Percutaneous tracheostomy: one center’s experience with a new modality

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Abstract

Background: A retrospective review of our experience with percutaneous tracheostomy was performed to determine our complication rate and pattern of use since this modality was introduced at our institution.

Methods: A retrospective chart review captured all patients in whom tracheostomy was performed or supervised by a trauma/critical care faculty member. Dates of hospital admission, ICU admission, intubation, discontinuation of mechanical ventilation, type and location of procedure, procedural complications, Injury Severity Score, charges, and patient demographics were collected. Percutaneous tracheostomy (PT) and open tracheostomy (OT) experiences were compared.

Results: Three hundred sixty-eight tracheostomies were performed (190 OT and 178 PT). The average time to tracheostomy (TTT) for PT patients decreased from 12.7 to 7.4 days. The average TTT for OT patients remained stable at 14.0 days. The complication rate was 3.5%, with 4 complications (1.5%) associated with OT and 9 complications (5.1%) associated with PT. All complications in the PT group occurred before using a single dilator system. The 9 complications in the PT group occurred among 5 surgeons, all before their 11th attempt. PT saves $444 in charges per procedure.

Conclusion: OT continues to be a safe method of performing tracheostomies. PT has a steep learning curve but can be mastered quickly. Benefits include a shorter time to tracheostomy, elimination of patient transport, and saving in charges. Initial PT attempts should be supervised by an experienced surgeon. © 2005 Excerpta Medica Inc. All rights reserved.

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Tracheostomy dates back approximately 4000 years. It was first described by the Greeks and subsequently documented in Roman and Arabic literature as a way of relieving upper airway obstruction. Historically, tracheostomy was the procedure of choice for securing an airway emergently. Today, endotracheal intubation is the first-line method of securing the emergent airway because of its ease and relatively low complication rate. Tracheostomy is usually reserved as a last resort in the emergent setting. Thus, the primary role for tracheostomy today is in the management of the patient with the need for a prolonged or permanent alternate airway. Tracheostomy placement provides for easier management of secretions, oral nutritional intake, a lower risk of dislodgement, and ease of weaning from mechanical ventilation by reducing the dead space and eliminating the anxiety associated with extubation [1–3]. More recently, a percutaneous insertion method has been introduced as a means of providing a surgical airway in these patients [1–11].

Tracheostomy, whether performed by an open or percutaneous technique, is not without complication. Major complication rates range from 6% to 66% with a mean of approximately 16%. The mortality rates range from 0% to 5% with a mean of 1.5%. The most common intraoperative complications are subcutaneous emphysema, pneumothorax, and hemorrhage [1,4,5]. Postoperative complications include tube dislodgement, peristomal hemorrhage, tracheoinnominate fistula, tracheitis, bronchial obstruction with

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lobar collapse, tube obstruction, and wound infections. Tracheal stenosis is the most common late complication with an incidence as high as 65%. However, tracheal stenosis is symptomatic in only 0% to 5% of these cases [5].

The safety and efficacy regarding the technique of tracheostomy has been under debate since the introduction of percutaneous tracheostomy (PT). Both large-scale prospective cohort studies [5] and small randomized controlled [6,7] studies have shown PT to be a safe technique in experienced hands when compared with the open tracheostomy (OT) done in the operating room or at bedside. The complications associated with PT are similar to those of OT, with an additional <1% risk of paratracheal tube insertion and posterior tracheal wall injury that are most common when the procedure is performed by inexperienced surgeons without bronchoscopic guidance or in patients with unfavorable anatomy [7].

A review of the literature between 1991 and 2004 shows conflicting reports of complication rates of PT and OT. In the earlier studies, both prospective and retrospective cohort studies reported lower complication rates with the percutaneous procedure [6,8,9]. However, Graham et al [10] published a retrospective cohort study in 1996 in which complication comparisons were inconclusive. Subsequently, studies became more meticulous in their analysis of complications by categorizing their severity. In a large meta-analysis reviewing all published reports of tracheostomies between 1960 and 1996, the authors showed a higher perioperative complication rate with PT but a higher postoperative complication rate with OT [11]. Conversely, Massick et al [7] conducted a prospective, randomized controlled trial that showed a higher postoperative complication rate with PT than OT. PT has been shown to be safe and effective [5,8,9], but the question that remains is whether one modality is superior to the other in those patients in whom either procedure can be performed. The purpose of this study is to determine the learning curve associated with the introduction of percutaneous tracheostomy at an American College of Surgeons–verified level I trauma center/teaching hospital and to compare complications associated with percutaneous tracheostomy with those of the open technique. We hypothesize that complications associated with PT decrease as the surgeon gains more experience with the new modality and that there are differences in the types of complications between PT and OT.

Patients and Methods

Between January 1998 and May 2004, 383 surgical airways were performed. Fifteen emergent cricothyroidotomies were excluded from the study. Of the remaining 368 elective tracheostomies, 190 OT and 178 PT were performed. Our first PT was performed in January 1998. Males accounted for 68% of our study population (63% OT, 73% PT, P = .043), and the mean age was 51.8 years (55.7 OT, 47.9 PT, P = .0002). The mean ISS in our trauma patients was 29.5 (28.9 OT, 30.1 PT, not significant). The mortality rate for those undergoing tracheostomy was 12.0% (12.1% OT, 11.8% PT, not significant). There were no deaths attributable to tracheostomy (Table 1).

The mean overall time from endotracheal intubation to tracheostomy (TTT) was 14.2 days with no statistical difference between the 2 groups. However, when TTT was evaluated over time, the mean TTT for PT significantly decreased from 12.7 days in 1998 to 7.4 days in 2004 (P = .001). Over the same time period, TTT for OT has remained relatively stable, with a mean of 14.0 days (Fig. 1).

<table>
<thead>
<tr>
<th>Table 1 Patient characteristics</th>
<th>All</th>
<th>Open</th>
<th>Perc</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>368</td>
<td>181</td>
<td>178</td>
</tr>
<tr>
<td>Average age</td>
<td>51.8</td>
<td>55.7</td>
<td>47.9</td>
</tr>
<tr>
<td>% male</td>
<td>68%</td>
<td>63%</td>
<td>73%</td>
</tr>
<tr>
<td>Average ISS</td>
<td>29.5</td>
<td>28.9</td>
<td>30.1</td>
</tr>
<tr>
<td>Mortality</td>
<td>11.7</td>
<td>12.1</td>
<td>11.8</td>
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NS = not significant.
The rates of OT and PT changed significantly ($P = .03$) from a more prevalent use of PT in 1998 (OT 42%, PT 58%) to a more prevalent use of OT in 2004 (OT 68%, PT 32%), as shown in Fig. 2. The number of admissions greater than 48 hours has increased from 1,381 in 1998 to 2,818 in 2003, and the overall incidence of tracheostomy has remained unchanged at approximately 3% (Fig. 3).

The mean ICU length of stay in patients who require tracheostomies was 31.8 days (OT = 31.8, PT = 31.9, not significant), and the mean ICU length of stay after tracheostomy placement was 18.5 days in both groups. The mean time from tracheostomy to discontinuation of mechanical ventilation was 15.5 days (OT = 15.8, PT = 15.0, not significant) after excluding 4 open tracheostomies and 5 percutaneous tracheostomies who were discharged to another facility still requiring mechanical ventilation.

The complication rate was 3.5% (1.5% OT, 5.1% PT, $P = .20$). There were 4 OT complications that included 2 cuff tears with leak, 1 tracheostomy malpositioning leading to desaturation, and 1 tube obstruction because of a retained blood clot. There were 9 PT complications that included 2 conversions to open because of an inability to visualize introducer needle entry into the trachea, 1 intraoperative desaturation, 2 episodes of intraoperative bleeding that resolved with pressure, 1 inferior thyroid artery injury requiring neck exploration, 1 intraoperative loss of the airway, 1 pneumothorax, and 1 tear in the membranous trachea confirmed by flexible bronchoscopy. The last PT complication occurred in March 2001. There have been 101 subsequent PT performed without complication. Since the introduction of the single dilator system in May 2001, no complications have been recorded.

Over the period of this study, 7 trauma/critical care faculty have performed and/or directly supervised the performance of all PT. With the exception of 2 surgeons who had only 4 and 7 recorded cases, the remaining 5 surgeons performed at least 10 PT (range, 11–63 PT). Subsequent to their performance of 11 PT, no faculty surgeon has had a recorded complication (Fig. 4).

Charge data were obtained from the hospital’s financial services. PT charges include a $198 endoscopy laboratory service charge, a $240 PT kit charge, and $50 pharmacy charge, for a total of $458. OT charges include $11.14/min of operating room time and $4.39/min for anesthesia time. These charges are calculated from the time the patient enters the room to the time the patient leaves the room. Our average operating room utilization time for OT is approximately 1 hour. This results in a total charge of $932. Thus, a $444 charge difference exists between PT and OT.

Fig. 1. Time to tracheostomy. Time to tracheostomy is defined as the time from intubation until tracheostomy has been performed. Significantly shorter time to tracheostomy in 2004 than in 1998 ($P = .001$).

Fig. 2. Method of tracheostomy. Significantly more OT/fewer PT in 2004 than in 1998 ($P = .03$).

Fig. 3. Incidence of tracheostomy. Admit = number of patients per year admitted for >48 hours.

Fig. 4. Complication rate by number of attempts. Number of attempts is per individual surgeon.
Comments

This study shows one institution’s experience with the introduction of a new modality. With no prior experience, using available information from previously published studies, as well as recommendations from the product manufacturer, 7 surgeons implemented the technique of percutaneous tracheostomy. As has been shown with other new techniques, enthusiasm for the use of percutaneous tracheostomy was initially very high, with 60% of all tracheostomies being performed using this technique. As each complication occurred, the technique was reevaluated and modified. Thus, despite the ease of performing PT and a similar complication rate over the study period compared with OT, our institution is performing fewer PT than OT. The reason for this can be attributed to a more restrictive pattern of patient selection. We showed an initial enthusiasm to perform a new procedure resulted in complications, the majority of which we ultimately attributed to poor patient selection. Although our absolute contraindications to PT included coagulopathy, an unstable cervical spine, and unfavorable anatomy, only the latter was based on individual surgeon judgment and preference. In general, a short or thick neck was considered unfavorable, but each surgeon’s definition of short and thick varied. None of our surgeons have stopped performing PT but as they have progressed along the learning curve, they have modified their patient selection criteria, which has resulted in a decreased complication rate over the study period for PT and no complications in our most recent 101 attempts.

Our current practice and recommendation is for the attending surgeon or another experienced bronchoscopist to manage the airway to help minimize the risk of inadvertent loss of the airway. One of our surgeons uses the bronchoscope to first advance the ETT tip to the carina. The bronchoscope is then removed, and the introducer needle is passed blindly into the trachea above the ETT cuff and the guide wire is then passed. The bronchoscope is then reinserted to the tip of the ETT, and the tube is slowly withdrawn until the guide wire is visualized entering the trachea. With the tube now perfectly positioned, the remainder of the procedure is carried out in standard fashion. This technique (1) minimizes the time the bronchoscope is in the airway as thus allows for better ventilation, (2) allows passage of the needle without the risk of damaging the bronchoscope, and (3) eliminates the risk of losing the airway while trying to blindly back the ETT out before passing the introducer needle. This technique is especially beneficial in the head injured patient with fragile ICP control.

The mean TTT between PT and OT was not statistically significant. However, a change in the length of time to PT versus OT was observed. Initially, TTT between PT and OT was almost identical. Now PT is being performed 4.5 days earlier than OT. This difference may be attributed to (1) increasing difficulty in obtaining operating room time, (2) logistical issues surrounding the actual trip to the operating room, (3) the coordination of open tracheostomy with other procedures, and (4) surgeon comfort with PT.

Our complication rate associated with tracheostomy placement, both open and percutaneous, is comparable to that reported in the literature. We have had no complications after 2001, subsequent to all attending surgeons having performed at least 11 PT and coincident with our change to the single dilator system. Whether our initial complications from PT were caused by inexperienced operators, poor patient selection, or technical issues with the instrumentation is difficult to elucidate in this retrospective study.

In conclusion, OT is a safe and effective method of performing tracheostomies. A steep learning curve exists for PT; however, this technique can be mastered quickly. As an adjunct to help minimize early complications, the operator should be supervised by a surgeon experienced in PT. This study also implies that the initial enthusiasm to use a new modality eventually diminishes as improved patient selection skills are developed. Our experience with this new modality has resulted in a significant decrease in TTT in the PT group. Charges for PT are $444 lower than those for OT. Further prospective studies should compare safety and cost of bedside PT with that of bedside OT.

References