ORIGINAL ARTICLE

Dilatational Percutaneous vs Surgical TracheoStomy in IntEnsive Care UniT: A Practice Pattern Observational Multicenter Study (DISSECT)

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Abstract

Introduction: Tracheostomy is among the common procedures performed in the intensive care unit (ICU), with percutaneous dilatational tracheostomy (PDT) being the preferred technique. We sought to understand the current practice of tracheostomy in Indian ICUs.

Materials and methods: A pan-India multicenter prospective observational study, endorsed and peer-reviewed by the Indian Society of Critical Care Medicine (ISCCM), on various aspects of tracheostomy performed in critically ill patients was conducted between September 1, 2019 and December 31, 2019. The SPSS software was used for the statistical analysis. Cross tables were generated and the chi-square test was used for testing of association. The p value < 0.05 was considered statistically significant.

Results: Out of 67 ICUs that participated, 88.1% were from private sector hospitals. A total of 923 tracheostomies were performed during the study period; out of which, 666 were PDT and 257 were surgical tracheostomy (ST). Coagulopathic patients received more platelet transfusion [$p = 0.037$ with platelet count (PC) $< 50 \times 10^9$, $p = 0.021$ with PC 50–100 $\times 10^9$] and fresh frozen plasma transfusion in the ST group ($p = 0.0001$). The performance of PDT vs ST by day 7 of admission was 28.4% vs 21% ($p = 0.023$). The single dilator technique (60.4%) was the preferred technique for PDT followed by the Grigg's forceps and then the multiple dilator technique. Fiberoptic bronchoscope (FOB) and ultrasonography (USG) were used in 29.3% and 16.8%, respectively, for guidance during tracheostomy. Most of the PDTs were performed by a trained intensivist (74.2%), whereas ST was mostly done by an ENT surgeon (56.8%). Percutaneous dilatational tracheostomy resulted in less hemorrhagic (2.6% vs 7%, $p = 0.002$) and desaturation complications (2.3% vs 6.6%, $p = 0.001$) as compared to ST. The duration of procedure was shorter in the PDT group (average shortening by 9.2 minutes) and the ventilator-free days (VFD) were higher in the PDT group. The cost was less in PDT by approximately Rs. 13,104.

Conclusion: Percutaneous dilatational tracheostomy, especially the single dilator technique, is preferred by clinicians in Indian ICUs. The incidence of minor complications like hemorrhagic episodes is lower with PDT. Percutaneous dilatational tracheostomy was found to be cheaper on cost per patient basis as compared to ST (with or without complications).

Keywords: Complications, Cost, Percutaneous dilatational, Surgical, Tracheostomy.

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Introduction

Tracheostomy means creating an opening in the trachea for the passage of a tube. This helps the patient to ventilate either spontaneously or with mechanical support. It is one of the most commonly performed procedures in the intensive care unit (ICU)[1] and is commonly done for patients who require long-term ventilator support. Tracheostomy leads to reduction in dead space, helps in bronchopulmonary toileting, prevention of aspiration, and facilitate selected patients to retain their voice with the help of a speaking valve.

Both surgical tracheostomy (ST) and percutaneous dilatational tracheostomy (PDT) are performed with PDT becoming the preferred technique of choice.[2] Till date, there has been no multicentric study looking into the practice of tracheostomy in India. This is the first multicentric nationwide study that hopes to explore various aspects in regards to the practice of tracheostomy in India. Certain aspects like indications, timing of tracheostomy, clinical parameters on which tracheostomy is being preferred, coagulation profile of patients, decision making between ST and PDT, preferred technique of PDT, guidance used during tracheostomy, sedation practices, operator details like experience and qualifications, minor and major complications, ventilator-free days (VFD), and cost implications are

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to be explored. This prospective survey will then help to formulate tracheostomy guidelines in critically ill adult patients pertaining to Indian scenario.

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Conflict of interest: None

Materials and Methods

The Indian Society of Critical Care Medicine (ISCCM) endorsed this study. The national principal investigator (PI) as appointed by ISCCM was responsible for conducting the study nationwide. Ethics approval was not mandatory from the participating centers as it was a data collection about tracheostomy without any new intervention on the patients but each participating center had to follow their local hospital norms. The consent waiver was taken from the ethics committee. The online case record form (CRF), approved by an expert panel of senior intensivist of ISCCM, was divided into five domains pertaining to: (a) patient demographics, (b) procedure, (c) operator, (d) complications, and (e) outcome. Invitation to participate in the study was send out to all ISCCM members via e-mail. Hospitals volunteering to participate had to complete an ICU registration form and were provided with a unique username and password to fill up the CRF after enrollment. Each site had one designated PI and co-PI as given at the time of ICU registration and they were responsible for data capturing and completing the online CRF. The data entry was carried out from September 1, 2019 to December 31, 2019. The operator was not asked to change the technique and modality of tracheostomy that do in their respective ICUs. The study enrolled all consecutive adult patients (>18 years of age) undergoing tracheostomy, both electively or as an emergency procedure. The data collected were verified and scrutinized by the national PI alongwith the expert panel made for the study.

All sections of the CRF were mandatory. Individual site data and patient demographics are provided in Tables 1 and 2. The clinical parameters like Glasgow coma scale (GCS), ventilator parameters at the time of tracheostomy, hemodynamic parameters as ascertained by the need of vasopressors at the time of tracheostomy, coagulation profile, and the blood product transfusion data are summarized in Table 3.

The procedure-related data included the technique of tracheostomy (PDT vs ST), indications of tracheostomy, timing of tracheostomy, and place of procedure. If PDT was opted, then the technique used like single dilator or multiple dilator or Griggs technique was noted. If ST was opted, then the indication for choosing ST was recorded. The methods like ultrasound, neck circumference (entire circumference of neck at the level of cricoid cartilage), cricosternal distance (distance between the lower end of cricoid cartilage to suprasternal notch in fully extended neck), or clinical judgment used for evaluation of neck anatomy were noted. Neck ultrasound was done by the linear high-resolution probe. The assessment was labeled as *excellent* (no blood vessels in the tract of the needle at first to second or second to third tracheal ring and avoiding isthmus while needle puncture), *good* (single blood vessel either at the center of the tract of the needle or isthmus present

Table 1: Enrolled ICU characteristics

Variables	*n = 67*	*Percentage*
Type of hospital		
Public	8	11.9
Private	59	88.1
Type of ICU		
Medical	11	16.4
Surgical	4	6
Medical + surgical	52	77.6
Zones		
North	16	23.8
South	17	25.3
East	16	23.8
West	11	16.4
Central	7	10.4

Table 2: Patient demographics

Variables	*Percutaneous (%)*	*Surgical (%)*	*p value*
Gender	*n* = 666	*n* = 257	0.271
Male	483 (72.5)	177 (68.9)	
Female	183 (27.5)	80 (31.1)	
Age distribution			
<21	19 (2.9)	3 (1.2)	
21–30	67 (10.1)	22 (8.6)	
31–40	82 (12.3)	23 (8.9)	
41–50	75 (11.3)	37 (14.4)	
51–60	147 (22.1)	52 (20.2)	
61–70	157 (23.6)	84 (32.7)	
71–80	88 (13.2)	24 (9.3)	
>80	31 (4.7)	12 (4.7)	
Mean ± SD (range)	54.3 ± 17.6 (17–93)	55.9 ± 15.9 (18–92)	0.212
Comorbidities			
Hypertension	327 (49.1)	110 (42.8)	0.086
Diabetes mellitus	226 (33.9)	88 (34.2)	0.930
Hypothyroidism	54 (8.1)	18 (7)	0.575
Hyperthyroidism	5 (0.8)	3 (1.2)	0.541
Chronic kidney disease	61 (9.2)	16 (6.2)	0.149
Chronic artery disease	142 (21.3)	27 (10.5)	0.0001*
Chronic liver disease	24 (3.6)	6 (2.4)	0.330
COPD	59 (8.9)	17 (6.6)	0.226
Malignancy	44 (6.6)	79 (30.7)	0.0001*
Indication			
Long-term airway protection	364 (54.7)	109 (42.4)	0.0008*
Weaning process	277 (41.6)	66 (25.7)	0.0001*
Surgical plan	5 (0.8)	63 (24.5)	0.0001*
Emergent airway	19 (2.9)	5 (1.9)	0.394
Malignancy	0	9 (3.5)	0.0001*
Poisoning	1 (0.2)	5 (1.9)	0.005*

*$p < 0.05$ statistically significant

Table 3: Clinical parameters of patients undergoing tracheostomy

Parameters	*Percutaneous (n = 666) (%)*	*Surgical (n = 257) (%)*	*p value*
GCS			
<8	353 (53)	129 (50.2)	0.445
9–12	170 (25.5)	86 (33.5)	0.015*
13–15	143 (21.5)	42 (16.3)	0.077
Ventilatory support			
Controlled ventilation, $FiO_2 < 0.40$	277 (41.6)	82 (31.9)	0.007*
Controlled ventilation, $FiO_2 > 0.40$	184 (27.6)	114 (44.4)	0.0001*
Spontaneous mode, $FiO_2 < 0.40$	155 (23.3)	29 (11.3)	0.0001*
Spontaneous mode, $FiO_2 > 0.40$	21 (3.2)	4 (1.6)	0.183
On T-piece	19 (2.9)	18 (7)	0.004*
Nonintubated	10 (1.5)	10 (3.9)	0.025*
Hemodynamic parameters			
Noradrenaline < 0.1 μg/kg/minute	87 (13.1)	24 (9.3)	0.112
Noradrenaline > 0.1 μg/kg/minute	62 (9.3)	34 (13.2)	0.082
Noradrenaline + other vasopressor	22 (3.3)	4 (1.6)	0.163
No vasopressor	495 (74.3)	195 (75.9)	0.616
Platelet count (PC)			
$<50 \times 10^9$	17	10	0.037*
No transfusion	6	0	0.021*
With transfusion	11 (64.7)	10 (100)	
$50–100 \times 10^9$	67	18	
No transfusion	46	7	
With transfusion	21 (31.3)	11 (61.1)	
$>100 \times 10^9$	582	229	
No transfusion	509	158	
With transfusion	73 (12.5)	71 (31)	0.0001*
INR			
<1.5	605	239	0.0001*
No transfusion	533	160	0.0001*
With transfusion	72 (11.9)	73 (30.5)	
>1.5	61	18	
No transfusion	29	6	
With transfusion	32 (52.5)	12 (66.7)	

*$p < 0.05$ statistically significant

at the site chosen for tracheostomy), or *unsatisfactory* (multiple blood vessels present at the site of tracheostomy and isthmus also present at the same site).

During the actual procedure, the guidance in form of bronchoscopy or real-time ultrasound used was recorded. The number of puncture attempts and the drugs used for sedation and analgesia used during tracheostomy were recorded. The operator-related data included the speciality and experience of the person performing the procedure.

Only the complications that happened during the procedure were captured and were named as immediate complications. The immediate complications during the procedure were divided into minor and major complications based on the severity. Hypotension was defined as systolic blood pressure (SBP) <90 mm Hg or mean arterial pressure (MAP) <65 mm Hg. The blood loss estimation was done by approximation with each 5 × 5 cm gauze piece soaking 5 mL of blood, so blood loss up to 15 mL was considered minor bleeding whereas more than 15 mL was taken as major bleeding complication. Similarly, new need of the ventilator or increase in requirement of the ventilator was also recorded as a complication. The same principle was followed for need of vasopressors. The need to perform bronchoalveolar lavage (BAL) for clearing of blood clots post-tracheostomy was recorded as a major complication. Pneumothorax, abandoning the procedure, and death due to procedure were taken as major complications.

The outcome-related data consisted of total duration of the procedure (minutes), which was taken as time from the needle insertion in case of PDT or surgical incision in case of ST to the cuff inflation of the tracheostomy tube. The success or failure of the procedure was recorded. The time from decision of tracheostomy to actual procedure was recorded. Similarly, the mechanical ventilator duration post-tracheostomy was recorded up to 7 days. The cost implication of tracheostomy was recorded.

The data collected were divided into PDT and ST categories and were then analyzed.

Statistical Analysis

The analysis included profiling of patients on different demographic, clinical, hemodynamic, coagulation, pre-, intra-, and post-tracheostomy, complication, and outcome parameters. Quantitative data were presented in terms of means and standard deviation. Qualitative/categorical data were presented as absolute numbers and proportions. Cross tables were generated and the chi-square test was used for testing of association. The independent Student's *t*-test was used for comparison of quantitative outcome parameters between two groups. The *p* value <0.05 was considered statistically significant. The IBM SPSS statistics software for windows (Version 24.0, Armonk, NY:IBM Corp) was used for all statistical analysis.

Results

The total enrolled ICUs were 78 out of which 67 ICUs (85.9%) contributed data. The rest 11 ICUs could not get their ethics approval or waiver for ethics in time and so could not participate in the study. The data of 923 patients were uploaded successfully on the online CRF, out of which 666 patients underwent PDT and 257 patients underwent ST.

The participation in the study had maximum contribution from private hospitals as compared to public ones (88.1% vs 11.9%) and most of the ICUs being mixed medical and surgical ICUs (77.6%). Centers from all five zones of ISCCM contributed in the data (Table 1).

The patients did not have difference in gender distribution ($p = 0.271$) and age distribution ($p = 0.212$) between the groups. Most of the tracheostomies were in the age group between 61 years and 70 years of age as they are the most vulnerable group to develop critical illness myoneuropathy and difficult candidates for extubation. The most common comorbidity was hypertension among both the groups followed by diabetes mellitus and then coronary artery disease (CAD). The PDT group had a higher CAD subset as compared to ST (21.3% vs 10.5%, $p = 0.0001$). Patients with orofacial malignancy underwent ST more commonly as compared to PDT (30.7% vs 6.6%, $p = 0.0001$), mostly due to altered neck anatomy or as a part of the surgical plan. Rest of the comorbidities were similar in both groups. The most common indication for tracheostomy was the need of long-term airway due to neurological issues as seen most commonly in ICU settings (Table 2).

The poor neurological status as determined by GCS < 8 was the common indication of tracheostomy. Patients with GCS between 9 and 12 had more ST than PDT (33.5% vs 25.5%, $p = 0.015$). Percutaneous dilatational tracheostomy was more common when the FiO_2 requirement was less than 0.40, whether during controlled ventilation ($p = 0.007$) or spontaneously breathing patients ($p = 0.0001$). Similarly, most of the patients underwent tracheostomy when they were hemodynamically stable with no need for vasopressor support. Most of the patients who underwent tracheostomy had a platelet count (PC) of more than 100×10^9 and an INR of <1.5 (Table 3). There was an observation that platelet transfusion was higher in the ST group across all levels of PC such as PC $<50 \times 10^9$ ($p = 0.037$), $50–100 \times 10^9$ ($p = 0.021$), or $>100 \times 10^9$ ($p = 0.0001$). Similar findings were observed regarding the use of fresh frozen plasma (FFP) as its usage was higher in the ST group as compared to PDT independent of INR (INR < 1.5, $p = 0.0001$; INR > 1.5, $p = 0.0001$) (Fig. 1).

Timing of tracheostomy was recorded at three timelines, within 4 days, within 7 days, and within 10 days of ventilation. When day 4 and day 7 were taken to differentiate between early and late tracheostomy, PDT was performed more in the late category at day 4 (64.3% vs 43.2%, $p = 0.0001$) and day 7 (28.4% vs 21%, $p = 0.023$). When day 10 was taken to decide, then there was no difference between ST and PDT incidence (10.1% vs 6.2%, $p = 0.068$). Majority of PDT were performed in ICU whereas ST was mostly performed in operation theater, although one-third of ST were also carried out bedside. Neck anatomy assessment was mostly on clinical grounds in both the groups. Ultrasound of the neck was performed more in the PDT group (38.6% vs 6.2%, $p = 0.0001$) (Table 4).

Among the three most commonly used techniques for PDT, the single dilator technique was the most preferred technique (60.4%) followed by the Grigg's forceps technique (28.7%) and then the multiple dilator technique (11%) (Table 5 and Fig. 2).

The indication for preferring ST over PDT was captured and the most common reason was the opinion of the admitting consultant (34.2%) as most of the patients undergoing ST were admitted under a surgical specialty. It was followed by the short neck of the patient (11.7%). Other reasons were coagulopathy, skill for PDT absent, altered anatomy like short neck, or guidance for PDT like fiberoptic bronchoscope (FOB) or ultrasonography (USG) absent (Table 6).

The use of guidance used from tracheostomy was captured and it was found that clinicians preferred clinical judgment over FOB or USG during tracheostomy ($n = 632/923$, 68.5%). Fiberoptic bronchoscope and USG were used more commonly in PDT as compared to ST (28.1 vs 1.2%, 14.1% vs 2.7%; $p = 0.0001$). Ultrasonography grading was divided into excellent, good, and unsatisfactory as defined earlier and the unsatisfactory anatomy group was more in ST as compared to PDT (66.7% vs 5.2%, $p = 0.0001$) (Fig. 3). All patients had a successful first-attempt incision in ST whereas 90.7% patients had first-attempt success while performing PDT ($p = 0.0001$). Sedation and analgesia used during tracheostomy were equal between both the groups except more use of morphine in the ST group (21.4% vs 1.8%, $p = 0.0001$) and more use of midazolam (44.6% vs 31.9%, $p = 0.0001$) and rocuronium (9.6% vs 1.2%, $p = 0.0001$) in the PDT group. The use of inhalational anesthetic agent in OT was not captured in the study. The procedure was performed mostly by the trained intensivist in PDT (74.2%) whereas ST was mostly performed by an ENT surgeon (56.8%). Other than them, anesthesiologist and pulmonologist who were not trained intensivist also performed PDT (18.9% and 1.1%). The neurosurgeons and ENT surgeons also performed PDT in ICU (4.2% and 1.7%). The ST was also performed by a mix of surgical specialties like neurosurgeon, maxillofacial surgeon, plastic surgeon, and general surgeon (42%) (Fig. 4). The ST was mostly performed by the trained surgeon in OT as compared to PDT, which was also

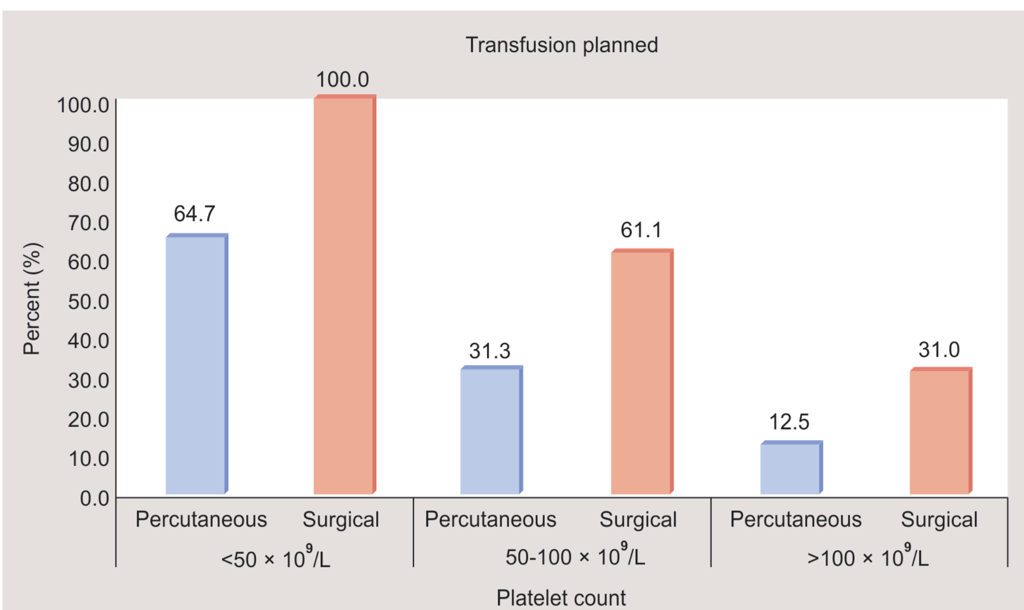

Fig. 1: Platelet transfusion trend

performed by trainees and less experienced operators (93.4% vs 85.1%, $p = 0.0007$) (Table 7).

All the complications captured were immediate in nature, i.e., occurring during the procedure. Complications were divided into minor and major complications. The PDT and ST were similar in terms of minor complications except more incidence of desaturation in the ST group (2.3% vs 6.6%, $p = 0.001$). In major complications, the ST group had more incidence of hemorrhagic events as compared to the PDT group (7% vs 2.6%, $p = 0.002$). Although rest of the major complications were more in ST group, they did not reach statistical significance (Figs 5 and 6).

Duration of the procedure was much shorter in the PDT group as compared to the ST group (19.1 ± 11.7 minutes vs 28.3 ± 18.4 minutes, average shortening by 9.2 minutes, $p = 0.0001$) (Fig. 7). All PDT were performed successfully except one that had to be converted to ST. One case of ST had to be abandoned due to bleeding and desaturation during the procedure. The time from decision to perform tracheostomy to actual procedure was much lower in the PDT group ($p = 0.002$) (Fig. 8). The ventilator-free days in the first week post-tracheostomy was higher in the PDT group, although not reaching statistical significance (4639 ± 3712 minutes vs 4301 ± 4451 minutes, $p = 0.251$) (Fig. 9).

The actual cost of the procedure as charged to the patient was much higher in the ST group as compared to the PDT group ($p = 0.002$). Other variables that can implicate the cost of the procedure like man hour cost, cost of blood products used, if any, and the cost implications of any complications were not captured in the study. On the basis of the actual procedure charges to the patient, the average cost difference was Rs. 13,104 between the two groups (Table 8).

Table 4: Timing of tracheostomy

	Percutaneous	*Surgical*	*p value*
Timing			
<4 days	238 (35.7)	146 (56.8)	0.0001*
>4 days	428 (64.3)	111 (43.2)	
<7 days	477 (71.6)	203 (79)	0.023*
>7 days	189 (28.4)	54 (21)	
<10 days	599 (89.9)	241 (93.8)	0.068
>10 days	67 (10.1)	16 (6.2)	
Place of procedure			
ICU	661 (99.2)	87 (33.9)	0.0001*
OT	5 (0.8)	170 (66.1)	
Neck anatomy assessment			
USG	257 (38.6)	16 (6.2)	0.0001*
Neck circumference	38.9 ± 5.1	37.8 ± 7	0.558
Cricosternal distance	4.9 ± 1.8	6 ± 1.8	0.086
Clinical	432 (64.9)	242 (94.2)	0.0001*

*$p < 0.05$ statistically significant

Table 5: Techniques used for percutaneous dilatational tracheostomy

	Percutaneous (n = 666)	*Percent (%)*
Single dilator	402	60.4
Multiple dilator	73	11.0
Griggs forceps	191	28.7

Discussion

We conducted this multicenter prospective data collection to understand the practices of tracheostomy in Indian ICUs and also to compare PDT with ST on selected variables. The nationwide representation from 67 ICUs contributed 923 cases and out of these two-third patients underwent PDT. This shows the clinicians prefer doing PDT at the bedside rather than ST in the operation theater. The same finding was observed in the questionnaire-based audit by Kumar et al.[3] where most of the clinicians preferred PDT over the surgical technique.

The contributing ICUs were mostly from private sector, similar to the trend seen in INDICAPS[4] where most of the data came from private hospital ICUs. This data were collected over 4 months and only about one-third of medium and large ICUs could submit the data, so by extrapolating the numbers, we may summarize that

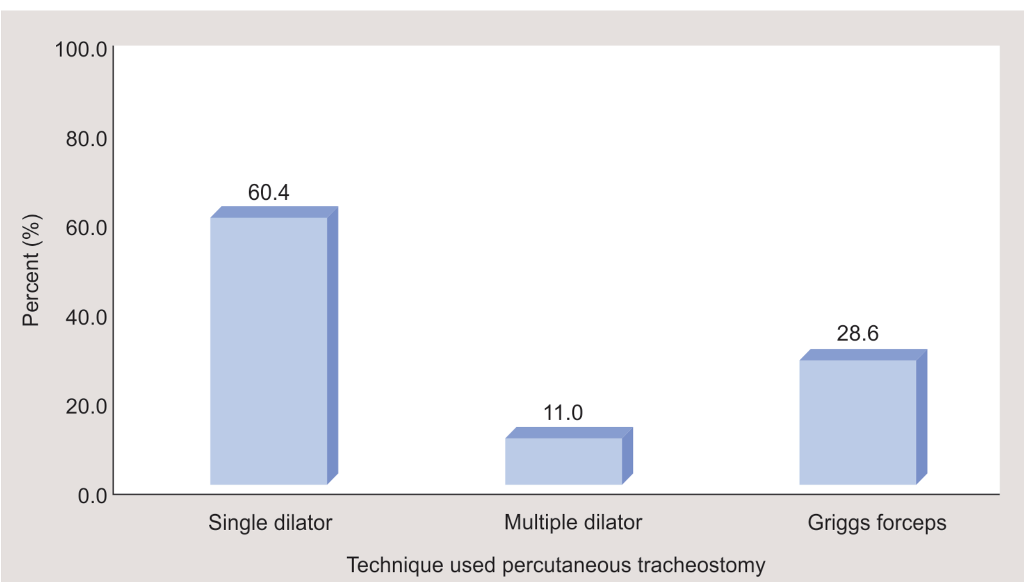

Fig. 2: Various techniques of percutaneous dilatational tracheostomy

Table 6: Indications for surgical tracheostomy

Indications	*Percentage*
Adequate skill for PDT absent	2.7
Admitting consultant opinion	34.2
Platelet count $<50 \times 10^9$	4.3
INR > 1.5	3.5
PDT cost thought to be high	4.3
Short neck	11.7
FOB or USG not available	3.1

the actual number of tracheostomies being performed in India in a calendar year would be around 8,500 out of which 75% would be PDT.

We found that most of the patients had one or more comorbidities but patients with CAD were more in the PDT group as compared to the ST group. The reason can be probably a safe index in performing a bedside procedure rather than subjecting to anesthesia for ST.

Tracheostomy should be performed as an elective procedure when the hemodynamic and respiratory parameters have been stabilized. In our study, the FiO_2 requirement was less than 0.40

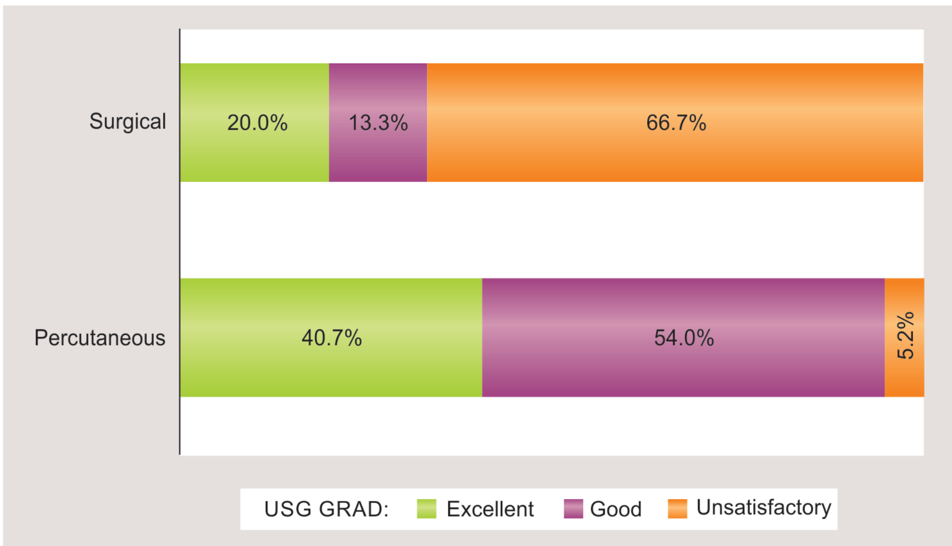

Fig. 3: Ultrasound grading of neck assessment

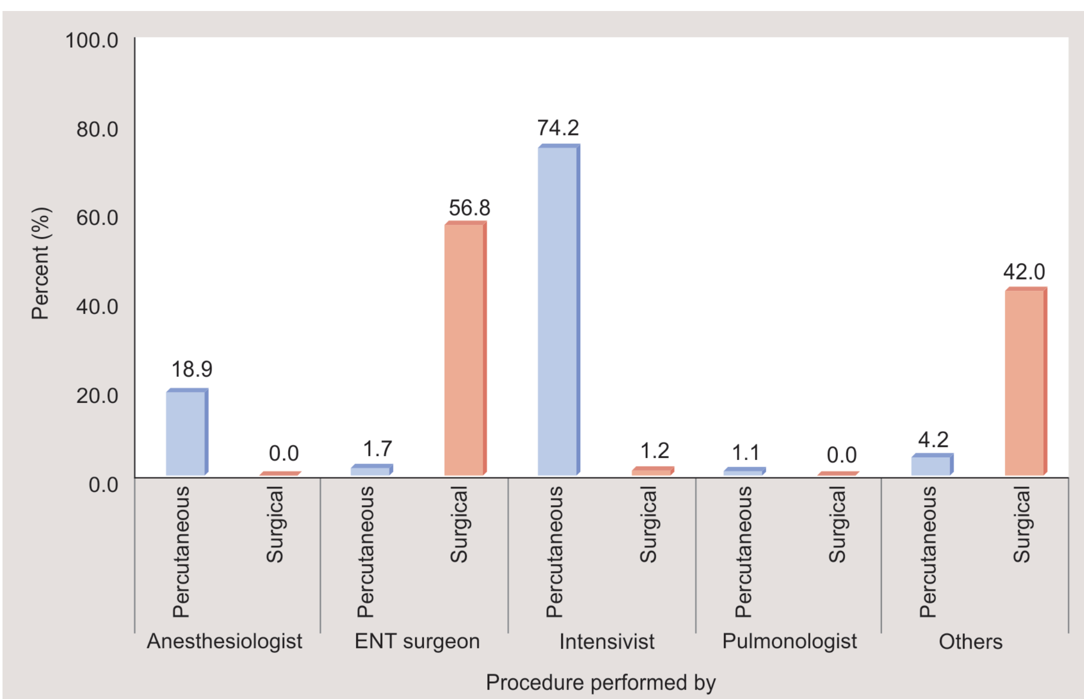

Fig. 4: Tracheostomy performed by various specialties

Table 7: Intraprocedure-related data

Variables	*Percutaneous (n = 666) (%)*	*Surgical (n = 257) (%)*	*p value*
Guidance used			0.0001*
Ultrasound	94 (14.1)	7 (2.7)	
FOB	187 (28.1)	3 (1.2)	
None	385 (57.8)	247 (96.1)	
Attempts			0.0001*
1	604 (90.7)	256 (99.6)	
2	48 (7.2)	1 (0.4)	
3	12 (1.8)	0	
5	2 (0.3)	0	
Mean ± SD (range)	1.12 ± 0.42 (1–5)	1.00 ± 0.06 (1–2)	
Sedation and paralysis			
Propofol	267 (40.1)	110 (42.8)	0.0453
Dexmedetomidine	5 (0.8)	4 (1.6)	0.264
Fentanyl	545 (81.8)	189 (73.5)	0.005*
Morphine	12 (1.8)	55 (21.4)	0.0001*
Midazolam	297 (44.6)	82 (31.9)	0.0001*
Succinylcholine/rocuronium	64 (9.6)	3 (1.2)	0.0001*
Vecuronium/atracurium/cisatracurium	442 (66.4)	162 (63)	0.340
Operator specialization			
Trained intensivist	494 (74.2)	3 (1.2)	0.0001*
Anesthesiologist	126 (18.9)	0	0.0001*
ENT surgeon	11 (1.7)	146 (56.8)	0.0001*
Pulmonologist	7 (1.1)	0	0.092
Others	28 (4.2)	108 (42)	0.0001*
Experience			
<10 tracheostomy	48 (7.2)	3 (1.2)	0.0004*
10–25 tracheostomy	51 (7.7)	14 (5.4)	0.222
>25 tracheostomy	567 (85.1)	240 (93.4)	0.0007*

*$p < 0.05$ statistically significant

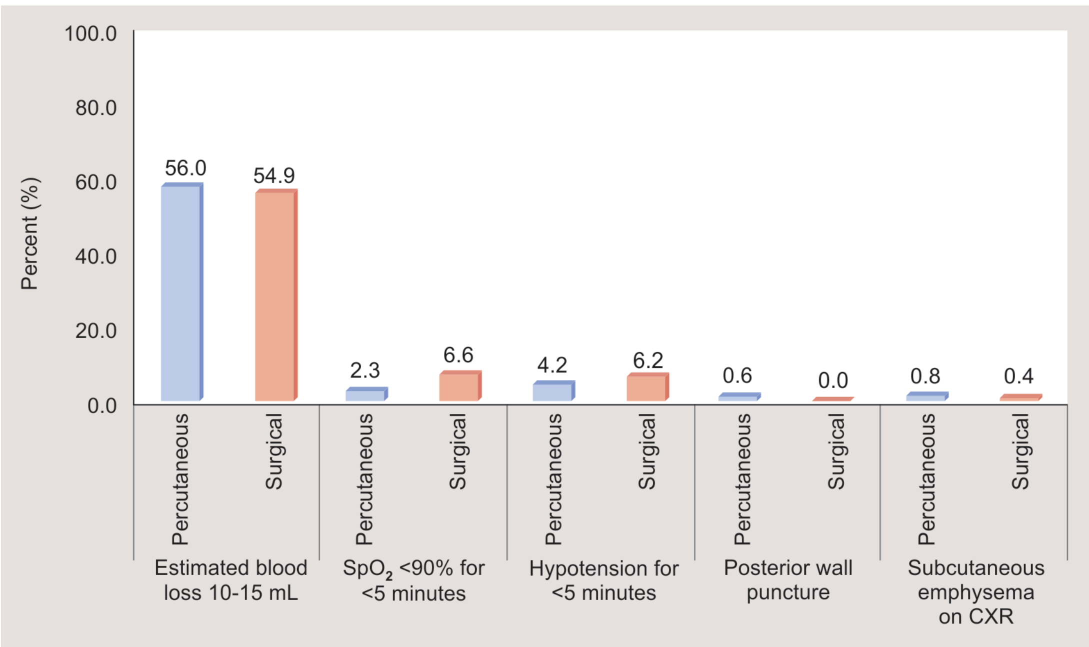

Fig. 5: Minor complications

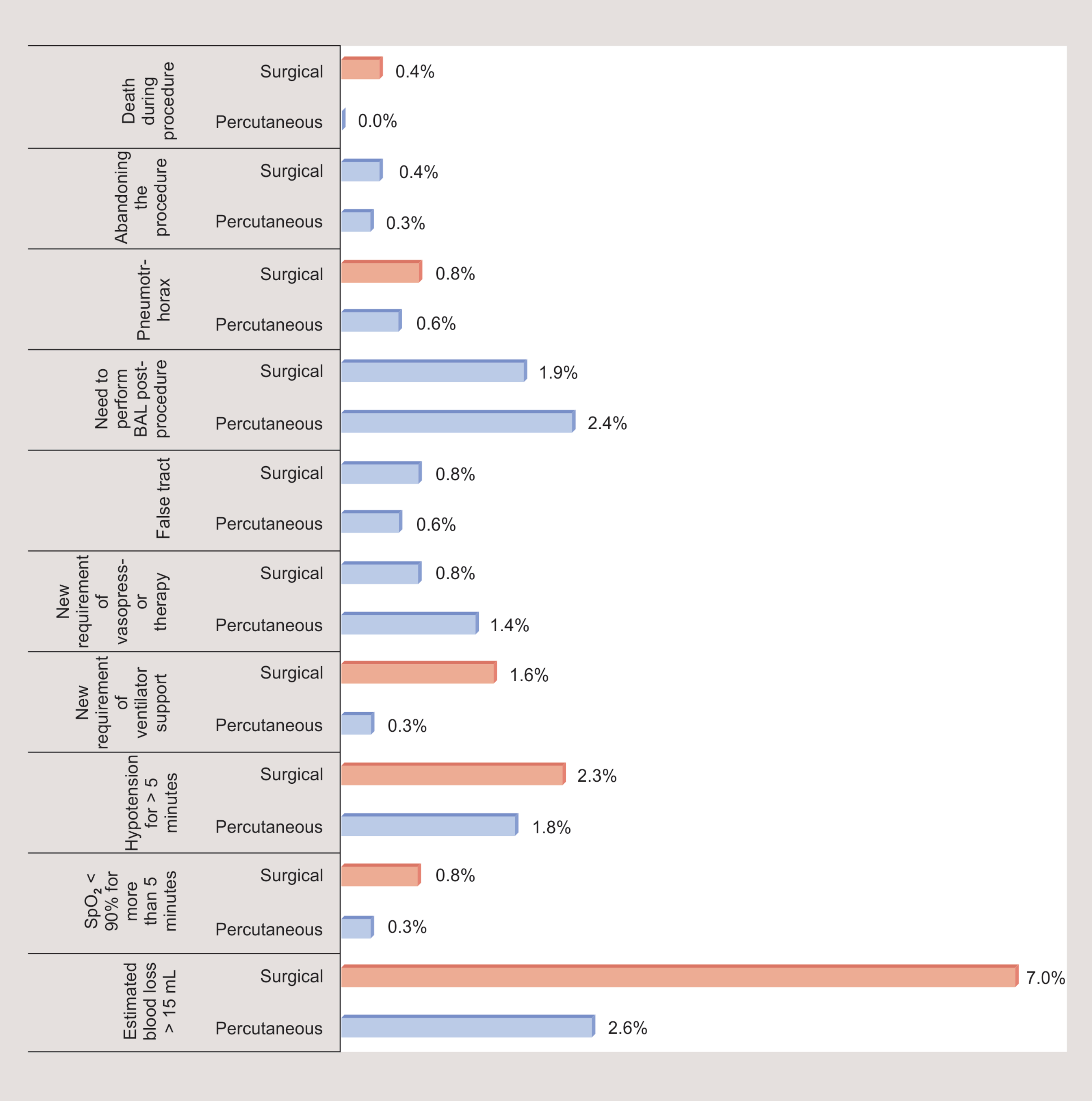

Fig. 6: Major complications

in the PDT group and most of them had hemodynamic stability. Coagulopathy was earlier considered as a contraindication to perform tracheostomy but with increasing experience, this has become now as an extended indication. In our study, PDT was safely performed in patients with platelet count <50 × 10^9/L and INR >1.5 with less need for platelet and FFP transfusion as compared to ST. Kluge et al.,[5] Ben-Nun et al.,[6] and other studies[7–9] also had similar experiences where they could demonstrate that PDT can be safely performed in coagulopathic patients and is noninferior to ST. Second, PDT may result in lower usage of blood products for correction of coagulopathy, although this should be at the sole discretion of the operator.

The timing of tracheostomy has been one of the most discussed variable. Definition of early tracheostomy (ET) and late tracheostomy (LT) is varied as per many randomized and retrospective trials. As per our study, most of the tracheostomies happened at around day 7 of ventilation and PDT was the predominant technique. As per the systematic analysis by Griffiths et al.,[10] they defined ET as within 7 days of ventilation and they compared incidence of ventilator-associated pneumonia (VAP). Similarly studies in head injury,[11,12] cardiac patients,[13] and general ICU patients[14–16] also defined ET ranging from 4 days to 10 days of ventilation. This shows that there is no standard definition of early and late tracheostomy but most of the studies defined ET between 7 days and 10 days of ventilation.

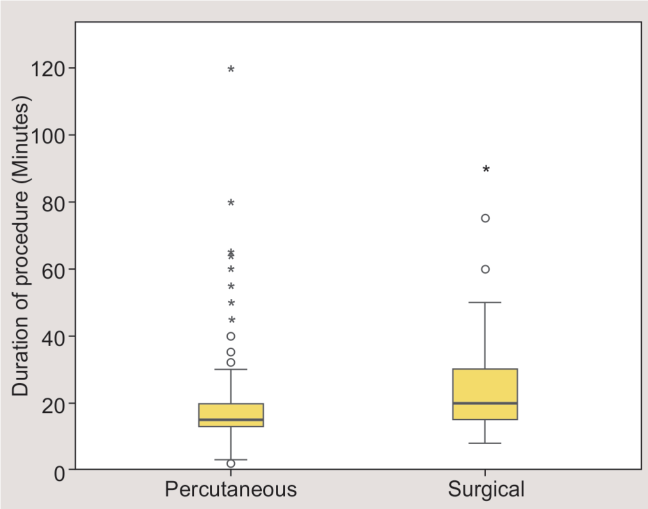

Fig. 7: Box plot representing the time taken for percutaneous dilatational tracheostomy and surgical tracheostomy

Various techniques of performing PDT are described in the medical literature. Our study revealed that the most preferred technique is the single dilator technique followed by the Grigg's forceps and then the multiple dilator technique. This is in accordance with other studies[17–19] that have compared various techniques of PDT and they have also concluded that single dilator technique is the most preferred technique by clinicians due to shorter learning curve and duration.

Among the reasons cited for performing ST were availability of ENT surgeon, decision of the admitting consultant, and absence of adequate skill to perform PDT. The same finding was observed in the questionnaire-based audit conducted by Kumar et al.[3]

In our study, the use of FOB or real-time USG was less and most of the clinicians performed the procedure based on clinical judgement. The maximum usage of these techniques were in the PDT group as compared to the ST group. Kost et al.[20] showed that FOB-guided PDT reduced hemorrhagic complications as compared to nonguided ST. Other studies[21–23] had also stressed that FOB should be used while performing PDT. Similarly, use of real-time USG guidance during PDT decreases the risk of hemorrhagic

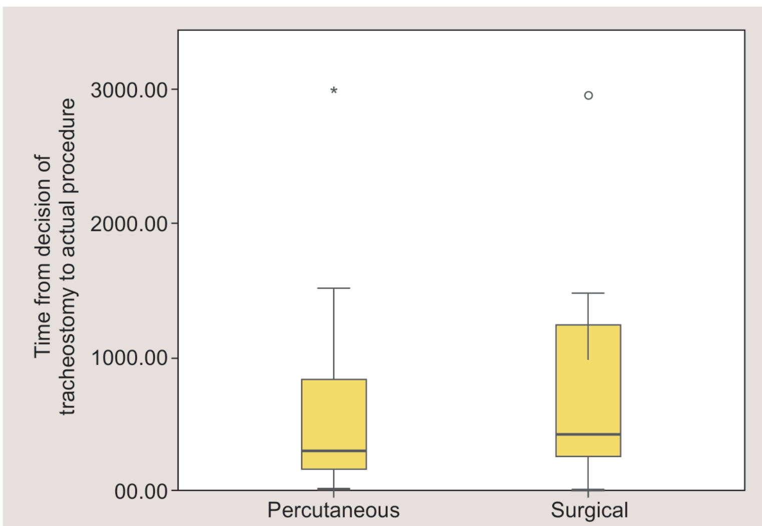

Fig. 8: Box plot representing the time taken from decision to actual procedure being done

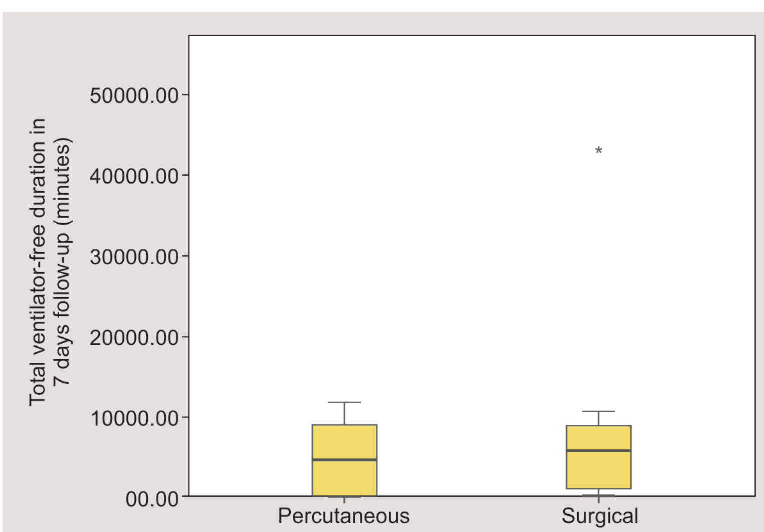

Fig. 9: Box plot representing the ventilator-free days between percutaneous dilatational tracheostomy and surgical tracheostomy

Table 8: Complications and outcome-related data

	Percutaneous (n = 666)		*Surgical (n = 257)*		
Variables	*n (%)*	*95% CI*	*n (%)*	*95% CI*	*p value*
Minor complications					
Estimated blood loss < 15 mL	373 (56)	52.1–59.8	141 (54.9)	48.6–61.1	0.754
SpO_2 < 90% for > 5 minutes	15 (2.3)	1.3–3.7	17 (6.6)	3.9–10.4	0.001*
Hypotension < 5 minutes	28 (4.2)	2.8–6.0	16 (6.2)	3.6–9.9	0.196
Posterior wall puncture	4 (0.6)	0.2–1.5	0 (0)	–	0.213
Subcutaneous emphysema	5 (0.8)	0.2–1.7	1 (0.4)	0.001–2.1	0.540
Major complications					
Estimated blood loss > 15 mL	17 (2.6)	1.5–4.1	18 (7)	4.2–10.8	0.002*
SpO_2 > 90% for > 5 minutes	2 (0.3)	0.001–1.1	2 (0.8)	0.1–2.8	0.322
Hypotension > 5 minutes	12 (1.8)	0.9–3.1	6 (2.3)	0.9–5.0	0.600
New ventilator requirement	2 (0.3)	0.001–1.1	4 (1.6)	0.4–3.9	0.033*
New vasopressor requirement	9 (1.4)	0.6–2.5	2 (0.8)	0.1–2.8	0.472
False tract	4 (0.6)	0.2–1.5	2 (0.8)	0.1–2.8	0.763
Need for BAL postprocedure	16 (2.4)	0.2–1.5	5 (1.9)	0.6–4.5	0.676
Pneumothorax	4 (0.6)	0.2–1.5	2 (0.8)	0.1–2.8	0.763
Procedure abandoned	2 (0.3)	0.001–1.1	1 (0.4)	0.001–2.1	0.832
Death during procedure	0 (0)	–	1 (0.4)	0.001–2.1	0.107
Duration of procedure					
Mean ± SD (range)	19.1 ± 11.7 (2–120)		28.3 ± 18.4 (8–90)		0.0001*
Median (IQR)	15 (13–20)		20 (15–30)		0.0001*
Time from decision of tracheostomy to actual procedure					
Mean ± SD (range)	540.4 ± 519.4 (10–2,880)		668.8 ± 606.6 (5–2,880)		0.002*
Median (IQR)	280 (150–810)		390 (240–1200)		0.0001*
Ventilator-free duration 1st week					
Mean ± SD (range)	4639 ± 3712 (0–11,340)		4301 ± 4451 (0–41,760)		0.251
Median (IQR)	4387.5 (60–8,640)		4260 (0–7,560)		0.083
Cost of procedure					
<10,000	250 (37.6)	33.8–41.3	108 (42)	35.9–48.3	0.219
10,000–20,000	279 (41.9)	38.1–45.7	72 (28)	22.6–33.9	0.0001*
> 20,000	137 (20.6)	17.6–23.8	77 (30)	24.4–36.0	0.002*

*$p < 0.05$ statistically significant

complications and also increases the success of first-attempt needle puncture.[24–26] Our study also showed that cases where USG guidance was used, the first attempt success rate was very high.

A trained intensivist mainly performed PDT in our study whereas ST was mainly done by an ENT surgeon. The result is similar to findings by audit of Kumar et al.[3] and other studies involving neurointensivist[27] or physician intensivist.[28]

We studied various minor and major complications that can occur during tracheostomy and compared between ST and PDT. The incidence of minor and major complications was higher in the ST group as compared to the PDT group but only desaturation for less than 5 minutes and bleeding more than 15 mL reached statistical significance. This is despite the fact that ST have been done in OT and the cautery may have been used. Similar findings have been reported by studies[29–31] comparing ST with PDT for various complications. Our study also reported that PDT is faster as compared to ST and the time from decision of tracheostomy to actual procedure is also shorter in the PDT group. This is probably due to nonavailability of an operation theater (OT) or the surgeon. The same findings were observed in the ESICM survey[32] and meta-analysis by Putensen et al.[33] The cost of the procedure is a significant concern in the developing nation like ours and we found that ST has a much higher cost implication that PDT. This is probably due to the surgical fee and the OT charges combined whereas PDT cost would probably involve the cost of the disposables and the procedure only. At many places, the kit is being reused by proper sterilization and this further reduces the cost of PDT in their settings. Similar findings were observed in the meta-analysis by Higgins et al.[34–36]

The limitations of our study was that we did not look at other outcome data like difference in incidence of VAP, mortality difference, long-term complications, and ICU length of stay between ST and PDT groups. The participation in the study was purely voluntary and not made mandatory by ISCCM. The data were mostly shared by the intensivists who were enthusiasts and interested in contributing for a research paper to understand the Indian practice. We assumed that the data uploaded are correct as per the inclusion criteria as there was no means of source data validation.

The strengths of this study include a large database from ICUs across the country and from different ICU specialties. Data will be used to prepare Indian guidelines on Tracheostomy in critically ill patients and will also form the basis of future studies on this topic. We could easily identify from this study that PDT is the most preferred modality of tracheostomy in India and clinicians prefer single dilator as the technique of choice. Although we did not estimate other outcome data like mortality and VAP, the incidence of complications was studied in detail and we could document that PDT is associated with less complications. This is the first Indian study that looked at the cost implications of tracheostomy and we could highlight the approximate cost difference between both the techniques. This study may be used as the basis of doing a more detailed study on the same topic with wider participation from ICUs across the country.

Conclusion

This multicenter, prospective data collected from 923 patients from 67 ICUs across the country is a snapshot of the practice pattern of tracheostomy in India. The highlights of the study are the acceptance of PDT with the single dilator technique as the modality of choice by trained intensivist. The hemorrhagic complications being lower with PDT as compared to ST. Percutaneous dilatational tracheostomy is quicker, both in terms of procedural time as well as from decision making to actual procedure, resulting in higher ventilator-free days. Percutaneous dilatational tracheostomy is economical compared to ST.

References

1. Koksal GM, Sayilgan NC, Oz H. Percutaneous dilatational tracheostomy. Middle East J Anesthesiol 2006;18(no. 5):903–910.
2. Cooper RM. Use and safety of percutaneous tracheostomy in intensive care. Report of a postal survey of ICU practice. Anaesthesia 1998;53(12):1209–1212. DOI: 10.1046/j.1365-2044.1998.00579.x.
3. Kumar P, Misra A, Anand R, Shastri BVR, Wadhawan S. Audit of the existing attitudes and practices of the medical intensivists regarding tracheostomy in the ICU's in India. Indian J Anaesth 2006;50(4):288–294.
4. Divatia JV, Amin PR, Ramakrishnan N, Kapadia FN, Todi S, Sahu S, et al. Intensive care in India: the Indian intensive care case mix and practice patterns study. Indian J Crit Care Med 2016;20(4):216–225. DOI: 10.4103/0972-5229.180042.
5. Kluge S, Meyer A, Kuhnelt P, Baumann HJ, Kreymann G. Percutaneous tracheostomy is safe in patients severe thrombocytopenia. Chest 2004;126(2):547–551. DOI: 10.1378/chest.126.2.547.
6. Ben-Nun A, Altman E, Best LA. Extended indications for percutaneous tracheostomy. Ann Thorac Surg 2005;80(4):1276–1279. DOI: 10.1016/j.athoracsur.2005.02.007.
7. Beiderlinden M, Eikermann M, Lehmann N, Adamzik M, Peters J. Risk factors associated with bleeding during and after percutaneous dilatational tracheostomy. Anaesthesia 2007;62(4):342–346. DOI: 10.1111/j.1365-2044.2007.04979.x.
8. Auzinger G, O'Callaghan GP, Bernal W, Sizer E, Wendon JA. Percutaneous tracheostomy in patients with severe liver disease and a high incidence of refractory coagulopathy: a prospective trial. Crit Care 2007;11(5):R110. DOI: 10.1186/cc6143.
9. Deppe AC, Kuhn E, Scherner M, Slottosch I, Liakopoulos O. Coagulation disorders do not increase the risk for bleeding during percutaneous dilatational tracheotomy. Thorac Cardiovasc Surg 2013;61(3):234–239. DOI: 10.1055/s-0032-1322608.
10. Griffiths J, Barber VS, Morgan L, Young JD. Systematic review and meta-analysis of studies of the timing of tracheostomy in adult patients undergoing artificial ventilation. BMJ 2005;330(7502):1243. DOI: 10.1136/bmj.38467.485671.E0.
11. Bouderka MA, Fakhir B, Bouaggad A, Hmamouchi B, Hamoudi D, Harti A. Early tracheostomy versus prolonged endotracheal intubation in severe head injury. J Trauma 2004;57(2):251–254. DOI: 10.1097/01.ta.0000087646.68382.9a.
12. Zirpe KG, Tambe DV, Deshmukh AM, Gurav SK. The impact of early tracheostomy in neurotrauma patients: a retrospective study. Indian J Crit Care Med 2017;21(1):6–10. DOI: 10.4103/0972-5229.198309.
13. Trouillet JL, Luyt CE, Guiguet M, Ouattara A, Vaissier E, Makri R, et al. Early percutaneous tracheotomy versus prolonged intubation of mechanically ventilated patients after cardiac surgery: a randomized trial. Ann Intern Med 2011;154(6):373–383. DOI: 10.7326/0003-4819-154-6-201103150-00002.
14. Terragni PP, Antonelli M, Fumagalli R, Faggiano C, Berardino M, Pallavicini FB, et al. Early vs late tracheotomy for prevention of pneumonia in mechanically ventilated adult ICU patients: a randomized controlled trial. JAMA 2010;303(15):1483–1489. DOI: 10.1001/jama.2010.447.
15. Blot F, Similowski T, Trouillet JL, Chardon P, Korach JM, Costa MA, et al. Early tracheotomy versus prolonged endotracheal intubation in unselected severely ill ICU patients. Intensive Care Med 2008;34(10):1779–1787. DOI: 10.1007/s00134-008-1195-4.
16. Meng L, Wang C, Li J, Zhang J. Early vs late tracheostomy in critically ill patients: a systematic review and meta-analysis. Clin Respir J 2016;10(6):684–692. DOI: 10.1111/crj.12286.
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(11):3734–3739. DOI: 10.1097/00003246-200011000-00034.
18. Sanabria A. Which percutaneous tracheostomy method is better? a systematic review. Respir Care 2014;59(11):1660–1670. DOI: 10.4187/respcare.03050.
19. Kumar M, Trikha A, Chandralekha. percutaneous dilatational tracheostomy: griggs guide wire dilating forceps technique versus ULTRA-perc single-stage dilator–a prospective randomized study. Indian J Crit Care Med 2012;16(2):87–92. DOI: 10.4103/0972-5229.99117.
20. Kost KM. Endoscopic percutaneous dilatational tracheotomy: a prospective evaluation of 500 consecutive cases. Laryngoscope 2005;115(S107):1–30. DOI: 10.1097/01.MLG.0000163744.89688.E8.
21. Taha A, Omar AS. Percutaneous dilatational tracheostomy. is bronchoscopy necessary? a randomized clinical trial. Trend Anaest Criti Care 2017;15:20–24. DOI: 10.1016/j.tacc.2017.06.002.
22. Hinerman R, Alvarez F, Keller CA. Outcome of bedside percutaneous tracheostomy with bronchoscopic guidance. Intensive Care Med 2000;26(12):1850–1856. DOI: 10.1007/s001340000718.
23. Jackson LSM, Davis JW, Kaups KL, Sue LP, Wolfe MM, Bilello JF, et al. Percutaneous tracheostomy: to Bronch or not to Bronch—that is the question. J Trauma 2011;71(6):1553–1556. DOI: 10.1097/TA.0b013e31823ba29e.
24. Yavuz A, Yılmaz M, Göya C, Alimoglu E, Kabaalioglu A. Advantages of US in percutaneous dilatational tracheostomy: randomized controlled trial and review of the literature. Radiology 2014;273(3):927–936. DOI: 10.1148/radiol.14140088.
25. Gobatto ALN, Besen BAMP, Tierno PFGMM, Mendes PV, Cadamuro F, Joelsons D. Ultrasound-guided percutaneousdilatational tracheostomyversus bronchoscopy-guided percutaneous dilatational tracheostomy in critically ill patients (TRACHUS): a randomized noninferiority controlled trial. Intensive Care Med 2016;42(3):342–351. DOI: 10.1007/s00134-016-4218-6.
26. Rudas M, Seppelt I, Herkes R, Hislop R, Rajbhandari D, Weisbrodt L. Traditional landmark versus ultrasound guided tracheal puncture during percutaneous dilatational tracheostomy in adult intensive care patients: a randomised controlled trial. Crit Care 2014;18(5):514. DOI: 10.1186/s13054-014-0514-0.
27. Seder DB, Lee K, Rahman C, Rossan-Raghunath N, Fernandez L, Rincon F, et al. Safety and feasibility of percutaneous tracheostomy performed by neurointensivists. Neurocrit Care 2009;10(3):264–268. DOI: 10.1007/s12028-008-9174-8.

28. Khan AZ, Khan A, Naseem A. Percutaneous tracheostomy by physician intensivists. J Colle Phys Surg Pakistan 2018;28(3):222–225. DOI: 10.29271/jcpsp.2018.03.222.
29. Friedman Y, Fildes J, Mizock B, Samuel J, Patel S, Appavu S, et al. Comparison of percutaneous and surgical tracheostomies. Chest 1996;110(2):480–485. DOI: 10.1378/chest.110.2.480.
30. Holdgaard HO, Pedersen J, Jensen RH, Outzen KE, Midtgaard T, Johansen LV, et al. Percutaneous dilatational tracheostomy versus conventional surgical tracheostomy. Acta Anaesthesiol Scand 1998;42(5):545–550. DOI: 10.1111/j.1399-6576.1998.tb05164.x.
31. Johnson-Obaseki S, Veljkovic A, Javidnia H. Complication rates of open surgical versus percutaneous tracheostomy in critically ill patients. Laryngoscope 2016;126(11):2459–2467. DOI: 10.1002/lary.26019.
32. Vargas M, Sutherasan Y, Antonelli M, Brunetti L, Corcione A, Laffey JG. Tracheostomy procedures in the intensive care unit: an international survey. Crit Care 2015;19(1):291. DOI: 10.1186/s13054-015-1013-7.
33. Putensen C, Theuerkauf N, Guenther U, Vargas M, Pelosi P. Percutaneous and surgical tracheostomy in critically ill adult patients: a meta-analysis. Crit Care 2014;18(6):544. DOI: 10.1186/s13054-014-0544-7.
34. Higgins KM, Punthakee X. Meta-analysis comparison of open versus percutaneous tracheostomy. Laryngoscope 2007;117(3):447–454. DOI: 10.1097/01.mlg.0000251585.31778.c9.
35. Freeman BD, Isabella K, Perren Cobb J, Boyle WA, Schmieg RE, Kolleff MH, et al. A prospective, randomized study comparing percutaneous with surgical tracheostomy in critically ill patients. Crit Care Med 2001;29(5):926–930. DOI: 10.1097/00003246-200105000-00002.
36. Heikkinen M, Aarnio P, Hannukainen J. Percutaneous dilatational tracheostomy or conventional surgical tracheostomy? Crit Care Med 2000;28(5):1399–1402. DOI: 10.1097/00003246-200005000-00023.

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