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Original Article

Auxiliary methods for percutaneous dilatational tracheotomy

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Abstract

Aim: Patient with long-term mechanic ventilation in the Intensive care unit can be used as an adjunct to the Light styles and Fiber optic bronchoscope as a guide in percutaneous dilatation tracheotomy. In our study, we planned to investigate the effects of Light styles and Fiber optic bronchoscope on perioperative complications in percutaneous dilatation tracheotomy.

Material and Methods: The study was conducted by scanning digital and written file records of 52 patients who underwent percutaneous dilatation tracheotomy between 2016 and 2018. Patients were evaluated in 3 groups using Light styles, Fiber optic bronchoscope and no additional methods.

Results: In the study; percutaneous dilatation tracheotomy were performed to 52 patients who were followed up at the Intensive care unit. Mean Percutaneous dilatation tracheotomy opening day was 17.03±4.18 days, operation time was 21.23±8.45 min, 69.2% was successful in the first attempt in all groups. There were 21 patients using Light styles, 12 using Fiber optic bronchoscope and 19 with no additional methods. In 26 patients (74.3%) the use of Light styles or Fiber optic bronchoscope was facilitated. In the Light styles group endotracheal tube puncture was less common (p=0.044). More venous hemorrhage was seen in longer periods of procedure (p<0.001), and more hypotension was observed in the longer Percutaneous dilatation tracheotomy administration time in all groups (p=0.012).

Conclusion: The use of Light styles and Fiber optic bronchoscope can be safely used in percutaneous dilatation tracheotomy.

Keywords: Lighted stile; Fiber optic bronchoscope; percutaneous dilatation tracheotomy.

INTRODUCTION

Tracheostomy is recommended for patients who are followed-up with endotracheal intubation in the Intensive Care Unit (ICU) and who will undergo long-term mechanical ventilation (1). Tracheostomy has positive effects such as decreasing the undesirable long-term effects due to endotracheal intubation (laryngeal damage, vocal cord paralysis, stenosis of glottis stenosis, tracheal damage and increased infection frequency), increasing patient comfort, facilitating mobilization, decreasing the need for sedation, allowing for oral feeding, fast and reliable weaning preparation, facilitating tracheal aspiration and shortening the duration in ICU stay (2,3).

Perioperative bleeding, postoperative complications and infection have lower incidences in percutaneous dilatational tracheostomy (PDT). In addition, it is preferred more than surgical tracheostomy (ST) due to its ease of application, shorter procedure time and lower cost (4).

In PDT, various stages of methods are used, such as the single procedure (5) with the help of special forceps (Howard Kelly) developed by Griggs et al., serial dilators (Ciaglia) (6), 'Percu Twist' (7) and 'Ciaglia Blue Rhino' soft curved cone (8). Among these methods, PDT application with the help of Howard Kelly forceps is the most widely used method (9). Tools such as ultrasonography, fiber optic bronchoscope (FOB) and lighted stylet (LS) can be used as auxiliary methods in PDT. The search for the ideal method and the auxiliary tool for the safety of the procedure and the prevention of the complications still continue.

Most complications in PDT are related to the technique and the procedure, and the frequency has been reported to vary between 1and 10% (10). Early (perioperative) complications include bleeding, hypoxia, hypotension, shock, bronchospasm, cardiac arrest, endotracheal tube cuff perforation, tracheotomy tube malposition,

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subcutaneous emphysema, pneumothorax, hemothorax, pneumomediastinum, trachea injury and wound site infection (10,11).

In this study, we aimed to retrospectively evaluate the effects of the use of auxiliary guidelines such as LS and FOB in the PDT procedure, which we had applied with the help of forceps for two years in ICU, in terms of perioperative complications and ease of operation.

MATERIAL and METHODS

52 patients over 18 years of age who were treated in the Anesthesia and Surgery ICU between 2017 and 2018 and who underwent PDT were included in our study. After obtaining the Ethics Committee decision No. 2018/52, dated 31.07.2018 from the Ethics Committee of Clinical Research of the Kanuni Training and Research Hospital in University of Health Sciences, files and automation records were retrospectively examined and recorded. Patients who underwent tracheostomy and ST before hospitalization in ICU were excluded from the study.

In our clinic, percutaneous tracheotomies are performed as (Griggs technique) PDT by physicians experienced in their fields and with the help of forceps (Howard Kelly). Before the procedure, informed consent was obtained from a first degree relative or legal heir for PDT, and then tracheostomy was applied at the bedside in ICU under elective conditions. PTD was not applied to those with bleeding disorders (those with platelet count below 50.000/mm^3 and those with activated partial thromboplastin and prothrombin time above 1.5 times the control value) and those with anomalies in the area of operation (anatomical defect, short neck, large goiter, hemangioma, burn scar, regional radiotherapy and skin infection). The patients were monitored by electrocardiography, pulse oximetry, invasive or non-invasive arterial blood pressure during the procedure following at least 4 hours after fasting. Adequate level of anesthesia and analgesia were provided with midazolam, fentanyl, propofol and muscle relaxant (rocuronium or vecuronium) if needed. The optimal position was tried to be achieved by providing elevation under the shoulder and extending the head. During the procedure, controlled mechanical ventilation was applied with 100% oxygen. 'Percutaneous tracheostomy kit' (Portex®, Hythe, Kent, England) was used. During the procedure, LS (Trachhlight®; Laerdal Medical, Armonk, NY) and FOB were used as auxiliary guideline methods in some patients.

When starting the procedure, the endotracheal tube (ETT) balloon was lowered and pulled to the bottom of the vocal cords and re-inflated. The tracheal cartilages were examined, and the second spacing for infiltration was determined and marked. In cases where LS was used, the tip was passed through the ETT with the tip facing 15-20 degrees forward, and the tracheal cartilages and the surrounding vascular structures were tried to be detected at the anterior wall of the neck with the help of light reflex. After the operation site was cleaned with antiseptic solutions, 1% lidocaine 2-4 cc containing adrenaline (1:200,000) was infiltrated into the skin-subcutaneous region at the planned site of operation. After adequate incision in the vertical direction, the injector filled with 3-5 cc physiological saline solution was advanced towards the trachea at the vertical plane from the determined site of infiltration with negative aspiration and with the help of the needle with plastic cannula in the tracheotomy kit. It was considered to be in the trachea when air came into the injector. In case of no air coming or blood coming into the injector, it was removed, the anatomical structure was checked, and operation procedure was repeated. Operation procedures failing after the 3rd attempt were transferred to ST. When air came into the injector, the needle was withdrawn while advancing the plastic cannula on the needle into the trachea. The guidewire was advanced into the trachea through the plastic cannula. The plastic cannula was removed, and a plastic dilator cannula was placed over the guidewire remaining in the trachea. After dilatation with the dilator cannula, the forceps was opened from the skin to the trachea with special forceps, the tracheal space was dilated, the forceps was withdrawn and opened as spaced-out, and the subcutaneous tissues and the skin were appropriately dilated. The tracheostomy cannula was placed into the trachea over the guidewire. In cases where FOB was used, the first entry of the needle into the trachea, the advancement of the guidewire and the placement of the tracheostomy cannula could be evaluated. A breathing circuit was connected to the tracheostomy cannula, and the respiratory sounds of the patient were listened and checked. The procedure was concluded by confirming that the cannula was in the trachea. The demographic data, hospitalization indications, tracheostomy opening times, duration of procedure, body mass index (BMI), use of LS or FOB and their corresponding data, the complications during the procedure and within the first 24 hours (incorrect placement of the cannula, ETT cuff perforation, desaturation, surgical bleeding, subcutaneous emphysema and pneumothorax) of the patients were scanned from the file records and recorded.

Statistical Analysis

For statistical analysis, frequency and percentage were used for categorical data, and median (min-max) values were used for continuous data. Due to the small numbers, the Mann-Whitney U test was used non-parametrically for the analysis of continuous data. In categorical data, Chi-squared tests and Fisher's exact test were used with 4-cell tables. The $p<0.005$ model was used for significance in all tests.

RESULTS

52 patients were included in the study. The median age was 71.9 (27-96). No significant difference was detected between the demographic data of the patients. The relevant data are given in table 1. The tracheostomy opening time in the patients included in the study: within the first 7 days in 1 (1.9%), 8 to 20 days in 42 (80.7%) and after 21 days in 9 (17.3%).

The data obtained for the use of LS and FOB in the study are given in table 2.

When evaluated in terms of venous bleeding, the number of patients with a bleeding amount >5 mL was 12 (LS:4, FOB:3, no auxiliary method: 5). There was no significant difference between gender and venous bleeding and perforation. Various complications of the procedure are given in table 3.

In 2 (3.8%) of the patients, bleeding from the incision line was observed within the first five days following the procedure, which were stopped by applying simple printed wound dressing.

During the tracheostomy procedures performed, arterial bleeding, bronchospasm, hypotension, atelectasis, pneumothorax, pneumomediastinum, cardiac arrest or any complication requiring surgery was not detected. Two cases with subcutaneous emphysema consisted of one patient with the use of LS and one with no auxiliary method. These reactions were in the form of local emphysema. They were not common and had no change on the patient's clinic.

A comparison of the possible complications in PDT procedure and the factors affecting them is given in table 4.

When PDT was opened, the day of intubation (median) was 21.5 (20-23) in patients with hypotension and 17 (6-28) in patients without hypotension (p=0.012, Mann-Whitney U).

The PDT procedure duration (median) was 27 (14-45) min in patients with venous bleeding >5 mL and 20 (10-45) min in those without venous bleeding >5 mL (p=0.012, Mann-Whitney U).

Table 1. Demographic and process data of patients

Age (years)		71.9±12.2
Gender (M / F)		27/25 (51.9%/48.1%)
Intubation Time (days)		17.03 ±4.18
Processing Time (min)		21.23±8.45
Number of attempts	=1	36 (69.2%)
	2	12 (23.1%)
	3	2 (3.8%)
	4	2 (3.8%)
BMI	20-25	12 (23.1%)
	25-30	32 (61.5%)
	30-35	5 (9.6%)
	>35	3 (5.8%)

Values; presented as mean ± standard deviation, number (%)
BMI: Body Mass Index

Table 2. Various data of Light Style and FOB use

Light Style Usage	21 (39.6%)
FOB Usage	12 (22.6%)
Light Style or FOB not used	19 (35.8%)
Translumination Significance	26 (74.3%)
Location of tracheotomy detected by palpation, displacement after Light Style or FOB use	17 (42.5%)
Easy procedure rate due to Illuminated Stile or FOB use	26 (74.3%)

Values; presented as number (%)
FOB: Fiber Optic Bronchoscope

Table 3. Various complications of processing

	Light Style	FOB	Without using auxiliary method	All
Bleeding (>5 mL)	4 (19%)	3 (25%)	5 (%26.3)	12 (23.1%)
Desaturation (SpO_2<90)	2 (9.5%)	5 (41.7%)	2 (%10.5)	9 (17.3%)
ETT Cuff Perforation Rate	2 (9.5%)α	3 (25%)	9 (47.4%) β	14 (26.9%)
Tracheotomy Tube Malposition Rate	1 (4.8%)	0	2 (10.5%)	3 (5.8%)
Hipotension	0	2 (16.7%)	2 (10.5%)	4 (7.7%)
Subcutaneous Emphysema	1 (4.8%)	0	1 (5.3%)	2(3.8%)

Values; presented as number (%). P <0.005 was considered significant
α: ETT cuff perforation was lower in the group with light style compared to the other groups (p=0.044)
β: ETT cuff perforation is higher in non-auxiliary methods than in auxiliary methods (Light Style or FOB) (P=0.028)
FOB: Fiberoptic Bronchoscopy

Table 4. Various complications and factors affecting the procedure

	Desaturation (SpO_2<90)			ETT Cuff Perforation			Hipotension			Venous Bleeding		
	Yes	No	P	Yes	No	P	Yes	No	P	Yes	No	P
Age (years)	69 (27-85)	69 (46-69)	0.242	71.5 (27-96)	69 (34-94)	0.734	65 (34-74)	69 (27-96)	0.120	71.5 (27-96)	69 (34-94)	0.788
Processing Time (min)	20 (12-35)	20 (10-45)	0.783	21 (12-45)	20 (10-45)	0.441	29.5 (12-35)	20 (10-45)	0.240	27 (14-45)	20 (10-45)	<0.001
Intubation Time (days)	14 (6-24)	17 (8-28)	0.560	17 (6-24)	17 (8-28)	0.446	21.5 (20-23)	17 (6-28)	0.012	15.5 (6-27)	17 (8-28)	0.327
Number of Attempts	1 (1-3)	1 (1-3)	0.788	1 (1-3)	1 (1-3)	0.508	1.5 (1-2)	1 (1-3)	0.498	1.5 (1-3)	1 (1-3)	0.077

Values are presented as median (min-max). P <0.005 was considered significant
ETT: Endo Tracheal Tube

DISCUSSION

In previous studies, PDT has been preferred more in ICU compared to ST due to its lower wound site infection, applicability at the bedside and lower cost, easier and shorter procedure, faster healing with smaller incision line, less bleeding and less perioperative complications and because it is a less traumatic procedure (4,12,13). PDT is preferred as it has less traumatic mediastinitis related to tracheostomy and due to the long-term intensive care unit stay and associated nosocomial infection in cardiothoracic patients and in patients with head trauma and neurological problems (14).

The selection of different methods such as single-stage or progressive dilatation according to the number and type of tracheal dilatation in PDT depends on the patient's clinic, the experience of the clinician and the possibilities available to him/her (15,16). While there are different opinions (3) on single-stage dilatation (Griggs), it is more preferred because it is fast, reliable, simple and easy to apply and has a high success rate (17-19).

PDT with the help of FOB has become popular in recent years, it is useful in detecting the midline and protecting the posterior wall from damage during infiltration as the trachea can be monitored, and the possibility of incorrect placement of the tracheostomy cannula is decreased. However, hypoxia and hypercarbia susceptibility and the possibility of accidental extubation are increased as ventilation is deteriorated with FOB. Intraoperative desaturation ranges between 8.2-13.3% depending on the use of FOB. (20-23).

LS is a tool used in endotracheal intubation that increases the chance of intubation, especially in cases of anatomically difficult airway or cervical trauma (24). When it is advanced through the ETT, the site of infiltration is confirmed by obtaining light translumination at the anterior wall of the neck. The surrounding cartilage and vascular structures can be determined again with the help of light translumination. The use of LS in PDT is effective, cheap and easy to apply. In addition, LS has been reported to be an auxiliary tool that protects against undesired complications such as cuff tube perforation and oxygenation deterioration. However, there are also studies reporting high perioperative complication rates, especially since it is a blind technique compared to CT (25).

In previous studies, PDT application time on intensive care patients ranged from 9.9 to 17.64 days (10,26). Most PDT procedures are performed within the first two weeks (10, 26, and 27). PDT opening time was found to be 8.65± 5.97 in a study with a mean age of 55.9±19.5 (10), while it was found to be 17.64±6.61 in another study (26) with a mean age of 69.8±1. In our study, the mean age and PDT opening time were found to be similar to those of the studies with similar age means (26). We think that the late times of performing the procedure in our study (8-20 days in 80.7%) compared to the literature were due to the high mean age of the patient population and the fact that the relatives of the patients were difficult to convince as they were reluctant to tracheostomy due to socio-cultural reasons.

The procedure duration in previous studies on PDT varied between 5.4-20.1 min (28,29). In their study where they evaluated the data of 622 patients, Young et al. (18) found that the procedure duration was 30 min (20-40 min) in patients who underwent PDT without the use of additional methods, 14.2-18 min(20, 30) in those with the use of FOB and 17.8±5.3 min in those with the use of LS (25). In our study, PDT duration was 20.57 min in the LS group, 22.25 min in the FOB group and 22.23 min in the no additional method group. We think that longer procedure durations in methodology compared to similar studies are due to the consideration of the procedure duration as the process when the skin incision was started to be ventilated from the tracheostomy cannula, due to the use of auxiliary equipment such as LS and FOB during the procedure and due to the fact that there was only one specialist physician assisting the practitioner.

In PDT, the most common early complication is bleeding with an incidence varying between 0-20 %(10). In the study of Kırca et al. with no additional methods, the most common early complication was reported to be bleeding with an incidence of 2.9%. In the PTD procedure of Song et al. (20) by using FOB, intraoperative bleeding was found to be 12.0±5.2 mL in the non-obese group (BMI<28) and 16.8±4.3 mL in the obese group (BMI>28). In the study of Diaz-Reganon et al. (31), this rate was found to be 1.6%. In the study of La Scienya et al. (32) on 266 patients, they found bleeding to be similar between the groups with and without the use of FOB (3%-4%). The results are different as there is no common evaluation on bleeding in the literature. In our study, >5 mL of bleeding was evaluated as a complication, and was present in 12 patients (23.1%). We think that the fact our results were higher compared to the literature was due to our evaluation of the amount of bleeding on a larger scale.

In our study, the procedure duration was found to be longer in the group with intraoperative bleeding ($p<0.001$). In cases where the procedure is complicated or difficult, higher bleeding is expected as more time will be spent. In our study, we observed bleeding in 2 patients (3.8%) in the early postoperative period (first 1 week), in parallel with the literature (4).

In the study of Song et al.(20), the number of successful attempts at the first try was found to be 75.3% in the non-obese group with FOP and 26.7% in the obese group (BMI>28). In our study, the number of successful attempts at the first try was found to be 69.2%. In the retrospective study of Dempsey et al. (19) on 576 patients undergoing PDT, the number of successful attempts at the first two tries was found to be 90%. In our study, this rate was found to be 92.3%, similar to the literature.

In the study of Ravi et al. (30) on 36 patients undergoing PDT using FOB, ETT cuff perforation was found to be

22.2%. In our study, the rate of ETT cuff perforation was found to be 25% in the FOB group, similar with the above-mentioned study. In our study, the rate of ETT cuff perforation was in parallel with the literature (25). It was found to be lower in the LS group (9.5%) compared to the other groups (25%, 47%) (p=0.044). Cuff perforation rate was found to be higher in those with an additional method (LS or FOB) compared to those with none (p=0.028).

Another complication in patients undergoing tracheostomy is hemodynamic impairment. In the study of Lee et al.(33) where they compared the PDTs performed early (first 48 hours) and late (14th-16th day) in 120 patients, they found positive effects of early application of PDT on mortality and morbidity. In our study, the day of intubation when the PDT was opened in patients with hypotension was longer than in those without hypotension (21.5 days/17 days). We think that this is due to increased general condition deterioration and hemodynamic instability in patients who did not undergo tracheostomy opening (due to infection, hematological problems and cerebrovascular events) or for whom no decision could be made.

In the study of Kollig et al. (22) on 72 patients using USG and FOB, the incision site detected by palpation for tracheostomy was reported to be changed in 23.6% of the cases with the use of USG and FOB. In our study, the procedure site was observed to be changed during the application in 17% of the cases due to the use of LS and FOB.

Bleeding that requires open surgical intervention, suture or cauterization may occur due to PDT (10). We think that the absence of these complications in our study was due to the fact that PDT procedure was performed under elective conditions, most procedures were performed under the guidance of LS or FOB, auxiliary tools were used and venous vessels in the subcutaneous region were noticed and possible trauma was avoided due to the inclusion of subcutaneous and fascia in skin incision. We suggest that large-scale bleedings can be prevented by the use of auxiliary tools and the advancement of the dissection line after skin incision but that the disadvantage of prolongation of the procedure also occurs.

Pneumothorax in PDT with the Griggs method can be 0-3% (1). In our study, posterior wall injury, tracheoinnominate artery fistula, hemothorax, pneumothorax and death were not observed in any of our patients. Only in two patients, subcutaneous emphysema occurred due to air intake between the tissues during the dilatation of the lumen during the procedure.

The study had limiting aspects such as the fact that the complication rates could not be determined clearly as there was a need for a larger number of patients for the rare complications and the fact that a patient classification according to BMI was not established.

CONCLUSION

Auxiliary methods such as LS and FOB in PDT; It does not make any difference in terms of complication and it facilitates the verification of incision site. In order to perform the tracheostomy safely, we believe that the physician may choose one of the two methods.

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