaryngeal tracheostomy: A new era? Minerva Anestesiol 1996;62:313-25.
4. Fantoni A, Ripamonti D. A nonderivative nonsurgical tracheostomy: The translaryngeal method. Intensive Care Med 1997;23:386-92.
5. Walz MK, Hellinger A, Walz MV, Nimtz K, Peitgen K. Translaryngealtracheostomy: Technique and initial results. Chirurg 1997;68:531-5.
6. Griggs WM, Worthley LI, Gilligan JE, Thomas PD, Myburg JA. A simple percutaneous tracheostomy technique. Surg Gynecol Obstet 1990;170:543-5.
7. Frova G, Quintel M. A simple method for percutaneous tracheostomy controlled rotating dilation. Intensive Care Med 2002;28:299-303.
8. Gründling M, Kuhn SO, Nees J, Westphal K, Pavlovic D, Wendt M, *et al*. Percutwist dilational tracheostomy: Prospective evaluation of 54 consecutive patients. Anaesthesist 2004;53:434-40.
9. Fikkers BG, Briedé IS, Verwiel JM, Van Den Hoogen FJ. percutaneous tracheostomy with the blue rhino technique: Presentation of 100 consecutive patients. Anaesthesia 2002;57:1094-7.
10. Byhahn C, Wilke HJ, Halbig S, Lischke V, Westphal K. Percutaneous tracheostomy: Ciaglia blue rhino Vs the basic Ciaglia technique of percutaneous dilational tracheostomy. Anesth analg 2000;91:882-6.
11. Ambesh SP, Pandey CK, Srivastava S, Agarwal A, Singh DK. Percutaneous tracheostomy with single dilatation technique: A prospective randomised comparison of Ciaglia blue rhino Vs Griggs'guidewire dilating forceps. Anesth Analg 2002;95:1739-45.
12. Añón JM, Escuela MP, Gómez V, Moreno A, López J, Díaz R, *et al*. Percutaneous tracheostomy: Ciaglia blue rhino Vs Griggs' guidewiire dilating forceps: A prospective randomized trial. Acta anaesthesiol scand 2004;48:451-6.
13. Patel PB, Ferguson C, Patel A. A comparison of two single dilator percutaneous tracheostomy sets: The Blue Rhino and the Ultraperc. Anaesthesia 2006;61:182-6.
14. Seldinger SI. Catheter replacement of the needle in percutaneous arteriography; A new technique. Acta Radiol 1953;39:368-76.
15. Dulguerov P, Gysin C, Perneger TV, Chevrolet JC. Percutaneous or surgicaltracheostomy: A meta-analysis. Crit Care Med 1999; 27:1617-25.
16. Escarment J, Suppini A, Sallaberry M, Kaiser E, Cantais E, Palmier B, *et al*. Percutaneous tracheostomy by forceps dilation: Report of 162 cases. Anaesthesia 2000;55:125-30.
17. Nates JL, Cooper DJ, Myles PS, Scheinkestel CD, Tuxen DV. Percutaneous tracheostomy in critically ill patients: A prospective, randomized comparison of two techniques. Crit care med 2000;28:3734-9.
18. Edwards SM, Williams JC. Tracheal cartilage fracture with the Blue Rhino Ciaglia percutaneous tracheostomy system. Eur J Anaesthesiol 2001;18:487.