Primary research
Percutaneous tracheostomy: comparison of Ciaglia and Griggs techniques

José M Añón, Vicente Gómez*, Mª Paz Escuela, Vicente De Paz, Luis F Solana, Rosa M De La Casa*, Juan C Pérez, Eugenio Zeballos and Luis Navarro

Hospital Virgen de la Luz, Cuenca, and *Clínica Moncloa, Madrid, Spain

Abstract

Background: Although the standard tracheostomy described in 1909 by Jackson has been extensively used in critical patients, a more simple procedure that can be performed at the bedside is needed. Since 1957 several different types of percutaneous tracheostomy technique have been described. The purpose of the present study was to compare two bedside percutaneous tracheostomy techniques: percutaneous dilatational tracheostomy (PDT) and the guidewire dilating forceps (GWDF).

Materials and methods: A prospective study in two medical/surgical intensive care units (ICUs) was carried out. Sixty-three critically ill patients who required endotracheal intubation for longer than 15 days were consecutively selected to undergo PDT (25 patients) or GWDF (38 patients) technique. Intraoperative and postoperative complications were recorded.

Results: Age (mean±standard error) was 63±1.1 years. The patients had been mechanically ventilated for an average of 19.8±1.2 days. The GWDF technique was significantly faster than PDT technique (P=0.02). Fifteen complications occurred in 10 out of 63 (15%) patients. They were as follows: tracheal tear (one patient in each group; in one case this was due to false passage); transient hypotension (one patient in the PDT group and two patients in the GWDF group); atelectasis (one patient in the PDT group); and haemorrhage (one patient in the PDT group and three patients in the GWDF group). In both patients with tracheal tear, reduced arterial oxygen saturation (SaO_2) with concomitant subcutaneous emphysema ensued.

Conclusion: We found no statistical differences between complications with both techniques. The surgical time required for the GWDF technique was less than that for PDT.

Keywords: complications, percutaneous, tracheostomy

Introduction

The standard tracheostomy technique described in 1909 by Jackson [1] has a complication rate of up to 66% [2–7]. The most severely ill patients admitted to an ICU often require a tracheostomy. A simple procedure, with a lower rate of complications and that can be performed at the bedside to eliminate the risk of transport to the operating room, is needed.

FIO$_2$ = fractional inspired oxygen; GWDF = guidewire dilating forceps; ICU = intensive care unit; PDT = percutaneous dilatational tracheostomy; SaO$_2$ = arterial oxygen saturation.

Percutaneous tracheostomy was first described by Shelden et al [8] in 1957. In 1969, Toy and Weinstein [9] described a percutaneous tracheostomy system using the guidewire approach of Seldinger. In 1985 Ciaglia et al [10] described PDT, a method based on needle guidewire airway access followed by serial dilatations with sequentially larger dilators. In 1989, Schachner et al [11] reported the Rapitrac (SurgiTech Medical, Sydney, Australia), a dilating forceps device with a beveled metal cone that is designed to advance forcibly over a wire into the airway. Griggs et al [12] reported on the GWDF technique in 1990. This method is uses a forceps similar to the that of the Rapitrac, except for the absence of a cutting edge on the tip of the instrument.

The objective of the present study was to compare two bedside tracheostomy systems, PDT and GWDF, in a population of critical care patients in two medical/surgical ICUs.

Materials and methods

A prospective study in two medical/surgical ICUs was carried out over a 36-month period. Sixty-three critical patients were consecutively selected to undergo PDT ($n=25$) or GWDF ($n=38$) techniques. Patients who required endotracheal intubation for more than 15 days were included. Exclusion criteria were as follows: presence of any haemostatic defect (platelet count below $50\,000/mm^3$, or activated partial thromboplastin time or prothombin time greater than $1.5 \times$ control); anatomic distortion of the trachea; previous neck surgery; goitre; and any evidence of infection in the soft tissues of the neck.

Both techniques were performed with minimal variation from their original descriptions [10,12]. All tracheostomies were performed by the staff physicians of the ICU, and only four intensivists (from a total of 14) were not previously skilled in these procedures. Tracheostomies performed by the latter four intensivists were directly supervised by experienced physicians, and all techniques were done at the bedside of the patient.

The following data were recorded: age, sex, Acute Physiology and Chronic Health Evaluation II score, fraction of inspired oxygen (FIO_2) before the tracheostomy, days in mechanical ventilation before the tracheostomy, bleeding, tracheal tear, subcutaneous emphysema, pneumothorax, wound infection, hypotension, lowering SaO_2 during the procedure, inability to complete the procedure and procedural mortality.

Complications were defined as follows: bleeding (a drop in haematocrit level to below 3 points during the first 24 h after the procedure); wound infection (cellulitis around the stoma with purulent secretion, and microbiological tests in this area documented); hypotension (mean arterial pressure <60 mmHg); lowering of SaO_2 during the procedure (a drop to <90%); inability to complete the procedure (when tracheostomy could not be performed with a chosen technique and had to be done using conventional technique or other percutaneous technique); subcutaneous emphysema, or pneumothorax documented by chest radiograph; procedural mortality (mortality directly related to a technique complication, during the procedure or later during the stay in the ICU); tracheal tear (a tear produced over tracheal wall during the procedure); and false passage (dilatation or insertion of the cannula outside the tracheal lumen).

Preparation of the patient

Patients were placed on a regimen of 1.0 FIO_2, and analgesia, sedation and relaxation were administered (midazolam, fentanyl and pancuronium intravenously). The neck was hyperextended and antiseptic solution on the surgical field was administered. The endotracheal tube was repositioned above the site of the proposed tracheostomy. The endotracheal tube cuff was deflated and it was withdrawn to just below the vocal cords by an assistant. After that the assistant held the tube with his or her hands continously throughout the whole procedure. Blood pressure, cardiac rhythm and arterial haemoglobin saturation were continuously monitored throught the procedure. According to their original descriptions [10,12], PDT and GWDF were performed in the space between the cricoid and the first tracheal cartilage or between the first and second tracheal cartilages when it was possible.

Ciaglia technique was performed using the Ciaglia multiple dilator kit (Ciaglia Percutaneous Tracheostomy Introducer Set; William Cook Europe, Bjaeverskov, Denmark). Griggs technique was performed using the Percutaneous Tracheostomy Kit (Portex Ltd, Hythe, Kent, UK).

Statistical analysis

Quantitative variables are described as mean ± standard error of the mean. Categorical variables are expressed as percentages. Comparisons between means were done with the Student's t-test. Comparison between percentages were performed with the χ^2 test. Data were analyzed using the Statistical Package for the Social Sciences Software (version 7.5) for Windows (SPSS Inc, Chicago, IL, USA).

Results

Sixty-three patients were entered into the study, 25 for PDT and 38 for GWDF. The mean age was 63 ± 1.1 years; 39 were men and 24 were women. The mean duration of translaryngeal intubation before the technique was 19.8 ± 1.2 days. The mean FIO_2 before the technique was 0.47 ± 0.01. The mean Acute Physiology and Chronic Health Evaluation (APACHE) II score was 21.6 ± 1.1. Fourteen patients died in the ICU (22.2%), although none of these deaths were related to technique complications. Mortality in the ICU was higher in GWDF group, but this

was not statistically significant ($P = 0.09$) and it was not attributable to the procedure. Mean duration of the procedure was significantly lower with the GWDF than with the PDT technique ($P = 0.02$; Table 1).

The complications of the procedures were divided into two categories: intraoperative and postoperative. Lowering of SaO_2, hypotension, tracheal tear and false passage were considered intraoperative events. Emphysema, atelectasis, haemorrhage, pneumothorax and wound infection were considered postoperative events. Intraoperative and postoperative complications are showed in Table 2. Three patients in the GWDF group developed bleeding, as compared with only one patient in the PDT group (not significant). Tracheal tear occurred in one patient from each group. There were a total of 15 (23%) complications in 10 (15%) patients, but there was no statistical difference between procedures.

Discussion
Of the different techniques for percutaneous tracheostomy, PDT is the more widely used method in intensive care medicine. Several studies [13–25] have been published since its introduction, demonstrating the method to be safe and cost-effective. Studies that compared PDT with standard tracheostomy [26–29] demonstrated that PDT was quicker, less traumatic, associated with fewer early and late complications, and more cost-effective. Not all studies that compared PDT with standard tracheostomy demonstrated reduced complications, however [30]. An increase in perioperative complications and mortality was seen in studies that used Rapitrac [31], and in studies in which the PDT was performed by physicians who were inexperienced in the technique [32]. A meta-analysis of studies to compare percutaneous versus surgical tracheostomy has been recently published [33]. Percutaneous tracheostomy was found to be associated with a higher incidence of perioperative complications, especially perioperative deaths and cardiorespiratory arrests, but postoperative complication rates were found to be higher with surgical tracheostomy. In that meta-analysis, however, the authors do not take into account the different techniques used, and that each technique has its own method and complication rates [34].

Recently, Ambesh and Kaushik [35] compared PDT and Rapitrach techniques in 80 patients (40 patients underwent each technique) and they found no significant differences between the two methods. Powell *et al* [36], however, in their review of the safety and efficacy of the four methods of percutaneous tracheostomy, found a high perioperative complication rate (22.9%) in nine series using the Rapitrac technique. Those investigators found only three series of patients who underwent the GWDF technique (248 cases in total) and 29 series of patients who underwent PDT (1074 cases is total). Only eight

Table 1

Demographic data between groups

Variable	Group	
	PDT	GWDF
n (%)	25 (39.7%)	38 (60.3%)
Age (years)	62.5 ± 2.3	62.7 ± 2.4
Male	14 (36%)	25 (64%)
APACHE II	23.5 ± 3.04	21 ± 1.2
Procedure duration (min)	25 ± 3.8*	17.3 ± 1.9
FIO_2 before technique	0.47 ± 0.01	0.48 ± 0.02
Translaryngeal intubation time (days)	19.9 ± 1.8	19.7 ± 1.6
Mortality in ICU	3 (4.9%)	11 (18%)

Where applicable, values are expressed as mean ± standard error of the mean. *$P = 0.02$, versus GWDF group.

Table 2

Procedure-related complications between PDT and GWDF techniques

Complication	Group		
	PDT	GWDF	Total
Intraoperative			
Lowering of SaO_2	1	1	2
Hypotension	1	2	3
Tracheal tear	1	1	2
False passage	0	1	1
Postoperative			
Emphysema	1	1	2
Atelectasis	1	0	1
Haemorrhage	1	3	4
Pneumothorax	0	0	0
Wound infection	0	0	0

complications (all haemorrhages) were reported with the GWDF technique, three during the procedure and five postoperatively. The PDT technique is the best studied, and only one study was reported by the developer of the technique [15], leaving 904 PDTs performed by other investigators. Six deaths were reported for PDT. The perioperative complications of 'blind' (nonendoscopic) PDT were 8.2%.

A limitation of our study was the sample size, which is too small to allow definitive conclusions to be drawn, but we believe that the present study makes a useful contribution.

A few series with GWDF have been published, and only one study, by Van Heerden *et al* [37], of 54 patients that compared both techniques has been performed. They used a bronchoscope for the first 15 cases and found that bleeding and damage to the endotracheal tube were the most common complications. They found no differences between the two groups in terms of complications.

The present results show no statistical differences between the two techniques. The complication rates (9.6% with PDT technique and 14.6% with GWDF technique) are comparable to those of other series reported in the literature using nonendoscopic PDT technique [13,16,21–23,26]. Our procedural mortality was 0% and there were no major complications such as tracheoinnominate fistula or mediastinitis. Only in one patient from each group did a clinical important adverse event (tracheal tear) occur. In the first patient a minimal anterior tracheal tear with PDT due to a false passage occurred. A surgical technique to repair it was performed. In the other patient, tracheal tear resulted from use of the GWDF technique and was probably due to the trachea characteristics of the patient. In both cases concomitant subcutaneous emphysema and lowering SaO_2 were produced.

Hypotension was transient, and it was related only to the administration of the anaesthesic agents. Haemorrhage did not require surgical ligation, surgical exploration or delay of the procedure. Only one patient needed blood transfusion due to haemorrhage after the procedure. The bleeding was stopped with conservative measures.

In three patients we were unable to complete the procedure. The first case, with the PDT technique, this was due to abnormal vasculature in the neck and we completed the procedure using a standard tracheostomy. The other two cases (with GWDF) were completed with PDT techique because of inability to pass the tracheostomy tube through the stoma. This was probably due to the design of the obturator in the first version of the kit launched in Spain. Once this obturator was replaced by an improved one, the problem did not occur.

The notion of a percutaneous tracheostomy 'learning curve' has been reported in the literature by several authors [13,32,38,39] and should be emphasized. Petros and Engelmann [24] documented an overall complication rate of 11% with PDT, but the rate of acute complications was 18.5% during the first 2 years and dropped to 6% during the last 2 years, which they attributed to the 'learning curve'. Our mean time for the procedure (with both techiques) was higher than mean time reported by others (4.3–15 min) [21,23–27], although the mean time required to perform the GWDF technique was significantly less than that required to perform the PDT technique. The overall time ranged from 6 min when the technique was

performed by intensivists who were experienced with both techniques, to 45 min when the physician who performed the procedure had no previous experience. Also the tracheal tear associated with false passage in a patient described above could have been be due to this lack of experience.

The more serious complication rates, such as false passage or tracheal tear, could be improved with endoscopic guidance. Studies with PDT performed with endoscopic guidance [14,18,19,40,41] have reported lower complication rates than studies performed with 'blind' PDT. Perioperative, postoperative and late complication rates for endoscopic and nonendoscopic PDT have been reported as follows: 7.2% versus 8.2%, 3.9% versus 6.1% and 1% versus 2.2%, respectively. The mortality rates were 0.65% and 0.52%, respectively, for endoscopically guided and 'blind' PDT [36].

Differences between rates of complications can be due to the lack of definition or homogeneity of complications. The definition of haemorrhage differs between different studies. Van Heurn *et al* [22] defined minor haemorrhage as bleeding that lengthened the procedure and was controlled by local compression, and major haemorrhage as bleeding that required suture ligation; Petros and Engelmann [24] defined moderate stomal oozing as blood loss of about 50–100 ml, whereas severe bleeding was defined as a loss of more than 100 ml. Also, the definition of wound infection differs between different studies. In the present study, in accord with other authors [22], we defined wound infection based on clinical and microbiological criteria. In other papers, only clinical criteria were recorded [19,26]. In other studies definitions of these complications are lacking, and therefore their description may be subjective [13,14,19,23,25,27,42].

We conclude that both techniques result in a safe placement of a tracheostomy tube in the ICU. Although bleeding was more common with GWDF, this was not statistically significant and the higher mortality in this group of patients was not related to the technique. The mean duration of procedure was significantly lower with GWDF than with PDT technique.

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Authors' affiliations: José M Añón, Mª Paz Escuela, Vicente De Paz, Luis F Solana, Juan C Pérez, Eugenio Zeballos and Luis Navarro (Intensive Care Unit, Hospital Virgen de la Luz, Cuenca, Spain) and Vicente Gómez and Rosa M De La Casa (Intensive Care Unit, Clínica Moncloa, Madrid, Spain)

Correspondence: José M Añón, Intensive Care Unit, Hospital Virgen de la Luz, Hdad, Donantes de Sangre-1, 16002 Cuenca, Spain. Tel: +34 969 224 211; fax: 34 969 230 407; e-mail: elizalde@iponet.es