

# Tracheostomy in the Intensive Care Unit: a University Hospital in a Developing Country Study

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## Abstract

**Introduction** Tracheostomy is the commonest surgical procedure in intensive care units (ICUs). It not only provides stable airway and facilitates pulmonary toilet and ventilator weaning, but also decreases the direct laryngeal injury of endotracheal intubation, and improves patient comfort and daily living activity.

**Objective** The objective of this study is to assess the incidence, indications, timing, complications (early and late), and the outcome of tracheostomy on patients in the intensive care units (ICU) at a university hospital in a developing country.

**Methods** This study is an observational prospective study. It was performed at the otolaryngology department and ICU new surgery hospital on 124 ICU admitted patients. We collected patients' demographic records, cause of admission, indications of tracheostomy, mechanical ventilation, and duration of ICU stay. We also gathered patients' tracheostomy records including the incidence, timing, technique, type, early and late complications, and outcome. All tracheostomized patients received follow-up for 12 months.

**Results** The indication for tracheostomy in ICU patients was mostly prolonged intubation (80.5%), followed by diaphragmatic paralysis (19.5%). All tracheostomies were done by the open approach technique. Tracheostomy for prolonged intubation was done within 17 to 26 days after intubation with a mean of  $19.4 \pm 2.07$  days. Complications after tracheostomy were 13.9% tracheal stenosis and 25% subglottic stenosis.

**Conclusion** Prolonged endotracheal intubation is the main indication of tracheostomy, performed after two weeks of intubation. Although there were no major early complications, laryngotracheal stenosis is still a challenging sequel for tracheostomy that needs to be investigated to be prevented.

## Keywords

- ▶ tracheostomy
- ▶ endotracheal intubation
- ▶ ICU
- ▶ mechanical ventilation

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## Introduction

Tracheostomy is the commonest surgical procedure in intensive care units (ICUs).<sup>1,2</sup> There are four main general indications for tracheostomy: long term mechanical ventilation, weaning failure, upper airway obstruction, and airway protection.<sup>3</sup> Tracheostomy in ICU is usually performed for patients with prolonged mechanical ventilation.<sup>4</sup>

Tracheostomy does not only provide stable airway and facilitate pulmonary toilet and ventilator weaning, it also decreases the direct laryngeal injury of endotracheal intubation, and improves patient comfort and daily living activity such as mobility, speech, and eating.<sup>5,6</sup>

Furthermore, early tracheostomy decreases the ventilator time, the incidence of ventilator-associated pneumonia (VAP), length of ICU stay, and overall length of hospital stay.<sup>7</sup>

There are two main tracheostomy techniques: surgical tracheostomy (ST), first described in 1909<sup>8</sup> and performed by surgeons, and percutaneous dilatational tracheotomy (PDT), described in 1985<sup>9</sup> and performed by surgeons, internists, or anesthesiologists.

So far, the choice of tracheostomy techniques has been a matter of debate, and it is primarily made in accordance with the surgeons' preference rather than by evidence.<sup>7,10,11</sup>

The aim of this study was to assess the incidence, indications, timing, early and late complications, and outcome of tracheostomy in ICU patients of a university hospital in a developing country.

## Patients and Methods

### Study Design

This prospective study took place at the otorhinolaryngology department and ICU of the new surgery hospital, Zagazig University Hospitals, Egypt, from June 2013 to June 2014. All enrolled subjects or their relative signed an informed consent after explanation of the research purpose.

### Methods

All the patients who needed surgical tracheostomy (ST) were transferred to the neighboring operation theater in the same floor within the same hospital (Zagazig new surgery hospital). During the transfer, all patients were assisted by a portable mechanical ventilator. Upon arrival to the operating room, the patient underwent a noninvasive blood pressure monitoring, 5 ECG leads, pulse oximetry, and capnogram for end tidal CO<sub>2</sub> monitoring. Anesthesia was induced with propofol 1–2 mg/kg, fentanyl 1–2 mcg/kg, and cis-atracurium 0.1 mg/kg. Then, the lungs were mechanically ventilated to maintain end tidal CO<sub>2</sub> tension between 30 to 35 mm Hg. Anesthesia was maintained with isoflurane 1–1.5% in 50% oxygen air. Otorhinolaryngology surgeons performed all the tracheostomies. At the end of the procedure, the surgeon introduced the tracheostomy tube with gradual withdrawal of the endotracheal tube. Then, the patients returned to the ICU, assisted by the portable mechanical ventilator.

In the ICU, the immediate postoperative priorities of care for a patient with a new tracheostomy include ensuring that

the tracheostomy tube is secured in place and is patent. Routine care, as well as prompt management of postoperative complication, can be facilitated by ensuring that proper equipment and supplies are quickly available (tracheostomy tube of the same size and 1 size smaller, endotracheal tubes of appropriate sizes with intubation equipment, and physiological saline).

No percutaneous dilatational tracheostomy (PDT) was operated in the current study.

We collected data as regarded to demographic patients' record, cause of admission, indications of tracheostomy, mechanical ventilation and duration of ICU stay. Tracheostomy records were also gathered including the incidence of tracheostomy, timing, technique, type, early and late complications, and the patients' outcome had been reported.

All tracheostomized patients received follow-up for 12 months post hospital discharge.

### Statistical Analysis

We performed a statistical analysis using SPSS 14.0 statistical software for Windows (SPSS Inc., Chicago, USA). The significance level was set at  $p < 0.05$ . We used the *t*-test for quantitative data and chi-square test for qualitative data.

## Results

This study includes 124 ICU patients; 108 male (87.1%) and 16 female (12.9%) with ages ranging from 12 to 67 years. The mean age was  $40.7 \pm 13.4$  years. Tracheostomy was performed for 36 patients (29%).

All the patients had surgical tracheostomy (ST); 3 (8.3%) female and 33 (91.7%) male. The indication for tracheostomy was prolonged intubation in 29 (80.5%) patients and diaphragmatic paralysis in 7 (19.5%) patients.

All the tracheostomies were surgical tracheostomy (ST) and done in the operative theater with otorhinolaryngology surgeons. So no percutaneous dilatational tracheostomy (PDT) was recorded or tracheostomy done by anesthesiologists. Horizontal collar incision with mid tracheostomy and removal of part of the tracheal cartilage was used in all cases except in children, with no tracheal flap.

Surgical emphysema, attributed to small tracheostomy tube size, was reported in three cases (8.3%) and resolved spontaneously. There were no other intraoperative or early post-operative complications and all the patients left the ICU with the tracheostomy tube. Out of the three most common tracheostomy emergencies (hemorrhage, tube dislodgement, and tube obstruction),<sup>1</sup> we encountered two cases of tubal obstruction in the current study and treated it by changing the tube (► **Table 1**).

During follow-up after discharge from ICU, 5/36 (13.9%) patients showed tracheal stenosis; 1 (2.8%) needed surgery and 1 (2.8%) depended on double lumen permanent tracheostomy while the remaining tracheal stenosis was mild and tolerable to the patients. On the other hand, 9/36 (25%) had subglottic stenosis; all were performed after 21 days of endotracheal intubation, and none of them required surgical interference (► **Table 1**).

**Table 1** Indications, complications of tracheostomy and duration between endotracheal intubation and tracheostomy

Tracheostomy		Number (percent)
Indications	Prolonged intubation	29 (80.5%)
	Diaphragmatic paralysis	7 (19.5%)
Complications	Surgical emphysema	3 (8.3%)
	Tube obstruction	2 (5.6%)
	Tracheal stenosis	5/36 (13.9%)
	Subglottic stenosis	9/36 (25%)
Duration between endotracheal intubation and tracheostomy	Range	17 to 26 days
	Mean	19.4 ± 2.07 days

Tracheostomy for prolonged intubation was done within 17 to 26 days after intubation with a mean of  $19.4 \pm 2.07$  days. No tracheostomy was performed within first two weeks of intubation.

ICU stay duration ranged between 2 and 100 days with a mean (SD) of  $15.87 (21.4)$ . This duration ranged between 3 to 100 days (mean;  $33.5 \pm 30.9$ ) for tracheostomized patients and ranged between 2 to 60 days (mean;  $8.6 \pm 10.1$ ) for intubated patients. Thus, there were significantly longer durations of ICU stay in tracheostomized patients ( $t = 3.4253$  and  $p = 0.0019$ ) (► **Table 2**).

Mechanical ventilation was required in 96/124 (77.4%) of studied patients and 32/36 of the tracheostomized patients with near significance difference (Chi-square test: 3.817 and  $p = 0.05$ ) (► **Table 2**).

## Discussion

Patients require long-term mechanical ventilation because of chronic respiratory failure, inability to maintain unassisted respiratory function, or failed weaning from ventilatory support.<sup>12</sup> We estimated that between 2% and 11% of ICU patients who required mechanical ventilation would receive a tracheostomy.<sup>13</sup>

Numerous studies aimed to determine the optimal interval between orotracheal intubation and placement of a trache-

ostomy tube, without definitive recommendations due to the varied results in different populations and in patients with distinctive comorbid conditions.<sup>12,14</sup> The American College of Chest Physicians recommends consideration of tracheostomy for patients who require an endotracheal tube for more than 21 days.<sup>15</sup> Benefits of establishing a tracheostomy rather than using an endotracheal tube include a decrease in direct laryngeal injury as well as improved comfort and daily activities of living such as mobility, speech, and eating.<sup>6</sup>

The tracheostomy tube may be placed surgically or percutaneously. Percutaneous tracheotomy is generally performed solely on intubated patients and, unlike surgical tracheotomy, it can be performed without direct visualization of the trachea. Bronchoscopy is used to guide and confirm placement of the tracheostomy tube within the trachea.<sup>16</sup>

Surgical placement is done in the operating room or at the bedside, generally under general anesthesia. A common technique is to create a "trap door" (Björk flap), by which a small part of the tracheal cartilage is pulled down and sutured to the skin.<sup>16</sup> We did not utilize this technique in the current study and conducted all the cases in the operating theater.

Percutaneous dilational tracheotomy (PDT) is the most common technique in most centers, especially in the developed countries. In study of ICU tracheostomy in the United Kingdom, PDT is preferred over the surgical technique; in 43% of units, PDT is performed in 95% of cases, in 32.4% of units it is

**Table 2** Differences between tracheostomized and non tracheostomized ICU patients

	Tracheostomized ICU patients	Other ICU patients	P value
Cases			0.33 NS ( $\chi^2 = 0.943$ )
Total	36	88	
Male	33 (91.7%)	75 (88.2%)	
Female	3 (8.3%)	13 (14.8%)	
Mechanical ventilation	32/36 (88.9%)	64/88 (72.7%)	0.05 near S ( $\chi^2 = 3.817$ )
Mean ICU stay	$33.5 \pm 30.9$	All ICU patients, $15.87 (21.4)$ For intubated ICU patients $8.6 \pm 10.1$	0.0004 S ( $t = 3.6365$ ) 0.0019 S ( $t = 3.4253$ )

Abbreviations: ICU, Intensive Care Unit; S, significant; NS, non-significant.

done in 75–95% of cases, in 16.6% of units it is done in 50 to 75% of cases, while in only 8% of units, ST is preferred with PDT accounting for less than 50% of cases.<sup>17</sup> In many studies about tracheostomy in ICU in many of European countries, PDT was usually the preferred technique; in Italy, it accounted for 89% of cases,<sup>18</sup> in Germany, 86% of cases,<sup>11</sup> in Spain, 72% of cases,<sup>19</sup> and in the Netherlands, 62% of cases.<sup>20</sup>

Surgical tracheotomy (ST) is the only technique used in our center; this is mainly due to the cost effectiveness, which is in the favor of ST because of the cost of the PDT insertion set as well as the otolaryngology surgeons easy 24-hour accessibility to the hospital. Furthermore, insufficient expertise in performing PDT can be added to the cause of preference of ST.

This agrees with the result of other studies<sup>21,22</sup> about tracheostomy in ICU in Nigeria's teaching hospital in which all the tracheostomies were surgical tracheostomy. In one of the international survey about tracheostomy in ICU; they found that ST was the most popular tracheotomy technique outside Europe, and was mainly performed by ENT specialists.<sup>23</sup> Even in some developed countries, such as France, the ST technique is still preferred over PDT.<sup>24</sup>

The importance of this study is while it was done in the ICU of a surgery hospital, so it was dealing mostly with surgical cases, which differ from other studies, which may include non-surgical cases, and even data of the met analysis studies involve non-surgical ICUs. At the same time, since study took place in a developing country, the cost effectiveness favors ST over PDT, because of ST's low-cost versus the cost of the single-use PDT tracheostomy set, as well as the availability of the surgical team.

In the study by Kluge et al,<sup>11</sup> 86.1% of ICUs routinely perform PDT and only 13.9% of ICUs perform ST; however, in answering a question of "which method is according to your opinion is safer," 50% answered there was no difference between the two methods, 27% answered PT, and 19% answered ST.

Some review studies prefer PT over ST because there is no need for the operating room (OR), it is less expensive, the reduced time between decision and performance of tracheostomy, and lower mortality rate.<sup>3</sup> In our study, however, the ICU is located in the same floor neighbor as the OR, and otolaryngology doctors are freely available 24/7 in the university hospital. This overrides the problems from transferring the patients from the ICU to the OR, as well as reduces the time between the decision and the performance of the tracheostomy. In fact, the ST turns out to be cheaper than PDT (no need for the costly disposable PDT set). As for mortality rate, there are many studies that found no difference between ST and PDT in this regard.<sup>7,10,11</sup> Because of the significant effect of tracheostomy on the patients life, it must be included in any learning process undergone by the otolaryngologist.

The results of current study showed that prolonged endotracheal intubation is the main indication of tracheostomy, and surgical open tracheostomy remains the most used technique in our institutional hospitals. We found no significant early complications, but still laryngotracheal stenosis is an important reported late complication that needs to be studied to manage factors related to occurrence of such a complication.

Although the incidence of laryngotracheal stenosis in this study was 14/36 cases (39%), only two cases (5.5%) were

significantly affected and needed intervention, either with surgery or permanent tracheostomy. In our concept, we did not attribute this to the tracheostomy technique per se, but mostly due to the long intubation period preceding it (more than 21 days), particularly since tracheostomy in ICU is elective.

International and national surveys report as the prevailing timing of tracheostomy between 7 to 15 days.<sup>11,17–20,23</sup> Some studies consider early tracheostomy to happen within 4 days of intubation and late tracheostomy after 10 days.<sup>25</sup> Thus, we hope to introduce the concept of earlier tracheostomy to a greater extent than the current protocol in our center, to avoid most of tracheostomy complications.

## Conclusion

Prolonged endotracheal intubation is the main indication for patients that have undergone tracheostomy performed after two weeks of intubation, in all cases. Although it does not present major early complications, laryngotracheal stenosis is still an unresolved sequel for tracheostomy that needs to be further investigated so it can be prevented.

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