ORIGINAL ARTICLE

Percutaneous Tracheostomy in Critically ill Patients: Experience in a Medical Intensive Care Unit*

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Background: Tracheostomy is a procedure commonly required in the intensive care unit. In the last two decades, the use of the percutaneous method has increased in parallel with improvements in the technique.

Objective: To describe our experience in employing the percutaneous method over the last 3.5 years.

Methods: We created, retrospectively, a database of prospective tracheostomy data related to 78 patients evaluated between January 2000 and July 2003. We used the percutaneous tracheostomy techniques of either progressive dilatation (in 36 patients) or forceps dilatation (in 42 patients). Data are expressed as number of occurrences or median with interquartile ranges.

Results: The mean age of the patients was 66 (range, 43-75), and the median APACHE II score was 16 (range, 12-21). The median time spent on mechanical ventilation prior to tracheostomy was 14 days (range, 10-17 days). Of the 78 patients studied, 18 (23%) died while in the intensive care unit. The most common cause of admission was acute central nervous system disturbance (in 45%). Most of the tracheostomies performed were indicated due to difficulty in weaning from mechanical ventilation (in 50%) or to Glasgow Coma scores consistently lower than 8 (in 49%). Bronchoscopy was used in all but 6 of the procedures. There were complications in 33% of the procedures. The most common complication was light bleeding, without need for transfusion. No patient died due to complications arising from the procedure.

Conclusion: Percutaneous tracheostomy is reasonable and safe when performed in an intensive care unit.

Key words: Tracheostomy/methods. Respiration, Artificial/methods. Respiratory Insufficiency/therapy. Respiratory Insufficiency/complications.

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Abbreviations used in this paper:

ICU – Intensive care unit
FiO2 – Fraction of inspired oxygen
CPAP – Continuous positive airway pressure
SIMV – Synchronized intermittent mandatory ventilation
PCV – pressure-controlled ventilation

INTRODUCTION

Tracheostomy is a common procedure required in the intensive care unit (ICU)[1]. It is classically performed as a surgical procedure. However, in the last two decades, this common technique has been replaced by simple procedures that basically involve puncture and dilatation of the trachea and subjacent soft tissues[2-5]. Some reviews and studies have shown the safety and feasibility of the percutaneous bedside procedure[6, 7], even in clinical ICUs[8].

The objective of this casuistic study is to describe our experience in employing percutaneous tracheostomy in the clinical intensive care unit (ICU) of a tertiary-care teaching hospital.

METHOD

We analyzed the procedures performed between January 2000 and July 2003. The initial date corresponds to the introduction of the percutaneous tracheostomy methodology as a bedside procedure in our clinic. Within this interval, we performed 78 percutaneous procedures in hospitalized patients in the Clinical ICU at the Hospital das Clínicas de São Paulo, which has 17 beds. A database of prospective tracheostomy data was created. Since the procedures were part of the routine treatment of patients, no written informed consent was required.

The medical team in the clinical ICU prescribed and performed the tracheostomies. Patients were monitored with continuous electrocardiography, pulse oximetry, arterial blood pressure measured every two minutes, or continuous invasive monitoring of arterial blood pressure. Prior to and during the procedure, mean arterial blood pressure was maintained above 65 mmHg, with systolic arterial blood pressure above 90 mmHg, and peripheral oxygen saturation above 90%. Mechanical ventilation was used in order to avoid hypoventilation or hypoxemia during the procedure – controlled volume, with respiratory frequency between 10 and 15 breaths per minute, tidal volume between 6 and 10 mL/kg, inspiratory flow between 40 and 60 L/min on a sliding scale, end-inspiratory pause between 0.2 and 0.5 seconds, positive end-expiratory pressure equal to or greater than 5 cm H_2O when necessary, and a fraction of inspired oxygen (FiO_2) of 1. As for airway pressure levels, the most important concern was to maintain plateau pressure equal to or less than 35 cm H_2O, without regard for peak pressure. Patients were sedated with midazolam and fentanyl and paralyzed with pancuronium. When necessary, hemodynamic balance was maintained by administration of crystalloids.

Subsequently, the patient was properly positioned with the head extended and supported by a pad between the shoulders. The orotracheal tube was inserted to the glottic area, visual access was gained by means of either bronchoscopy or direct laryngoscopy, and cuff was carefully reinflated. The techniques used were progressive dilatation with tapered dilators as described by Ciaglia et al.[2] or forceps dilatation as described by Griggs et al.[3], depending on the preference of the medical team. Local anesthesia was achieved by means of lidocaine 2% with a vasoconstrictor. The use of bronchoscopy to guide the team in performing the procedure was optional.

No statistical analysis was performed. Quantitative data are shown as medians and interquartile ranges, and qualitative data are shown as number of occurrences and percentages.

RESULTS

General characteristics of patients, including comorbidities and diagnoses at admission are shown in Table 1. Table 2 summarizes the reasons why the procedure was performed. The item “difficulty in weaning from mechanical ventilation” was characterized by the following criteria: either there was failure in two sequential extubation attempts during

the same ventilatory weaning procedure, or there was failure in one extubation attempt and patients presented limiting clinical conditions, such as accumulation of tracheal fluid, decreased consciousness (but with a Glasgow Coma Score above 8 points), or relevant dysphagia with frequent inspiration. The level of consciousness was considered insufficient for airway protection when the Glasgow Coma Score was consistently below 8 points.

Immediately prior to the procedure, 56 patients were submitted to continuous positive airway pressure (CPAP), 14 patients were submitted to synchronized intermittent mandatory ventilation (SIMV), and 8 patients to pressure-controlled ventilation (PCV). Median final expiratory pressure was 8 cm H_2O (range, 5-10 cm H_2O), and median FiO_2 was 0.30 (range, 0.21-0.40). The percutaneous tracheostomy techniques were progressive dilatation with tapered dilators (in 36 patients) and forceps dilatation (in the remaining 42 patients). In 72 patients, bronchoscopy was used as a guide for the procedure and for anatomical verification at the end of the tracheostomy.

There were 25 patients who presented complications directly related to the procedure. A list of complications, as well as their classification in relation to the tracheostomy technique used, is shown in Table 3. Among the 6 patients who were submitted to the procedures without the use of a bronchoscope, one had emphysema and one had hemorrhage. The resolution of bleeding, since it was localized, was achieved through compression. In a patient presenting systemic venous hypertension due to acute exacerbation of a chronic embolism, hemorrhage was caused hypertrophic cervical venous plexus, and surgical tracheostomy with electrocauterization was therefore chosen. Fractures of tracheal rings were only monitored since there were no relevant deviations. Subcutaneous emphysema was also only monitored because there were no signs of tracheal wall lesions. A patient not submitted to bronchoscopy during the performance of the tracheostomy presented subcutaneous emphysema, and a subsequent diagnostic bronchoscopy was carried out. In general, when dilatation was difficult to achieve, there was high soft-tissue resistance. However, the use of forceps to help separate these parts solved the problem. A case of false passage was resolved by repositioning the system with the aid of a bronchoscope. However, another case could only be resolved through surgery, since the procedure caused a hematoma in the anterior portion of the tracheal wall. Graph 1 shows complications during the period of data collection, with the discrimination of types of complications by period.

DISCUSSION

The objective of this article was to describe our experience in employing bedside percutaneous tracheostomy in a clinical ICU. Although there are at least 4 different techniques that can be used to perform this procedure[2-5], we only employed two of them.

The population in the study is representative of a typical clinical ICU, i.e. older patients presenting frequent comorbidities. The most common reason for ICU admission was decreased consciousness due to acute encephalopathy, followed by respiratory insufficiency secondary to bronchopneumonia (Table 1). Tracheostomy was indicated for most of these patients due to difficulty in weaning them from mechanical ventilation (Table 2). Performing a tracheostomy in a critically ill patient is still debatable and there is no consensus within the pulmonology community[1].

Tracheostomy is not a routine procedure in our ICU. It is used in order to facilitate the transfer of certain patients to semi-intensive care centers or infirmaries. Classical tracheostomy is only performed in the surgical center in our hospital, in accordance with the recommendations of the hospital infection control group. The waiting list for our busy surgical center is considerable, and the delay can negate the benefit of the procedure, the objective of which is early, safe discharge from the ICU. However, percutaneous tracheostomy is performed at bedside. The need to request the surgical procedure arose only twice during the percutaneous tracheostomies performed in our study – and this can be done some time after the decision to change procedures is made. In light of this, the

possibility of performing the procedure at bedside makes the percutaneous technique very useful in the ICU.

The use of bronchoscopy in order to improve orientation during the procedure has been recommended because it makes the procedure safer[9-11], but it is not mandatory[12]. Although it was possible for us to perform percutaneous tracheostomy without the aid of a bronchoscope, we found that the team felt less confident during the procedure if bronchoscopy was not available. Therefore, we have chosen to always perform percutaneous tracheostomy with the aid of a bronchoscope in our ICU, but this is not standard practice[10,11].

No patients died due to complications arising from the procedure. Light bleeding has been reported to be frequent[6, 8], and it was also the most common complication in our study (Table 3 and Figure 1). Some authors have defined significant bleeding as the need for blood transfusion or the presence of asphyxia[12, 13]. This happened to none of our patients. In other studies with a greater numbers of cases, difficult dilatation, accidental extubation, and false passage have not been reported as common complications and are sometimes not even being mentioned[14]. Tracheal ring fracture, despite its rarity, has been related to tracheal stenosis as a late endoscopic complication in up to 89.5% of the cases[11]. Cellulitis and emphysema are rare but can be extensive[15, 16]. In our study, there were only minor complications, and these were easily resolved without any serious consequences for the patients.

The distribution of complications during the period of the study is interesting to observe. Incidence of adverse effects was high during the first year, decreased in the second and third years, and increased again in the last year (Graph 1). Our best complication rates were between 0% and 18%. These rates are, in general, higher than others reported in the literature (between 2.2% and 11%)[6, 8-12]. These results may be due to unusual determining factors, such as the fact that ours is a teaching hospital where procedures are performed by third-year intensive-care residents. In addition, some of the complications we described, such as difficult dilatation and light bleeding, might not have been considered in other studies[6, 8-12, 14].

Neither the time spent during the procedure nor tracheostomy costs were evaluated in the present study. In the literature, mean duration of the procedure ranges from 7 to 10 minutes[9, 17]. According to other studies in which costs have been evaluated, the cost of percutaneous tracheostomy appears to be lower than that of the surgical procedure.

In conclusion, when we reassess our experience over the last 3.5 years employing bedside percutaneous tracheostomy, using either the progressive dilatation technique or the forceps technique, we can conclude that it is a feasible procedure that results in few serious complications to patients.

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TABLE 1
General characteristics, comorbidities, and diagnosis of 78 patients

Characteristics	Values
Age (years) *	66 (43,75)
Gender (female) – n (%)	44 (56)
APACHE II **	16 (12,21)
CO_2 retention *** - n (%)	4 (5)
Prior use of mechanical ventilation (days)**	14 (10,17)
Mortality in ICU – n (%)	18 (23)
Comorbidities – n (%)	
Systemic arterial hypertension	18 (23)
Diabetes mellitus	4 (5)
Chronic cardiac insufficiency	4 (5)
Chronic renal insufficiency	5 (6)
Syndromic diagnosis at admission – n (%)	
Encephalopathies	35 (45)
Respiratory insufficiency	34 (44)
Bronchopneumonia	10 (13)
Uncompensated COPD	7 (9)
Peripheral neuropathies	7 (9)
Acute pulmonary edema	5 (6)
Acute respiratory distress syndrome	4 (5)
Lung embolism	1 (1)

*mean (minimal and maximal)
**median and interquartile ranges
***Patients presenting arterial carbon dioxide tension equal to or greater than 45 mmHg prior to admission
COPD: chronic obstructive pulmonary disease; ICU: intensive care unit

TABLE2
Indications for tracheostomy

Reason	n (%)
Difficulty in weaning from MV	39 (50)
Decreased consciousness	38 (49)
Obstructive sleep apnea secondary to morbid obesity	1 (1)

MV: mechanical ventilation

TABLE 3
Complications in the population studied in relation to the technique employed

Complication – n (%)	Technique employed		
	Forceps (n = 42)	Dilators (n = 36)	Total (n = 78)
Subcutaneous emphysema	0 (0)	2 (6)	2 (3)
Accidental extubation	0 (0)	3 (8)	3 (4)
Slight bleeding*	6 (14)	3 (8)	9 (12)
Ring fracture without deviation	2 (5)	3 (8)	5 (6)
Difficulty in dilatation **	1 (2)	2 (6)	3 (4)
False passage***	0 (0)	2 (6)	2 (3)
Cervical cellulitis	1 (2)	0 (0)	1 (1)
Total number of complications	**10 (23)**	**15 (42)**	**25 (33)**

*Bleeding resolved through compression
**Repositioning of dilator or forceps, or use of surgical material, required in order to improve dilatation
***Parallel routes in relation to the trachea, without transfixation

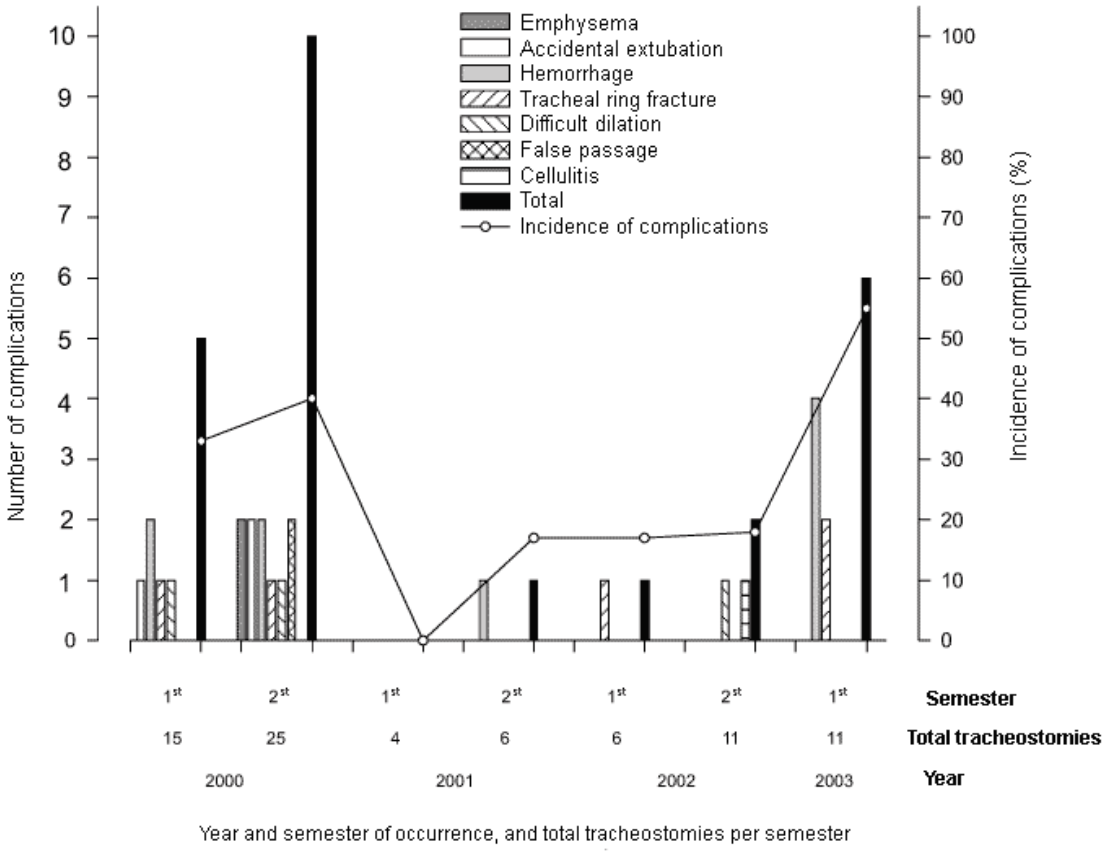

Figure 1. The total absolute number of complications (black bars) and the number of each complication in detail (bars in accordance with the legend) are shown per semester, starting from the first semester of 2000 until the first semester of 2003. The number of tracheostomies performed per semester is shown below the x-axis. Incidence of complications, i.e. the ratio between the total number of complications and the number of tracheostomies performed (both in relation to the semester in question), is shown by the continuous line over the black bars. Incidence of complications is expressed in percentages on the y-axis on the right.