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Comparison of Conventional Surgical Tracheostomy and Percutaneous Dilatational Tracheostomy in the Intensive Care Unit

Reda Sherif[1], Mostafa Eisa[2], Khalid Yahya[3], Engy Abdallah[3], Mostafa Gooda[3], Anass Alnil[3], Mohammed Allam[3], Essa Muallemi[4], Esraa Gaafar[5], Islam Masadeh[5], Lubaba Jawad[6], Joumana Jawad[7], Mohamed H. Badawy[8]

[1] *Critical Care Consultant, Kuwait Hospital, Sharjah*
[2] *ICU specialist, Kuwait hospital Sharjah*
[3] *Intensivist, Kuwait Hospital, Sharjah*
[4] *Surgical consultant, Kuwait Hospital, Sharjah*
[5] *Anesthesia and ICU resident, Kuwait hospital, Sharjah*
[6] *ICU senior nurse, Kuwait Hospital, Sharjah*
[7] *ICU senior nurse, Nursing Department, Kuwait Hospital, Sharjah*
[8] *ICU and Anesthesia Consultant, Kuwait Hospital, Sharjah*

***Corresponding author:** Reda Sherif
Email: sherifre@gmail.com

Abstract

Background: Percutaneous dilatation tracheostomy (PDT) is a minimally invasive and blind procedure, whereas conventional surgical tracheostomy (CST) is an open procedure. CST is accompanied by intraoperative and postoperative complications, whereas PDT can reduce the associated risks and has the benefits of reducing costs and being relatively simple.

Objective: To compare between CST and PDT in ICU.

Design: Retrospective research.

Setting: The Intensive care unit (ICU) at Kuwait Hospital Sharjah (KHS).

Patients and Methods: The patients enrolled were those who underwent PDT by intensivists, and patients who underwent CST performed by ENT physicians. The collection of data related to PDT cases was done from October 2021 to September 2023, whereas that of CST cases was done from January 2018 to July 2021. The collected data included demographics, laboratory tests, comorbidities, and outcomes.

Main outcomes and measure: Recovery, adverse outcomes and complications were the primary outcomes, where adverse outcomes, included mortality.

Sample size: 110 subjects, where categorized into 55 subjects in PDT and 55 subjects in CST group.

Results: There was age, gender, and APACHEII match between both groups. Significant variations were found between both groups regarding delay time (P= .001), airway protection indication (P= .002), bleeding (P= .01), bleeding diathesis (P= .02), and days of mechanical ventilation (P< .001).

Conclusion: PDT was superior to CST regarding delay time, mechanical ventilation days, bleeding, and usage of blood and blood components. However, both interventions displayed no superiority regarding mortality and length of stay.

Limitations: The retrospective design.

Conflict of interest: None.

Keywords: Tracheostomy, PT, ICU.

Introduction

Tracheostomy is a common procedure required for Intensive Care Unit (ICU) patients.[1] It is performed in neurosurgery or neurocritically ill cases for many causes, such as airway protection, prolonged intubation, or prevention of aspiration risk caused by brain injuries.[2,3]

Tracheostomy facilitates mechanical ventilation weaning off and has benefits in managing secretions in the lower airway.[4] It is usually performed either by intensivists percutaneously at the bedside or by ENT physicians surgically or percutaneously. When compared to endotracheal intubation, tracheostomy is linked with better comfort, less sedation, and helping in faster weaning from ventilation.[1]

Percutaneous dilatation tracheostomy (PDT) is a minimally invasive, blind procedure that is preferred when neck anatomy is suitable and the trachea is safely accessible blindly, while conventional surgical tracheostomy (CST) is an open procedure that is preferred when the trachea is difficult to access blindly.[5,6] CST was the gold standard until the mid-2000s.[7]

CST involves full dissection of pre-tracheal tissue and tracheostomy tube insertion into the trachea under direct vision.[8] CST is accompanied by intraoperative and postoperative complications such as stomal infection, bleeding, and cellulitis.[9] Additionally, critically ill subjects require transportation to the operative room from the ICU.[10] Furthermore, its elective usage is not preferred by most otolaryngologists due to consequences such as vocal cord paralysis and subglottic stenosis; therefore, CST is recommended for emergent situations only.[11. 12]

PDT was first presented by Ciaglia in 1985,[13] and it involves blunt dissection of pre-tracheal tissue followed by tracheal dilation over the guidewire and tracheal cannula placement with the Seldinger approach.[14, 15] PDT can be underwent directly in the ICU, and it can reduce the associated risks. It also has the advantages of reducing costs and being relatively simple.[16] PDT has been increasingly adopted due to its ease of use and lower rates of clinically considerable bleeding and infection.[3] It also provides increased patient comfort, reduction of required sedation, ensures and shortens safer execution of the weaning process, oral hygiene improvement, oral nutrition, and airway care outside the ICU.[17, 18]

Despite the presence of studies comparing CST and PDT, there was no study compared between them regarding several aspects and based on the healthcare personnel;

therefore, this study was established to compare CST performed by ENT physicians and PDT performed by intensivists regarding conditions of the intervention, indications, delay time, and outcomes including complications, mortality, and ICU stay.

Subjects and Methods:

Design and settings:

This retrospective study was conducted at the ICU at Kuwait Hospital Sharjah (KHS). The data related to PDT cases was collected from October 2021 to September 2023, and that of CST was collected from January 2018 to July 2021. The collected data included demographics, laboratory tests, tracheostomy indications, comorbidities, and outcomes. The inclusion criteria for PDT were adult cases in the ICU who underwent PDT by intensivists, whereas PDT cases by personnel other than intensivists were excluded. CST included adult cases in the ICU who underwent CST by ENT physicians, whereas those who underwent combined surgical procedures and those lacking the required information in the medical record were excluded.

Technique and Steps for the Procedure:

Under complete aseptic technique, bedside PDT was performed with guidance from a bronchoscope. The endotracheal tube was repositioned under bronchoscopic guidance to ensure proper placement just above the vocal cords. Sedation was administered, and the patient was placed in a supine position with a rolled towel under the shoulders to facilitate neck hyperextension. A commercial kit for percutaneous tracheostomy (Portex) was used. After positioning and cleaning the surgical area with chlorhexidine, a needle with a cannula was inserted into the trachea, followed by the introduction of a guide wire. The correct position of the needle and guide was confirmed, and a small skin incision was made vertically before passing the dilator. The tracheal wall was dilated, and an obturated tracheostomy tube was placed over the guide wire. The connection to the ventilator was established, and the patient's oxygen saturation and hemodynamic status were monitored. A chest X-ray was performed post-procedure to assess for complications. Precautions for the procedure included a routine ultrasound of the neck to check for anatomical abnormalities and a complete blood count and anticoagulation profile assessment before the procedure.

Statistical analysis:

Data analysis was established using SPSS version 25; qualitative data was represented as a number (%), whereas quantitative data was represented as median and range. Comparisons were made by applying a T-test or Chi-square based on the data type; a P-value$\leq .05$ was defined as significant.

Results:

The study included 110 participants, categorized equally into 55 CST cases and 55 PDT cases. There were age, gender, and APACHE II matches between both groups. Less than half of the participants (43.6%) were aged ≥65 years, and nearly two-thirds of the participants (67.3%) were male. The median APACHE II score was 40 (range: 15-95). Regarding comorbidities, the most frequent comorbidities among the total subjects were hypertension (56.4%), diabetes (50.9%), and coronary disease or cardiac failure (40%), with no considerable difference in comorbidities between the percutaneous and surgical groups. However, bleeding diathesis or antiplatelet/anticoagulant use was significantly higher in the surgical category than in the PDT (10.9% Vs. 0%, respectively; *P*-value = .027), **(Table1)**.

Table 1: Baseline demographic and clinical data

	Total (n=110) Number (percent) / Median (range)	**Percutaneous (n=55)** Number (percent) / Median (range)	**Surgical (n=55)** Number (percent) / Median (range)	***P***
Age				
≤45 c years	20 (18.2%)	11 (20%)	9 (16.4%)	.868
46 – 64 years	42 (38.2%)	21 (38.2%)	21 (38.2%)	
≥65 years	48 (43.6%)	23 (41.8%)	25 (45.5%)	
Male gender	74 (67.3%)	38 (69.1%)	36 (65.5%)	.684
Comorbidities				
Diabetes	56 (50.9%)	26 (47.3%)	30 (54.5%)	.466
Hypertension	62 (56.4%)	30 (54.5%)	32 (58.2%)	.701
Coronary disease or cardiac failure	44 (40%)	20 (36.4%)	24 (43.6%)	.436
Chronic Pulmonary Disease	17 (15.5%)	7 (12.7%)	10 (18.2%)	.429
Chronic Kidney disease	17 (15.5%)	7 (12.7%)	10 (18.2%)	.429
Chronic Liver disease	3 (2.7%)	2 (3.6%)	1 (1.8%)	.560
Active Cancer	1 (0.9%)	0 (0%)	1 (1.8%)	.317
Immunocompromised	4 (3.6%)	2 (3.6%)	2 (3.6%)	1.000
Bleeding diathesis or antiplatelet/anticoagulant	6 (5.5%)	0 (0%)	6 (10.9%)	.027
APACHE II	40 (15-95)	42 (15-97)	40 (15-85)	.754

Laboratory findings displayed no considerable variations between both groups, except for HG, where the surgical group displayed significantly higher HG on the day of intent (*P*= .015) and at the date of the procedure (*P*= .001). However, no significant variations were found regarding other parameters, including INR, PTT, and PLT **(Table 2)**.

Table 2: Laboratory data among the participants

	Total (n=110) Median (range)	**Percutaneous (n=55)** Median (range)	**Surgical (n=55)** Median (range)	***P***
Investigations (baseline)				
INR	1.1 (0.8-37.8)	1.1 (0.9-1.4)	1.1 (0.8-37.8)	.238
PTT	35.9 (22.8-67)	36.0 (25.7-57)	35.9 (22.8-67)	.864
HG	9.9 (7-15)	9.4 (7-13.8)	10.5 (7.1-15)	**.015**
PLT	248.5 (9.9-715)	244 (76-715)	253 (9.9-693)	.926
Investigations (date of procedure)				
INR	1.1 (0.8-1.8)	1.1 (0.9-1.4)	1.1 (0.8-1.8)	.324
PTT	37.2 (22.8-70.7)	38 (23.5-50.3)	36 (22.8-70.7)	.318
HG	9.7 (7.3-14.8)	9.1 (7.3-12)	10 (8.2-14.8)	**.001**
PLT	276 (51-780)	244 (76-715)	253 (9.9-693)	.966

Regarding the procedures, the majority of the participants had a tracheostomy delay time of less than 10 days, and there were considerable variations between both groups as PDT significantly recorded less delay compared to CST (*P*= .001). Regarding indications, a higher proportion of subjects were indicated for CST for airway protection (87.3%) compared to PDT (61.8%) (*P*= .002), **(Table 3)**.

Table 3: Procedure related data

	Total (n=110) Number (percent) / Median (range)	**Percutaneous (n=55)** Number (percent) / Median (range)	**Surgical (n=55)** Number (percent) / Median (range)	***P***
Tracheostomy delay time	7 (0-35)	6 (0-30)	8 (4-35)	.001
Indications of Procedures				
Weaning failure due to respiratory muscle weakness.	101 (91.8%)	48 (87.3%)	53 (96.4%)	.161
Airway protection	82 (74.5%)	34 (61.8%)	48 (87.3%)	.002

Comparing outcomes and complications between both groups revealed significant variation regarding bleeding, where a significantly higher proportion of bleeding was recorded in the surgical category compared to the percutaneous group (*P*= .013). Also, the total days of mechanical ventilation were significantly higher in surgical cases compared to the percutaneous ones (*P*< .001). Nonetheless, there were no significant differences in mortality or ICU length of stay between both categories **(Table 4)**.

Table 4: Complications

	Total (n=110) Number (percent) / Median (range)	**Percutaneous (n=55)** Number (percent) / Median (range)	**Surgical (n=55)** Number (percent) / Median (range)	***P***
Bleeding	7 (6.4%)	0 (0%)	7 (12.7%)	**.013**
Pneumothorax	1 (0.9%)	0 (0%)	1 (1.8%)	.317
Blood transfusion	10 (9.1%)	4 (7.3%)	6 (10.9%)	.507
FFP	5 (4.5%)	1 (1.8%)	4 (7.3%)	.363
Platelets	1 (0.9%)	0 (0%)	1 (1.8%)	.317
Mechanical ventilation off	45 (40.9%)	26 (47.3%)	19 (34.5%)	.175
total days on Mechanical ventilation	31.5 (9-255)	25 (10-142)	50 (9-255)	<.001
Mortality				
Three days	3 (2.7%)	0 (0%)	3 (5.5%)	.243
28 days	23 (20.9%)	10 (18.2%)	13 (23.6%)	.482
Overall mortality	41 (37.3%)	18 (32.7%)	23 (41.8%)	.324
Length of ICU stay (days)	49.5 (9-282)	47 (20-208)	50 (9-282)	.860

Discussion:

Tracheostomies are carried out in the general ICU to keep the airway from aspiration pneumonia and to secure it in subjects requiring prolonged mechanical ventilation. Despite the wide acceptance of CST, it still has several complications, with a total incidence of 36%–41%, including subcutaneous emphysema, pneumothorax, bleeding, stoma infections, and, less commonly, mortality.[19, 20]

The safety and feasibility of PDT have already been proven in previous prospective studies and meta-analyses. Nonetheless, its relative or absolute contraindications remain controversial. Factors such as cervical spinal injury, pediatric age, coagulopathy, emergency airway necessity, the anomaly of the aortic arch branches, difficult anatomy, and severe respiratory disease have been considered contraindications in various studies.[13, 21] In this work, we compared PDT and CST approaches in terms of tracheostomy delay time, consumption of blood components, ventilator days, mortality, and length of hospital stay.

Our patients displayed no considerable variations regarding comorbidities, and such findings were in agreement with previous studies that reported no considerable variations between both groups regarding comorbidities, including diabetes, hypertension, and other comorbidities.[9, 22, 23]

There has been no definite consensus on tracheostomy timing so far.[24-26] Therefore, caution should be considered while deciding the time of tracheostomy as early intervention might lead to unnecessary procedure in some cases, whereas late intervention might lead to prolonged endotracheal intubation and associated consequences leading to considerable prolonged weaning from mechanical ventilation.[19]

In the current study, PDT subjects displayed considerably less delay time compared to surgical intervention. This difference could be explained by the implementation of early tracheostomy and the bedside nature of the procedure, which reduces preparation and prerequisites.[1, 5, 6] In contrast to our findings, PDT patients in one study significantly tended to spend more days before tracheostomy compared to surgical ones.[22]

A previous analysis enrolled 41 studies that declared that defining early tracheostomy as that done within seven days of intubation resulted in better results than those defining early tracheostomy as that done within 14 or 21 days of intubation.[27] Late tracheostomy was found to be significantly associated with longer ICU stays and longer mechanical ventilation among neurosurgical cases.[19]

Regarding indications in the present study, despite the higher proportion of surgical cases who reported weaning failure, the variation between both groups wasn't significant (P= .1). However, the surgical approach was considerably indicated for airway protection rather than the percutaneous approach. Such findings were in line with that reported in similar research, where no considerable variations between both groups were found regarding ventilator weaning, but surgical subjects significantly tended to be indicated for airway protection.[22]

In contrast to our findings, one study demonstrated no considerable variations between PDT and CST regarding indications of tracheostomy. However, airway protection was slightly and non-significantly higher for CST cases.[23]

The current research revealed favorable findings of the percutaneous approach regarding bleeding and total days of mechanical ventilation; none of the subjects who underwent PDT experienced bleeding, and the total days on mechanical ventilation were significantly fewer compared to those who underwent the surgical approach.

Also, consumption of blood-related components was much lower in the percutaneous group. This difference may be attributed to the smaller incision, ultrasound guidance, and use of fiberoptic bronchoscopy in the percutaneous group, whereas in the surgical group, the higher incidence of bleeding could be attributed to incision and dissection of paratracheal tissue, retraction, or division of the isthmus, and proximity of the vessels supplying the thyroid.[28, 29] Total days of mechanical ventilation were significantly lower in the percutaneous group compared to the surgical group (*P*-value < .001), which could be explained by early tracheostomy and early weaning trials in the percutaneous group.[30]

Similar to our findings, PDT cases in one study reported no major bleeding, whereas a considerable proportion of CST cases reported bleeding, revealing the tendency of surgical intervention to cause bleeding compared to the percutaneous one.[22] In contrast to our findings, a previous study revealed no considerable variations between both groups regarding intraoperative and postoperative minor and major bleeding.[9] Another study also displayed no variations in bleeding, involving major, minor, and moderate bleeding between both groups.[23]

Our findings revealed that both categories of patients reported no significant variations in mortality rate and length of ICU stay. Similarly, previous research found that CST and PDT categories didn't display significant variations in total ICU mortality, length of ICU, or hospital stay.[9, 22, 23]

Conclusion:

PDT performed by intensivists was associated with fewer delay times and mechanical ventilation days, less bleeding, and lower use of blood and blood components compared to CST performed by ENT. However, both interventions were comparable in terms of mortality and length of stay. Therefore, the selection of the intervention should be based on the case conditions.

Limitations, strengths and recommendations:

The retrospective design of the study is a limitation, whereas the comparison between PDT and CST regarding various aspects was a strength point. Further studies are recommended to determine the delaying time and criteria for patients who are appropriate for PDT and those appropriate for CST.

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