Early Complications of Tracheostomy

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Complications from surgical procedures are common and must be taken into account when assessing the risks and benefits of a particular treatment approach. Common acute risks of tracheostomy include bleeding, airway loss, damage to adjacent structures, and failure of the chosen technique to achieve successful airway placement. The frequency and severity of these occurrences depends on several factors. These include the specific approach to tracheostomy, the skill and experience of the operator, and patient anatomic and physiologic factors. The incidence of undesired outcomes during tracheostomy cannot be exactly predicted because of the interaction of the above issues. This paper will consider some of the common and less common acute complications of several of the usual techniques for temporary tracheostomy placement in critically ill patient. *Key words: tracheostomy; complications; technique, surgical; hemorrhage; airway, artificial; airway obstruction.* [Respir Care 2005;50(4):511–515. © 2005 Daedalus Enterprises]

Introduction

Critically ill patients often receive tracheostomy for continued airway support. The decision to place a tracheostomy should be made by considering the balance between benefits versus risks of the procedure. In addition, this decision should consider the risks of *not* placing the surgical airway and of continuing translaryngeal intubation or attempting extubation in a marginal situation. Most of the risks and benefits are not precisely known for any particular surgical technique and in most clinical situations. Thus, deciding when and if to perform a tracheostomy in any particular patient is an individual decision and should be approached as such. Probably the best understood factors that should be taken into account are the acute risks of tracheostomy, and some of these will be discussed in this paper.

There are basically 2 approaches to tracheostomy: open surgical tracheostomy (ST) and percutaneous dilational tracheostomy (PDT). Most reported literature compares these 2 techniques, and much of our understanding of risks of tracheostomy is based on this dichotomy. However, these comparisons are often flawed, because patients are not prospectively matched and then randomized to receive one or the other type of procedure. In general, more difficult patients are usually given the "standard" treatment (ie, ST). Other factors to keep in mind include the fact that with any technical procedure the level of experience of the person performing the procedure will influence the out-

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come and risk. It is difficult to perform comparisons of techniques of tracheostomy, even if done by the same individuals, since experience (and preference) will be different for each of the treatment arms. Another problem in comparing techniques of tracheostomy is that the patients cannot be blinded, since the tracheostomy placement looks different. Another concern with the literature comparing tracheostomy techniques is that there is a wide variety of more or less "different" techniques of both ST and PDT, and from the published report it is often difficult to identify the exact details of the techniques that were compared. Also, specific medical specialties have allied with specific techniques for performing tracheostomy and have a vested interest in promoting their particular methods. Thus, bias is common in studies of tracheostomy.

One of the biggest impediments to understanding differences in risks between ST and PDT is the lack of standardization of the definition of what is a particular outcome or risk. For example, some reports suggest that bleeding is more common with PDT than with ST, but when examined closely, the threshold for diagnosis of "bleeding" was different between the 2 techniques. Reports that include differences in dichotomous variables whose definitions are explicitly listed (eg, alive or dead, bleeding needing transfusion) give more usable information about the differences.

With these limitations in mind, this paper will consider what can be generalized about differences in acute risks between ST and PDT. In some reports, very specific different modifications of the PDT technique are compared to each other.

Definition of Risks

There are no common standard definitions of risks and complications associated with tracheostomy. In addition to "medical" complications, some authors report "efficiency" measures (ie, time it takes to perform the procedure) and "costs" to compare different techniques. While analysis of these measures are beyond the scope of this paper, a word of caution is in order. The time for the procedure can be calculated in a number of ways, and could include preparation time, transportation time, equipment setup time, recovery time for anesthesia or sedation, as well as operator time. Small differences may be significant statistically but are meaningless clinically when all factors affecting efficiency are considered. These many factors are often unique to an institution and direct application of published data are not helpful.

Similar concerns apply to costs. Purchase prices vary considerable from institution to institution, as well as in the market, which changes daily. Institutional charges are often unrelated to costs. Personnel costs and time are rarely directly captured or reported. Physician and other professionals' fees are also unrelated to reimbursement, as rates are usually set by contract or payer. Any claim about a cost benefit of one tracheostomy technique over another should be ignored, although the factors used to make the claim should be considered and evaluated.

Controlled, Randomized, Prospective Comparisons

With the above concerns in mind, the available literature elucidating early complications of tracheostomy will be reviewed. One of the most informative comparisons of the complications of PDT and ST was reported by Massick et al.[1] They performed a controlled, randomized, prospective trial comparing ST with PDT. In this study, patients were randomized to receive either an ST at the bedside or a PDT performed by the same group of otorhinolaryngologic surgeons.[1] Exclusion criteria relating to neck anatomy and patient general stability created a third (nonrandom) group of patients who underwent ST in the operating room (OR). The selection criteria were as follows: (1) palpable cricoid cartilage at least 3 cm above the sternal notch during head extension, (2) history of uneventful/uncomplicated translaryngeal intubation, (3) positive end-expiratory pressure requirement of < 10 cm H_2O. Fifty patients were randomized to each of the 2 study groups, and 64 patients met exclusion criteria to become an "OR ST" group. Overall, there was no difference in acute complications between the study (intensive care unit) groups. There were only a total 5 acute complications in the 100 patients: 4 in the PDT group, 2 with minor bleeding and 2 procedures that had to be completed "open"; and 1, an arrhythmia that was easily terminated, in the ST group. Interestingly, the OR ST group had almost 3 times the complication rate (13/64) of the intensive care unit group. Pneumothorax, substantial hemorrhage, airway loss, and hypotension were the complications more frequently seen in the ST OR group. Besides confirming a low complication rate for PDT and ST performed in the intensive care unit, this study highlights the high rate of complications in ST performed in the OR. The late complications included one death in a patient in the PDT group in whom attempts at reinsertion of an accidentally displaced tracheostomy tube as well as translaryngeal intubation both failed. This fatal complication occurred late, following elective tracheostomy-tube change performed on day 7. It is unclear that the technique used to place the tracheostomy contributed initially to the poor outcome.

There are a large number of uncontrolled, case series reports of complications of PDT. There are also a few prospectively collected comparative studies of the complications of PDT and ST and of different methods of PDT. Combination of these small groups may provide useful insight into early complications. A meta-analysis[2] of 5 prospective, randomized comparisons of the classic Cia-

Table 1. Frequency of Reported Complications in Prospective Controlled Trials That Compared Surgical Tracheostomy With Percutaneous Dilational Tracheostomy*

Complication	Patients Who Experienced the Complication (%)	
	ST	PDT
Minor hemorrhage	0–80	0–20
Major hemorrhage	0–7	0
Pneumothorax	0–4	0–4
Accidental decannulation	0–15	0–4
Subcutaneous emphysema	0–4	0
Stoma infection	0–63	0–10
Difficult insertion	0	0–27
False placement	0	0–4
Hypoxia	0–8	0–25
Loss of airway/death	0	0–8

*Adapted from data in References 2–7.
ST = surgical tracheostomy
PDT = percutaneous dilational tracheostomy

Table 2. Frequency of Reported Complications During Surgical Tracheostomy and Percutaneous Dilational Tracheostomy, Collected From Nonprospective and Prospective Reports*

Complications	Cases per 10,000 Procedures		p
	ST	PDT	
Serious			
Death	3	44	0.00114
Arrest	6	33	0.022
Pneumothorax	74	66	1.0
Pneumomediastinum	3	6	0.864
Total	86	149	0.049
Intermediate			
Desaturation/hypotension	23	77	0.0056
Tracheal wall injury	6	50	0.00163
Cannula misplacement	17	44	0.089
Convert to open	NA	83	NA
Aspiration	0	0	NA
Total	46	254	< 0.00001
Minor			
Hemorrhage	142	143	1.0
Difficult tube placement	6	220	0.00001
False passage	11	160	0.00001
Subcutaneous emphysema	20	105	0.00007
Total	179	628	< 0.00001

*Adapted from data in Reference 8.
ST = surgical tracheostomy
PDT = percutaneous dilational tracheostomy
NA = not applicable

glia PDT and ST (in the OR)[3–7] found similar and infrequent acute complications for the 2 techniques. The complications noted and the range of their occurrences in the individual reports are listed in Table 1. This report included pooled data of 236 patients.

Another meta-analysis that included case series as well as prospective studies suggested a better outcome for stoma wound infection and tracheal stenosis with PDT, but a higher mortality.[8] Comparison of ST (21 trials, 3,512 patients) and PDT (27 trials, 1,817 patients) demonstrated that perioperative complications are more frequent with PDT (10% vs 3%), whereas postoperative complications were more frequent following ST (10% vs 7%). Most of the differences were in minor complications, except perioperative death (0.44% vs 0.03%) and serious cardiorespiratory events (0.33% vs 0.06%), which were higher with PDT. The incidence of various complications is calculated from this large group of patients and reported in Table 2.[8] Due to the inclusion of nonrandomized patients, this meta-analysis should be viewed cautiously. Over-reporting of fatal complications is likely to influence the analysis. Minor complications such as bleeding not needing interventions, transient desaturation, and the need to convert to open procedure from PDT were reported rarely.

Anecdotal Reports of Complications

Anecdotal case reports and small series often report the most serious complications. Serious bleeding can occur with either ST or PDT, but appears to be less frequent with PDT.[9] One of the more serious concerns is posterior tracheal wall injury.[10] This may be more likely with PDT, but is also reported with ST. This can lead to typical barotrauma and even tracheal disruption.[11] Pneumothorax is infrequent with PDT but may occur in 1–3% of ST. Routine chest radiograph is no longer recommended following tracheostomy placement, unless there are signs of unexpected compromise of air exchange.[12,13] Other forms of barotrauma are reported with both techniques, and no particular technique is more likely to cause it. Airway loss with inability to replace the tube is a problem with tracheostomy in general. The assumed safety of this airway route is not born out in reported studies.[14]

Safety of PDT and ST

Most reports suggest there is very little difference in acute serious complications between the 2 techniques.[15] It is suggested that experience and operator preference should determine the choice. There are a few situations that may suggest one technique be chosen over the other. Obese patients experience a higher complication rate with either ST or PDT, but the seriousness and frequency may be higher with PDT.[16]

Table 3. Suggested Definitions for Reporting and Characterizing Acute Tracheostomy Complications

Risk or Outcome of Concern	Definition
Hypoxemia	Arterial oxygen saturation (via pulse oximetry) ≤ 90% for > 30 seconds
Severe hypoxemia	Arterial oxygen saturation (via pulse oximetry) ≤ 90% for > 60 seconds, or ≤ 85% at any time
Loss of airway	Failure to be able to access the trachea for more than 20 seconds
Bronchospasm	Bronchial constriction identified by wheezing
Severe bronchospasm	Bronchospasm requiring bronchodilator administration
Minor cardiac dysrhythmias	Bradycardia, premature ventricular beats, premature atrial contractions, and supraventricular tachycardia, with no change in blood pressure
Severe cardiac dysrhythmias	Ventricular tachycardia, ventricular fibrillation, asystole, or any dysrhythmia with poor perfusion
Inadvertent extubation	Unexpected removal of translaryngeal airway during performance of tracheostomy or in transport to the operating room
Inadvertent decannulation	Unplanned removal of tracheostomy tube
Difficult replacement of tracheostomy tube	Requiring more than 2 tries at reinsertion, or requiring translaryngeal placement
Difficult tracheostomy tube placement	Requiring more than 2 attempts at insertion during primary placement procedure
Cuff leak	Failure of tracheal cuff to remain inflated
Hypotension	Blood pressure ≥ 20% less than baseline pressure during procedure
Significant hypotension	Hypotension requiring treatment with vasopressor bolus or < 1,000 mL of fluid infusion during the procedure
Severe hypotension	Hypotension requiring repeated vasopressor injection or continuous infusion or fluid infusion of > 1000 mL during procedure
Unusual bleeding	Any amount of bleeding considered "abnormal" by the person performing the procedure
Excessive bleeding	More than 20 mL estimated blood loss
Major bleeding	Hematocrit decrease of ≥ 3 points, or transfusion of ≤ 2 units of packed red cells
Massive bleeding	Hematocrit decrease of ≥ 6 points, or transfusion of ≥ 2 units of packed red cells
Minor continued bleeding	Requiring dressing change, direct pressure, or suture placement
Major continued bleeding	Exploration or re-exploration needed to control bleeding
Hematoma	—
Minor barotrauma	Subcutaneous emphysema
Moderate barotrauma	Mediastinal emphysema
Major barotrauma	Pneumothorax
Extratracheal placement of tracheostomy tube	False passage or paratracheal placement
Posterior tracheal wall injury	Injury to membranous trachea from scalpel, tracheostomy tube, needle, dilator, or wire
Specific to percutaneous dilational tracheostomy	
Bending of guide wire	Wire unable to form direct path to trachea
Knotted or trapped guide wire	Wire unable to be easily removed
Dilator failure	Requiring a second kit to complete procedure
Lateral stoma placement	Stoma placed outside the anterior quadrant of the tracheal wall
Tracheal ring fracture	Ring broken at any part of the procedure
Posterior tracheal wall injury	Membranous tracheal injury with needle, wire, or dilator
Specific to surgical tracheostomy	
Injury to nerve, artery, or vein	Complications identified and requiring open intervention during procedure
Esophageal injury	Identified and repaired intraoperatively
Thyroid injury	Requiring lobe or gland removal

Some variation in complications is seen with different techniques for PDT. The single-dilator technique (Blue Rhino) appears to be faster and incurs no more risk than the multiple-dilator technique of Ciaglia.[17,18] Because neck extension is not possible with cervical injury, ST has been recommended as a safer technique in this group of patients. However, in patients with cervical fusions and fresh incisions, PDT provides a lower infection risk than ST, favoring its use in this group of patients.[19] Two variants of PDT seem to carry more risk of injury. These include Fantoni's device, in which periods of desaturation during placement, as well as tracheal injury, seem to be increased, compared to the Griggs forceps technique.[20] The PercTwist is associated with more difficult tracheostomy tube placement and possibly more posterior wall injury: a complication it was specifically designed to prevent.[21]

Summary

Little objective comparative information about acute complications of various techniques of tracheostomy are available. Part of this problem is due to nonuniform def-

initions of the occurrences. The use of standard and complete definitions, such as offered in Table 3, would help in the future. Generally, PDT has fewer acute complications than ST, although this may vary by the specific PDT technique. Patient factors also influence complications. Until a registry using standard reporting conventions is established, individualized patient decisions and clinical judgment are necessary to choose a tracheostomy technique.

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