Percutaneous Tracheostomy: To Bronch or Not to Bronch—That Is the Question

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Background: Percutaneous tracheostomy is a routine procedure in the intensive care unit (ICU). Some surgeons perform percutaneous tracheostomies using bronchoscopy believing that it increases safety. The purpose of this study was to evaluate percutaneous tracheostomy in the trauma population and to determine whether the use of a bronchoscope decreases the complication rate and improves safety.

Methods: A retrospective review was completed from January 2007 to November 2010. Inclusion criteria were trauma patients undergoing percutaneous tracheostomy. Data collected included age, Abbreviated Injury Score by region, Injury Severity Score, ventilator days, and outcomes. Complications were classified as early (occurring within <24 hours) or late (>24 hours after the procedure).

Results: During the study period, 9,663 trauma patients were admitted, with 1,587 undergoing intubation and admission to the ICU. Tracheostomies were performed in 266 patients and 243 of these were percutaneous; 78 (32%) were performed with the bronchoscope (Bronch) and 168 (68%) without bronchoscope (No Bronch). There were no differences between the groups in Abbreviated Injury Score by region, Injury Severity Score, probability of survival, ventilator days, and length of ICU or overall hospital stay. There were 16 complications, 5 (Bronch) and 11 (No Bronch). Early complications were primarily bleeding (Bronch 3% vs. No Bronch 4%, not statistically significant). Late complications included tracheomalacia, tracheal granulation tissue, bleeding, and stenosis; Bronch 4% versus No Bronch 3%, (not statistically significant). One major complication occurred, with loss of airway and cardiac arrest, in the bronchoscopy group.

Conclusion: Percutaneous tracheostomy was safely and effectively performed by an experienced surgical team both with and without bronchoscopic guidance with no difference in the complication rates. This study suggests that the use of bronchoscopic guidance during tracheostomy is not routinely required but may be used as an important adjunct in selected patients, such as those with HALO cervical fixation, obesity, or difficult anatomy.

Key Words: Percutaneous tracheostomy, Bronchoscopy, Complications.

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Tracheostomy is one of the oldest described surgical procedures, dating back 3,500 years documented in writings from the Egyptians and subsequently the Greeks and Hindus.[1] In 1909, Jackson[2] described the indications for the procedure and the technique and developed anatomically appropriate tracheostomy tubes. A method of percutaneous tracheostomy was developed in 1969 and was subsequently described in a series of trauma patients in 1986.[3,4] Further refinements of the percutaneous tracheostomy technique have included the use of a Seldinger wire, serial dilatation, the use of a tapered dilator, and the performance of the procedure under bronchoscopic control.[5–8]

A number of authors have recommended the use of bronchoscopy during percutaneous tracheostomy because it allows direct visualization of the airway during tracheostomy placement;[8,9] however, there is no clear consensus in the literature about the use of bronchoscopy. We hypothesized that there would be no difference in complications in performing percutaneous tracheostomy with bronchoscopy or without bronchoscopy. The purpose of the study was to evaluate percutaneous tracheostomy with and without the use of the bronchoscope and compare the safety and complications of the procedure.

MATERIALS AND METHODS

A retrospective review of all trauma patients admitted to Community Regional Medical Center, Fresno, CA, an American College of Surgeons-verified Level I trauma center in central California, was performed from January 2007 through November 2010 using the trauma registry. Inclusion criteria were intensive care unit (ICU) admission, patients requiring mechanical ventilation, and need for tracheostomy. Patients with thermal injury were excluded. Data collected included age, gender, ventilator days, length of ICU stay, presence of cervical spine injury and HALO fixation, body mass index (BMI), overall hospital length of stay (LOS), follow-up care, and outcomes. Abbreviated Injury Score (AIS), Injury Severity Score (ISS), and probability of survival (PS) were also collected. Complications of tracheostomy were defined as early, if occurring within 24 hours of the procedure, and late, if occurring after 24 hours. Early complications included bleeding from the insertion site, loss of airway, or conversion of a percutaneous tracheostomy to an open tracheostomy. Late complications were tracheomalacia, tracheal stensosis, granuloma, or polyp and bleeding from the tracheostomy site. Other complications included damage to the bronchoscope incurred during the procedure. Continuous data are expressed as mean ± SEM and were analyzed using *t* test. Categorical data were analyzed using Pearson χ^2 and

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Fisher's exact test, with significance attributed to a p value of less than 0.05. Approval for the study was obtained from the Institutional Review Board of the University of California, San Francisco at Fresno.

Procedure

All of the percutaneous tracheostomies were performed using the Ciaglia Blue Rhino kit (Cook Critical Care Inc; Bloomington, IN) with a size 6 or 8 cuffed tracheostomy cannula (Shiley; Irvine, CA) inserted. Patients were positioned with a roll under their shoulders to extend the neck unless a contraindication such as a cervical fracture was present. The use of the bronchoscope was at the discretion of the attending physician. The use of bronchoscopy was primarily based on surgeon preference. Of the seven trauma/critical care faculty performing percutaneous tracheostomy, four use bronchoscopy selectively (difficult anatomy, HALO fixation for cervical injury, and morbid obesity), two use bronchoscopy for a majority of cases, and one uses bronchoscopy routinely. Video-guided bronchoscopy was performed by the attending surgeon or surgical critical care fellow or surgical resident with supervision, while another member of the team performed the percutaneous tracheostomy. When the bronchoscope was used, positioning of the endotracheal tube and the placement of the needle into the trachea were done under direct visualization. If the tracheostomy was performed without bronchoscopy, the midline of the trachea was determined by palpation of the trachea after the pretracheal fascia had been bluntly dissected. Procedural sedation, analgesia, and muscle relaxation were performed by the surgical team in the ICU. A respiratory therapist was also part of the team for procedures done in the ICU. Anesthesia services were used only for procedures done in the operative suite.

RESULTS

Over the study period, 9,663 trauma patients were admitted. Of these, 1,587 had endotracheal intubation and were admitted to the trauma ICU. There were 266 tracheostomies performed: 23 via an open technique and 243 were performed percutaneously and make up the study cohort. A total of 78 (32%) were done with video bronchoscopy guidance (Bronch group) and 165 (68%) were done without use of the bronchoscope (No Bronch group).

The groups were similar in regard to age, gender, AIS score in all regions, ISS and PS scores, ICU LOS before tracheostomy placement, days of mechanical ventilation, and ICU and overall hospital LOS (Table 1). There were 59 patients with cervical fractures; 20 (26%) in the Bronch group and 39 (24%) in the No Bronch group (not statistically significant). HALO fixation was present in 3 of 20 (15%) patients in the Bronch group and 8 of 39 (20%) in the No Bronch group (not statistically significant). There was no difference between the Bronch and No Bronch groups in mean BMI, or in the percentage of patients with BMI $\geq$35.

Of the 243 percutaneous tracheostomies, 213 were performed in the ICU and 30 in the operating room (OR). Eight of the 30 were performed in the operative suite because the patient was scheduled for another surgical procedure with only 22 patients (9%) were taken to the OR solely for placement of a percutaneous tracheostomy. The decision to perform the procedure in the OR was at the discretion of the attending surgeon. All patients received analgesia and sedation, muscle relaxation was used in 83% of the patients with no differences between the bronchoscopy and no bronchoscopy groups. The trauma team was responsible for the procedural sedation in the ICU, and the department of anesthesia was responsible for the procedural sedation for all patients undergoing percutaneous tracheostomy in the OR. All percutaneous tracheostomies were supervised by an attending trauma surgeon and were generally performed by a postgraduate year 2 with the assistance of a senior resident or fellow. If bronchoscopy was used, an attending (or another resident or fellow) performed the bronchoscopy during the procedure.

TABLE 1. Patient Demographics (Mean ± SD)

	Bronchoscopy (N = 78)	No Bronchoscopy (N = 165)	p
Age	48 ± 21	43 ± 19	0.060
Head AIS	3.0 ± 1.9	3.2 ± 1.9	0.849
Chest AIS	2.6 ± 1.5	2.4 ± 1.8	0.424
Abdomen AIS	1.1 ± 1.5	1.1 ± 1.5	0.948
Injury Severity Score	29.5 ± 12.6	31.1 ± 13.2	0.427
ICU length of stay (d)	27.1 ± 14.6	26.1 ± 16.8	0.198
Ventilator days	25.6 ± 14.4	24.2 ± 16.2	0.136
Time to tracheostomy (d)	12.4 ± 7.5	11.6 ± 7.4	0.469
Length of stay	35.5 ± 18.9	36.1 ± 22.6	0.868
Probability of survival	0.66907 ± 0.299582	0.65526 ± 0.317004	0.874

Follow-up after discharge was 27% in the Bronch group and 28% in the No Bronch group. The majority of the patients had one follow-up visit in the surgical clinic after discharge. There were no additional complications from the percutaneous tracheostomy procedures reported from the ENT Clinical Service or from the Regional Trauma Audit Committee. The overall mortality rates in the Bronch and No Bronch groups were similar (9% and 7%, respectively, not statistically significant). There were no deaths related to the percutaneous tracheostomy procedure.

Complications

There were 6 (8%) complications in the Bronch group and 11 (7%) in the No Bronch group (not statistically significant). In the Bronch group, two early complications occurred; one patient had hemorrhage from the anterior jugular vein and one attempted percutaneous tracheostomy was converted to an open tracheostomy. There were three late complications identified. Two patients had tracheal stenosis, managed with dilatation and laser treatment. One patient had bleeding from the tracheostomy site after the tracheostomy was downsized on postoperative day 12. The patient was taken to the OR for evaluation for possible trachea-innominate artery fistula and control of superficial bleeding.

One major complication occurred in the Bronch group. Loss of airway occurred while the endotracheal tube was being pulled back, under direct visualization, with the bronchoscope in place, leading to cardiac arrest. A laryngeal mask airway was placed and advanced cardiac life support resuscitation was initiated. The percutaneous tracheostomy procedure was com-

pleted emergently, without the use of the bronchoscope. The patient survived without apparent sequelae.

In the No Bronch group, there were six early complications (3.6%), five due to bleeding, none requiring transport to the OR. One of these patients also became hypotensive during the procedure. The estimated blood loss was less than 100 mL and the hypotension seemed related to procedural sedation. In the sixth patient, the percutaneous procedure was converted to an open surgical tracheostomy. There were five (3%) late complications, including a tracheal polyp, stenosis, granulation tissue, and tracheomalacia. One patient had two episodes of bleeding from the tracheostomy site on postoperative day 18 and 25. The patient was taken to the OR each time for evaluation for possible trachea-innominate artery fistula and control of bleeding.

The use of video bronchoscopy also requires some additional resources. In addition to technologist time, ultrasonic cleaning of the bronchoscope before reuse requires ~45 minutes. Similarly, any damage to bronchoscopy equipment must be taken into account. Using data from hospital medical records and the Olympus repair records for the bronchoscopes used exclusively by the Department of Surgery, complete information was available from October 2009 through July 2010. During that time period, 42 percutaneous tracheostomies done with bronchoscopic guidance. Six perforations of the bronchoscope occurred, leading to major repairs in two and minor repairs in four. All these were damaged during performance of the percutaneous trachestomy by the surgical team. The total cost of the repairs was ~$10,000 with the greatest single repair cost of $6,000 and an average cost of $465.

DISCUSSION

Numerous studies have compared open surgical tracheostomy with percutaneous tracheostomy. A meta-analysis of 15 prospective randomized controlled trials including ~1,000 patients showed no significant differences but a trend toward fewer complications with percutaneous tracheostomy.[10] However, the study also noted an increase in decannulation, obstruction, and creation of false passages in the percutaneous group.

The number of procedures performed in the ICU including tracheostomy has increased in recent years.[8,11] Several reports have recommended the use of bronchoscopy to help prevent complications and cannula misplacement during percutaneous tracheostomy.[12–15] The use of the bronchoscope allows direct observation of the needle entering the trachea, the actual dilation of the tracheostomy site, and the final placement of the tracheostomy tube. One study noted that, although the complication rate was equivalent with or without bronchoscopy, the more severe complications (perforation of the posterior tracheal wall and death from tension pneumothorax) occurred in the cohort without bronchoscopy.[15] A survey of 455 European ICUs revealed that 97.7% routinely used bronchoscopy for performance of percutaneous tracheostomy, and an additional 1% used bronchoscopy if they suspected that the patient would have a difficult airway.[11] A retrospective study of 183 patients undergoing percutaneous dilatational tracheostomy noted two punctures of the posterior tracheal wall. The use of the bronchoscope allowed repositioning of the needle to prevent serious complications.[14] Peris et al. studied the use of video-guided bronchoscopy versus conventional bronchoscopy, with the endoscopist instructing the operator on needle and tracheostomy placement. They noted a decrease in number of needle punctures and time to complete the procedure. The study also noted a 33% complication rate with standard bronchoscopy, including seven cases of hemorrhage, three tracheal ring ruptures, and one episode each of posterior wall perforation, hypoxia and extubation. Using video bronchoscopy, the complication rate was decreased to 8% with three cases of hemorrhage, three patients with tracheal ring rupture, and one episode of hypoxia.[16]

Other reports in the literature have concluded that bronchoscopy is an unnecessary adjunct and adds expense to the procedure.[17–20] A modification of the technique describes a careful blunt dissection down to the pretracheal fascia, with palpation of the airway before needle puncture of the trachea. One study reported 100 consecutive patients with successful percutaneous tracheostomy placement and only three minor bleeding complications.[19] In another study, 117 patients underwent tracheostomy with a 97.4% success rate without the use of bronchoscopy.[21] Several other studies noted that bronchoscopy was used initially for performing percutaneous tracheostomy and then, after acquiring experience with the procedure, the use of bronchoscopic guidance was discontinued without an increase in complications.[17,18] In addition, several authors have reported significant hypercarbia related to impaired ventilation because of bronchoscopy use during tracheostomy.[22,23]

There have been few studies comparing percutaneous tracheostomy with and without bronchoscopic guidance. Diaz-Reganon et al. used bronchoscopy in only the first 35 of 800 procedures. The authors noted that since there was no difference in complication rate, bronchoscopy was no longer routinely performed in an effort to decrease the time of the procedure.[17] Cobean et al. described using flexible bronchoscopy while gaining familiarity with the technique but then discontinued the use of bronchoscopy after the third procedure. Berrouschot et al. performed a prospective study of 76 patients with and without the use of bronchoscopy and showed complication rates to be equivalent at 7% and 6%, respectively. Severe complications occurred in six cases (8%). Without bronchoscopy, one patient had tension pneumothorax and in another patient, the tube dislodged and bronchoscopy revealed a tracheal laceration, which required a thoracotomy. In the last patient, the patient had a tension pneumothorax and autopsy revealed a laceration of the trachea which subsequently led to her death. With bronchoscopy, there were two cases of intratracheal bleeding and one was converted to an open procedure. Another patient suffered dislocation of the cannula the day after the procedure, which caused massive bleeding and death. Even though there was a death in each group, bronchoscopic monitoring was felt to minimize complications. The authors felt that the use of bronchoscopic guidance could have prevented one death.[15]

The current study is the largest comparative study that we have been able to identify and did not show a difference in complication rate with the use of video bronchoscopy. In fact, the most significant complication, loss of airway and subsequent cardiac arrest occurred in the bronchoscopy group. Other studies have also reported loss of airway despite bronchoscope use.[8]

One complication of bronchoscopic-guided percutaneous tracheostomy noted in the current study, which has not been described in other reports, was damage to the bronchoscopes. The equipment damage was not included for analysis in the number of complications but clearly is of concern. The perforations of the bronchoscope were all by surgical residents, despite direct attending physician supervision. One other study noted an increase in complications with surgical residents; specifically, an increase in technical complications with residents performing their first five percutaneous tracheostomies.[17]

This study has several limitations. It is retrospective and it is possible that there were some complications (cellulitis, late tracheal stenosis, etc.) that were not identified. There was also a difference in the number of tracheostomies done with and without bronchoscopic guidance. Percutaneous tracheostomy has been performed at our institution for over a decade, and when introduced, was done without bronchoscopy. Over time, with the addition of other faculty, and as an adjunct in residency training, the use of video bronchoscopy was added to the procedure. This progression differs from what has been previously described, i.e., physicians learning the procedure with video bronchoscopic guidance and then gradually performing percutaneous tracheostomy without bronchoscopy.

Five of the seven trauma surgeons at our institution were trained in the procedure without the routine use of bronchoscopy; currently, four use bronchoscopic guidance selectively (cervical fracture, obesity, and short neck) to make the procedure easier to accomplish in the ICU, instead of performing an open tracheostomy in the OR. The remaining three surgeons use bronchoscopy more liberally for better visualization and facilitating resident education. However, there was no difference between the Bronch and No Bronch groups with respect to the presence of cervical fractures, HALO fixation, BMI, AIS region score, ISS, PS, ventilator days, or time to procedure.

CONCLUSION

Percutaneous tracheostomy was safely and effectively performed by an experienced surgical team both with and without bronchoscopic guidance without a difference in the complication rate. This study suggests that the use of bronchoscopic guidance during tracheostomy is not routinely required but may be an important adjunct in selected patients, such as those with HALO cervical fixation, obesity, or difficult anatomy.

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