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Harmonious Team Approach for Safe Airway Management -The Keio University Experience-

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Abstract

Surgical Tracheostomy (ST) has been a standard procedure for surgical airway management for a long time. Recently, Percutaneous Dilatational Tracheostomy (PDT) is getting more and more popular in the US and Europe in this field. In Japan, PDT is becoming well-known following the trend in other countries mainly due to its relatively easy procedure even for non-surgeons to secure the airway. However, part of the multidisciplinary participants in preparing/performing tracheostomy and postoperative care do not have opportunities to understand the (contra) indications of PDT, or to precisely learn the technical difference between ST and PDT. Furthermore, instruction for use is hard to be strictly followed in diverse situations to potentially induce multiple accidents.

In our institution, PDT was adopted under the collaboration between anesthesiologists and otolaryngologists in January 2008. However, at that time, responsibilities and roles of every participant engaged in the tracheostomy were not clarified, while multiple responsible decisions were necessary for harmonious procedure, e.g. necessity of tracheostomy for the candidate, timing to perform the procedure, selection of proper surgical procedure, and the place where the tracheostomy should be performed. Considering such a muddled situation, we organized a committee consisted of surgeons, anesthesiologists, nurses and administrative organizers to comprehend the recent complicated situations surrounding tracheostomy. The final purpose of organizing the committee was to build a unique intramural rule to prepare and perform elective tracheostomy safely and harmoniously.

In this communication, multiple issues to produce the present confused situation for harmonious elective tracheostomy are summarized. We show our current intramural protocol for elective tracheostomy, delivered in July 2010, which clarifies the sequential role and responsibility of every multidisciplinary participant at each indispensable decision for safe procedure. Furthermore, current practice of tracheostomy in our institution, especially in the intensive care unit, was assessed.

Keywords: Tracheostomy; Percutaneous dilatational tracheostomy; Multidisciplinary teams' approach; Airway management; Protocol

Introduction

Tracheostomy is a common surgical procedure to secure the airway in critically ill patients. Surgical Tracheostomy (ST) has long been the gold standard tracheostomy procedure since Jackson first standardized the technique in 1909 [1]. Shelden et al. [2] described Percutaneous Dilatational Tracheostomy (PDT) concept in 1955 to simplify the tracheostomy procedure. In 1985, Ciaglia et al. [3] introduced an epoch-making PDT method using the relatively easy Seldinger technique to introduce the serial dilators and a tracheostomy tube into the trachea. The Griggs Guidewire Dilating Forceps (GWDF) technique, introduced in 1990, was based on an idea to enlarge a small tracheal aperture with a guidewire-dilating forceps especially manufactured for this technique [4]. In 1998, a modification of Ciaglia technique which utilizes a single sharply tapered dilator was introduced (Ciaglia Blue Rhino Percutaneous Tracheostomy Introducer Kit, Cook Critical Care Inc., Bloomington, IN). The Ciaglia Blue Rhino (CBR) technique allowed the complete dilation of the stoma in one step [5]. Recently, a meta-analysis study showed the superiority of the CBR technique in terms of safety and success rate among multiple PDT techniques [6]. Multiple studies have proved the advantages of PDT compared with ST [7-10], and PDT is gaining popularity as a procedure to secure the airway especially in the Intensive Care Units (ICUs) worldwide [11, 12]. In Japan, PDT is becoming a well-known procedure following the trend in other countries. In our institution, the CBR technique was adopted under the collaboration between anesthesiologists and otolaryngologists in 2008. Firstly, sequential multiple decisions are necessary for the successful tracheostomy by a team consisted of multidisciplinary participants. Additionally, PDT's entry into the airway management field allowed the non-surgeons to perform the tracheostomy using the Seldinger technique, as long as the indications and contraindications of the procedure were strictly followed. Thus, at this point, the role and responsibility of each participant engaged in the tracheostomy became complicated in order to accomplish safe and harmonious procedure [13]. Although, only anesthesiologists were the non-surgically trained members of the airway management team to perform PDT in our institution, it had not been clarified who was responsible for each step and who was to make specific decisions among sequential responsible decisions required for successful tracheostomy. We organized a committee to comprehend such recent complicated situations surrounding tracheostomy and to build a multidisciplinary collaborative system with unequivocal rules for safe and smooth elective tracheostomy. Our original intramural protocol for successful tracheostomy was delivered in 2010. Our protocol clarified

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the respective roles and responsibilities of each multidisciplinary participant at each of the respective indispensable decisions. In this communication, our intramural protocol for tracheostomy is shown expecting to be one practical reference for the ideal system in the future. At present, PDT is routinely performed in our institution as the first choice tracheostomy procedure for adult patient receiving long-term mechanical ventilation in the ICU. Current practice of tracheostomy in our institution, especially in the ICU, was further assessed to speculate the validity of our current tracheostomy protocol in this report.

Our Multidisciplinary Protocol for Safe and Harmonious Tracheostomy

In our institution, anesthesiologists invited us to observe them from the airway surgeon's point of view on adopting the PDT procedure in the ICU. Anesthesiologists preferred and desired to adopt the CBR technique as they were familiar with the Seldinger technique, and our collaborative approach to the PDT started in January 2008. During the first 3 months period, otolaryngologists performed PDT as experienced airway surgeons, while anesthesiologists assisted the procedure by performing the bronchoscopy. During this training period, anesthesiologists learned the PDT technique as well as the internal anatomy of the subglottic-tracheal region as an important knowledge for safe PDT procedure [13]. Since April 2008, anesthesiologists started to perform PDT by themselves at the bedside in the ICU. At present, PDT is routinely performed by anesthesiologists in our institution and considered the first choice tracheostomy procedure for adult patient receiving long-term mechanical ventilation in the ICU. Our collaboration has been providing the on-site or on-call otolaryngologist available on each PDT case as needed.

While adopting the CBR technique under cooperation of two departments, we organized a committee consisted of airway surgeons, anesthesiologists, nurses and administrative organizers to build an original, multidisciplinary collaborative system with unequivocal rules for safe and smooth elective tracheostomy. As airway surgeons, a thoracic surgeon and an otolaryngologist (KS in this manuscript) were incorporated.

One GWDF PDT kit (Portex® Percutaneous Tracheostomy Kit, Smiths Medical Japan Ltd., Tokyo, Japan), and three CBR PDT kits (Ciaglia Blue Rhino® G2 Advanced Percutaneous Tracheostomy Introducer Set, Cook Japan Inc., Tokyo, Japan; Neo Perc™ Percutaneous Tracheostomy Kit, Covidien Japan Inc., Tokyo, Japan; Portex® ULTRAperc® Single Stage Dilator Technique Kit, Smiths Medical Japan Ltd.) are currently available in Japan. To comprehend the recent complicated situation surrounding tracheostomy and to understand the details of newly adopted PDT technique, we first read and compared the instructions for use (IFU) package inserts of these PDT kits thoroughly. It has been emphasized that PDT could be a safe method of choice for performing elective tracheostomy in the appropriately selected patients receiving mechanical ventilation [7-9]. However, several contraindications for PDT performance provided in the IFU package inserts of four PDT kits were not shared among all of these kits as absolute contraindications to possibly cause confusions and raise the related morbidity. In other words, several conditions were considered as absolute contraindications in some PDT kits, while IFU package inserts of other PDT kits not mentioned these conditions or rated these conditions as relative contraindications. While shared absolute contraindications included 1) emergency case, 2) inability to palpate the cricoid cartilage, 3) pediatric patients, 4) active cervical infection, and 5) presence of a midline neck mass, the following conditions were not mentioned as absolute contraindications in all of the four PDT kits available in Japan. These confusing contraindications included 6) thyroid hypertrophy, 7) coagulopathy, 8) difficult airway (patients with difficult tracheal intubation), 9) unprotected airway (patients not intubated), 10) patients requiring high PEEP, 11) inability to extend the neck, 12) previous surgery in the neck/tracheal area, and 13) deformity of the neck/tracheal area. Additionally, detailed description of the proper environment for PDT to prefer the performance in the ICU or OR under control of critical care specialists was observed in the IFUs supplied by Smiths Medical Japan Ltd. (Portex® Percutaneous Tracheostomy Kit; Portex® ULTRAperc® Single Stage Dilator Technique Kit). Intraoperative visual support by bronchoscopy was recommended, but not mentioned, as mandatory in all of the available IFU package inserts. To perform the newly adopted PDT procedure with minimal risk, the committee decided to consider all the possible contraindications as absolute contraindications in our institution. Furthermore, the committee decided that PDT should be performed only in the ICU or OR under the bronchoscopic visual guidance. The committee preferred to perform ST in the OR rather than to perform in the ward in consideration of the quick access to the required resources and critical care specialists. Intramural unified Informed Consent (IC) form of the tracheostomy was revised to include PDT as a surgical option additional to ST. The IC form clearly mentioned that the procedure might be shifted from PDT to ST as needed during surgical procedure.

As we have mentioned before [13], sequential responsible decisions are necessary for the success of cooperative tracheostomy by multidisciplinary participants. When there is a candidate for tracheostomy, the necessity of the procedure is the first topic to be determined. Subsequently, the timing to perform the tracheostomy is determined, and in case of emergency, ST is performed immediately. In an elective case, subsequent decisions include the selection of the proper procedure (ST or PDT) and place (ICU, OR, or ward) to perform tracheostomy for the patient. It is necessary to clarify the respective roles and responsibilities of each multidisciplinary participant at each indispensable decision necessary for safe and harmonious tracheostomy. Our original intramural protocol for tracheostomy was established July 2010. This protocol is summarized in Figure 1. This protocol was established mainly for elective cases, and in emergency cases, this chart could be modified to meet the situations. In every case, multidisciplinary teams consist of attending physicians, airway surgeons (mainly otolaryngologists in our institution), anesthesiologists, and nurses. Sequential decisions and "respective roles" of *each participant* were clarified as follows (Figure 1).

1) When there arises a candidate for tracheostomy, *attending physicians* and *airway surgeons* are responsible to "determine the necessity of tracheostomy". *Anesthesiologists* "cooperate with them to make a better decision as needed".

2) Once the tracheostomy performance is decided, *attending physicians* take the responsibility to explain the necessity of tracheostomy to the patient and the persons concerned to "acquire the informed consent regarding the necessity of the procedure". At the same time, *anesthesiologists* receive the mandatory notification of the tracheostomy performance from the airway surgeons and "join the team as critical care specialists".

3) *Airway surgeons* and *anesthesiologists* take the subsequent responsibility to "decide the timing of the procedure (elective or immediate)". In emergency cases, ST is performed immediately

by airway surgeons with the modification of the following steps to secure the patient's life.

4) In elective cases, *airway surgeons* and *anesthesiologists* "determine the proper method of tracheostomy (ST or PDT)".

5) *Airway surgeons* and *anesthesiologists* further take the responsibility to "determine the place to perform the procedure (ICU, OR, or ward)".

6) *Nurses* are responsible to "prepare the resources and environments" to perform safe and smooth surgical procedure.

7) At this point, *either airway surgeons or anesthesiologists who are to perform the procedure* explain the surgical procedure and potential risks to the patient and the persons concerned to "acquire the informed consent regarding the surgical performance". As PDT is the first choice tracheostomy procedure for the patient receiving long-term mechanical ventilation in the ICU, "PDT is mostly performed in the ICU" by *anesthesiologists* at the bedside. *Airway surgeons* "perform ST on most of the residual cases in the OR" with the potential PDT performance in the OR.

8) *Airway surgeons* and *anesthesiologists* "cooperate with each other during the procedure either in a PDT case or in a ST case". In all PDT cases, a surgical tracheostomy tray and on-site or on-call otolaryngologist are available in the event that conversion to open tracheostomy is necessary.

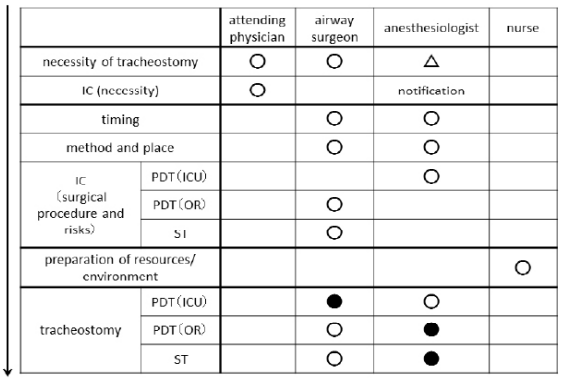

Figure 1: Our current intramural protocol for tracheostomy is shown. Sequential indispensable decisions and events are shown in order from the top to the bottom in the left columns. The multidisciplinary team consists of attending physicians, airway surgeons (mainly otolaryngologists in our institution), anesthesiologists, and nurses. The roles and responsibilities of each participant are clarified for each step. If necessary, anesthesiologists are invited to join the discussion to decide the necessity of the tracheostomy for the patient. Once the tracheostomy performance is decided, it is mandatory for the airway surgeons to notify the anesthesiologists of the tracheostomy performance. At this point, anesthesiologists join the team as critical care specialists. Circle, Member(s) to take the responsibility for each step; Filled circle, Member(s) to back up the responsible member(s) at each step; Triangle, Member(s) to join the discussion as needed.

IC: Informed consent; ICU: Intensive care unit; OR: Operating room.

Our Current Practice of Tracheostomy

Based on the retrospective chart review, current practice of tracheostomy in our institution, especially in the ICU was assessed to speculate the validity of our current protocol. Fifty-seven consecutive patients who underwent elective tracheostomy from April 2012 to September 2013 were incorporated in this assessment. Of these, 7 patients (2 boys and 5 girls) were under 15 y.o. and these pediatric cases were excluded from this assessment to focus on the elective adult tracheostomies. Of the residual 50 adult patients (30 males and 20 females; mean age, 67.8 y.o.; range, 31-95 y.o.), 39 patients were ICU cases (23 males and 16 females; mean age, 67.7 y.o.; range, 31-88 y.o.). Choice of procedure was reviewed, and the delay from the decision to perform a tracheostomy to the procedure being performed (waiting period), and perioperative complications were compared between ST group and PDT group in all the cases. Subgroup analyses were further performed on the ICU cases. In our institution, currently, the first choice tracheostomy procedure for the intubated patient in the ICU is PDT, while most of the other patients underwent ST in our institution as a teaching hospital for airway surgeons. However, some of the patients in the ICU underwent ST and the conditions being contraindications for PDT in these patients were assessed. Furthermore, the waiting period, duration of intubation, and ICU stay after tracheostomy were compared between ST group and PDT group. The results are summarized in Tables 1 and 2. Statistical analyses were performed using Mann-Whitney U test, and the significant level was set at $p<0.05$. All PDT

Procedure	Cases Sex; Age	Waiting Period* Average ± SD; Range (Days)	Perioperative Complications
ST	M, 17; F, 11; 31-95 y.o. (mean, 68.4 y.o)	4.0 ± 4.1; 0-14	1**
PDT	M, 13; F, 9; 43-88 y.o. (Mean 67.2 y.o.)	2.6 ± 1.6; 1-7	0

M: Male; F: Female; *: Delay from the decision to perform a tracheostomy to the procedure being performed; **: Bleeding required local suture

Table 1: Fifty consecutive patients who underwent elective tracheostomy from April 2012 to September 2013.

Procedure	Cases Sex; Age	Waiting Period* Mean ± SD; Range (Days)	Endotracheal Intubation Before Tracheostomy Mean ± SD; Range (Days)	ICU Stay After Tracheostomy Mean ± SD; Range (Days)	Conditions Being Contraindications For PDT
ST	M, 10; F, 7; 31-87 y.o. (Mean 68.4 y.o.)	2.4 ± 2.8; 0-9	8.3 ± 4.6; 0-15; n=14**	5.3 ± 3.3; 2-13; n=15***	coagulopathy, 6; previous surgery in the neck, 4; no intubation, 3; inability to palpate the cricoid cartilage, 2; thyroid hypertrophy, 1; other****, 1
PDT	M, 13; F, 9; 43-88 y.o. (Mean 67.2 y.o.)	2.6 ± 1.6; 1-7	8.6 ± 3.3; 2-14	6.0 ± 4.6; 1-18	n.a

M: Male; F: Female; *: Delay from the decision to perform a tracheostomy to the procedure being performed; **:As shown in the right panel, 3 patients were not intubated at the tracheostomy, and 14 patients were incorporated in this group; ***: Two patients died during ICU stay after tracheostomy, and 15 patients were incorporated in this group; ****: Serious heart failure which required circulation control with OR resources during surgery

Table 2: ICU patients who underwent elective tracheostomy.

procedures were performed at the bedside in the ICU using the CBR kit (Neo Perc™ Percutaneous Tracheostomy Kit, Covidien Japan Inc.), while all ST procedures were performed in the OR. There was a trend that ST need shorter waiting period compared with PDT, however, the difference was not statistically significant (ST, 4.0 ± 4.1 days; PDT, 2.6 ± 1.6 days; p=0.70). One patient in the ST group required local suture to control the bleeding from the muscle in the anterior neck, however, no perioperative complication was observed in the PDT group (Table 1). Values of the waiting period (ST, 2.4 ± 2.8 days; PDT, 2.6 ± 1.6 days; p=0.27), endotracheal intubation before tracheostomy (ST, 8.3 ± 4.6 days; PDT, 8.6 ± 3.3 days; p=0.95), and ICU stay after tracheostomy (ST, 5.3 ± 3.3 days; PDT, 6.0 ± 4.6 days; p=0.89), were similar when ST group and PDT group were compared with each other in the ICU patients. Two patients died during ICU stay because of their original diseases (1 patient suffered upper mesentery arterial thrombosis and the other suffered end-stage lung cancer), and ICU stay after tracheostomy was assessed in the residual 15 patients. Conditions being contraindicative for PDT consisted of coagulopathy (n=6), previous surgery in the neck (n=4), no intubation (n=3), inability to palpate the cricoid cartilage (n=2), thyroid hypertrophy (n=1), and serious heart failure to require careful circulation control with OR resources during surgery (n=1) (Table 2).

Discussion

Following multiple Randomized Clinical Trials (RCTs) comparing ST and PDT to define the superior procedure with respect to both resource use and morbidity, several meta-analyses of these RCTs have been performed [7-10]. These reports supported the idea to favor PDT in terms of perioperative bleeding, intraoperative drop of oxygen saturation level, operative time, wound infection, unfavorable scarring, waiting period, and costs [7-10]. As a result, combined with its relative technical ease, PDT is the favored tracheostomy technique for an adult intubated patient, especially in the ICUs worldwide [11,12].

On the other hand, advantages of performing PDT by collaborative multidisciplinary teams have been reported by Polderman et al. [14] and Blankenship et al. [15]. Their teams consisted of otolaryngologists, and either intensivists or pulmonary/critical care specialists. Their systems enabled the professional anesthesia support and airway management accompanied by an intensivist or anesthesiologist with a smooth conversion to ST as needed by a backup otolaryngologist. The main structure of their multidisciplinary team is similar to the members of our system, whereas our system incorporated attending physicians and nurses, as well as anesthesiologists and airway surgeons. Our protocol further clarified the respective roles and responsibilities of each multidisciplinary participant at each of the sequential indispensable decisions.

Although there was a trend that PDT patients have shorter waiting period compared with ST patients, the difference was not statistically significant in our current practice of tracheostomy. Furthermore, no perioperative complication was observed in the PDT group. Subgroup analysis of ICU patients showed no difference between ST and PDT in terms of waiting period, endotracheal intubation before tracheostomy, and ICU stay after tracheostomy. Partially due to the PDT performance at the bedside without OR scheduling, shorter waiting period prior to the performance, and shorter endotracheal intubation before procedure in the PDT group, have been reported when compared with the ST group [9,10]. Furthermore, early tracheostomy has been reported to reduce the duration of artificial ventilation and length of stay in the ICU [16]. Different from the previous RCTs comparing ST and PDT, most of the STs were performed on the patients with serious complications being contraindications for PDT performance (n=14, 82 %) in our recent ICU practice. Residual ST patients were not intubated at the performance (n=3, 17 %). All PDT procedures were performed at the bedside and all ST procedures were performed in the OR. However, ST patients (2.4 ± 2.8 days) were not required the longer waiting period compared with PDT patients (2.6 ± 1.6 days). Thus, no difference was observed in terms of endotracheal intubation before tracheostomy and ICU stay after tracheostomy. These results suggest the potential of our protocol to assist the collaboration of multidisciplinary teams to complete the smooth tracheostomy without time-consuming OR scheduling even on the patients with serious complications. In our recent practice, perioperative complication was not observed in the PDT group, while one patient in the ST group suffered wound bleeding to require local suture. These results may support the idea that our choice of tracheostomy procedure strictly followed the (contra)indications of PDT to minimize perioperative morbidity. Although there may remain a potential for PDT to be an effective alternative procedure in challenging cases such as children [17] and trauma patients with difficult airways [18], it could never be overemphasized, at present, that PDT could be a safe method of choice for performing elective tracheostomy in the appropriately selected adult patients receiving mechanical ventilation [7-9]. In our recent ICU practice, there was one patient in the ST group who suffered serious heart failure which required circulation control with OR resources during surgery. PDT might not have been a contraindication procedure for this patient with a normal-size neck; however, the team preferred ST owing to the practical ST experiences of airway surgeons involved in the particular case.

It should be noted that false passage of a tracheostomy tube trends toward favoring ST [10]. To reduce the overall complication rate related to PDT [19], bronchoscopic visual guidance was determined as mandatory for PDT performance in our protocol. As we have reported before [13], intraoperative bronchoscopy enables the clear visualization of the subglottic-tracheal lesion including the subglottic bulge in the anterior wall as an anatomical landmark representing the lower edge of the cricoid to the first tracheal ring. Additionally, decannulation/obstruction of the tracheostomy tube were reported to be more likely to occur in the PDT group compared with the ST group, partially related to the less frequent use of a tracheostomy tube with an inner and outer cannula that facilitates nursing [10]. In the UK, more than half of the ICUs routinely use tracheostomy tubes with inner liners [12]. Considering these situations, revision of the current protocol is underway to define the proper tracheostomy tube either for ST or PDT in our institution. Although several revisions might be necessary after assessment of long-term outcomes [9, 10], our current system could be one of the practical references to build an ideal collaborative multidisciplinary team for successful airway management in the future.

Conclusions

PDT's entry into the airway management field allowed the non-surgeons to perform the tracheostomy in selected cases, and the cooperative multidisciplinary teams' approach is indispensable for successful tracheostomy at present. We have established an original tracheostomy protocol to clarify the respective role and responsibility of each participant at each of the sequential decisions required for smooth procedure with minimal risk. We believe our current protocol could be one practical reference as a system to enable the safe and harmonious multidisciplinary airway management. Future assessments and revisions of our current protocol are warranted.

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