Early Experience With Percutaneous Tracheotomy

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Early reports of a percutaneous dilatational technique for tracheotomy tube placement have been encouraging. This method uses a needle for placement into the trachea, a J-tipped guidewire, and progressively larger dilators to widen the stoma for insertion of a tracheotomy tube.

A prospective study was undertaken to assess the efficacy of this percutaneous tracheotomy technique. Serious complications were encountered, including difficulty with dilatation, excessive bleeding, false passage of the tracheotomy tube, and death. Because of this unacceptable morbidity, the study was terminated after enrollment of only seven patients. Percutaneous tracheotomy is a dangerous procedure with potential for catastrophic complications. These complications were encountered by third- and fourth-year surgical residents performing the procedure under close supervision. If the puncture technique is further popularized and attempted by untrained physicians, these authors predict many disasters.

INTRODUCTION

Tracheotomy continues to be a frequently performed operation for immediate airway access, prolonged ventilatory support, and pulmonary toilet. Despite the relative simplicity of this procedure, conventional tracheotomy carries a significant rate of complications.[1–6] With increasing numbers of critically ill patients requiring tracheotomies for ventilatory support, efforts have been made to simplify and expedite the procedure. Several authors have reported success with a percutaneous technique for tracheotomy placement.[7–9] In this method, a needle is used for entry into the trachea, a J-tipped guidewire is passed through the needle, and progressively larger dilators are used to widen the stoma for insertion of the tracheotomy tube. Preliminary reports of percutaneous tracheotomy experiences from other institutions have been favorable, with a remarkably low incidence of complications.

A prospective study was undertaken at UCLA to assess the safety and efficacy of this percutaneous tracheotomy technique. Despite encouraging reports from other institutions, our experience with this technique was much less satisfactory. Technical problems and serious complications were encountered, including difficulty with dilatation, false passage of the tube, pneumothorax, and death. Our institution's disastrous outcomes are reported herein. It is our strong belief that clinical investigators should be willing to share adverse experiences in order to accurately portray the failure of this new technique.

PATIENTS AND METHODS

Percutaneous tracheotomy tube systems were provided by Shiley Incorporated (Irvine, Calif.). Approval for investigational use was obtained from the Human Subject Protection Committee at UCLA. Informed consent for this investigational technique was obtained from all patients prior to enrollment in the study. Indications for percutaneous tracheotomy were similar to those for the conventional procedure (Table I), and included prolonged ventilator dependence, vocal cord paralysis, and major head and neck cancer resection. One senior staff member attended a course to learn the percutaneous tracheotomy technique, and subsequently instructed the other surgeons in the procedure. All operations involved both an attending surgeon and an otolaryngology resident, and were done either in the intensive care unit or in the operating room.

The technique is illustrated in Figure 1. Fifteen minutes before the start of the procedure, the concentration of

TABLE I.
Patients Receiving Percutaneous Tracheotomy at UCLA.

Patient	Age	Sex	Indication for Tracheotomy	Complication
1	42	M	Ventilator dependence	None
2	90	M	Ventilator dependence	None
3	63	F	Tongue cancer resection	Pneumothorax
4	51	M	Partial laryngectomy	Calcified tracheal ring—procedure aborted
5	47	F	Ventilator dependence	None
6	61	M	Ventilator dependence	None
7	64	F	Bilateral vocal cord paralysis	Death

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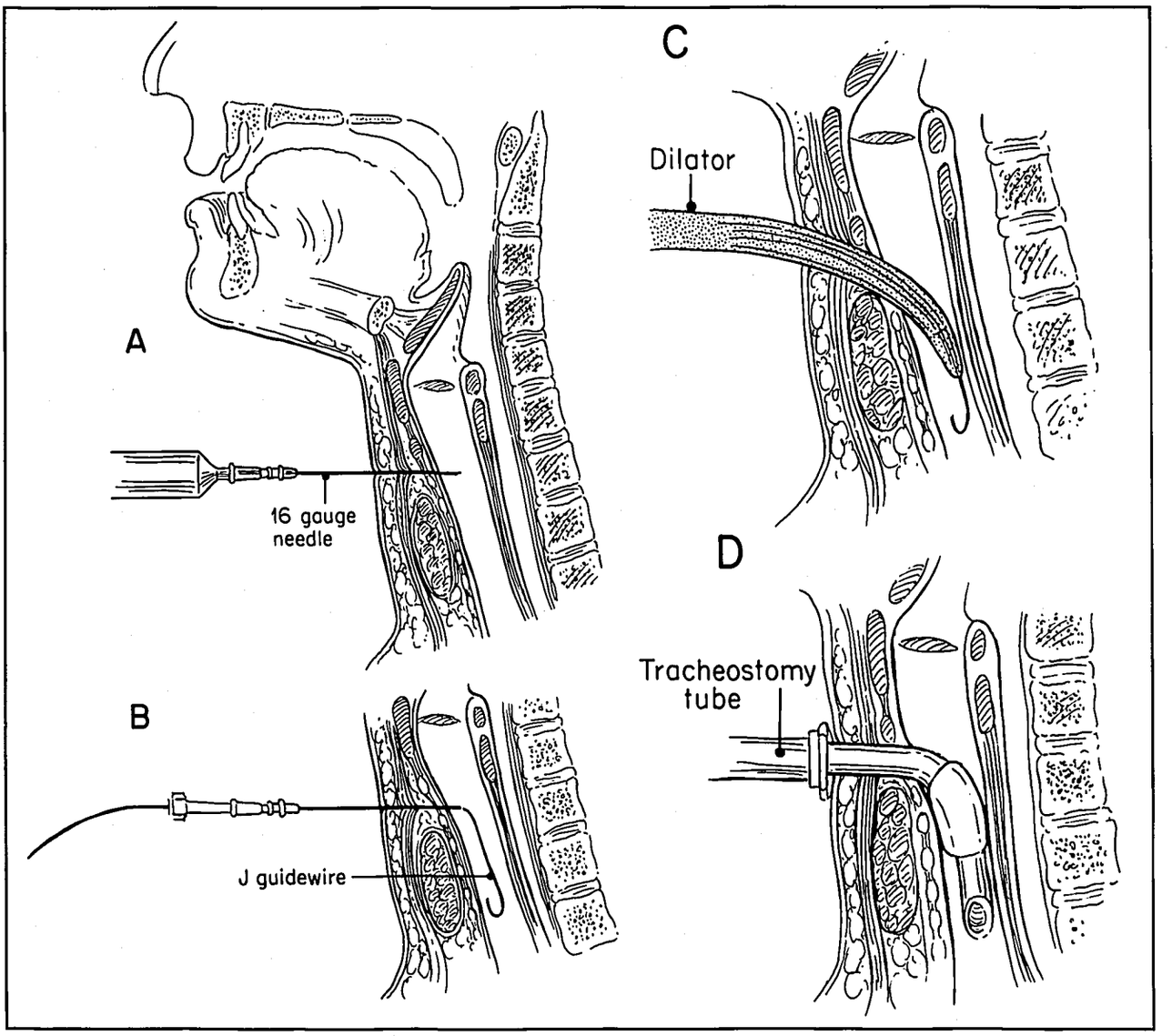

Fig. 1. Technique for percutaneous tracheotomy. **A.** Needle and syringe with lidocaine are inserted into the tracheal lumen. Aspiration of air into the syringe confirms the position of the needle in the trachea. **B.** J-tipped guidewire is passed through needle into the trachea. **C.** Progressively larger dilators are passed over the guidewire into the trachea. **D.** Tracheotomy tube with obturator/dilator is passed into the trachea.

inspired oxygen (FiO_2) was increased to 100%. Continuous electrocardiographic, blood pressure, and pulse oximetric monitoring were used. Intravenous sedation with morphine or benzodiazepines was used if the patient was awake. The patient was positioned with the neck maximally extended, and the anterior neck was palpated for the optimal site for tracheotomy, midway between the cricoid cartilage and the sternal notch. The respiratory therapist or anesthetist was positioned at the head of the bed and was responsible for suctioning the endotracheal tube and mouth and manipulating the endotracheal tube attachments.

The anterior neck was then prepared with a povidone-iodine solution and draped in a sterile manner. The skin over the second to third tracheal rings was anesthetized with 4 to 6 mL of 1% lidocaine hydrochloride with 1:100,000 epinephrine solution. A 16-gauge introducer needle was attached to the syringe containing the lidocaine, and advanced gradually through the tissue overlying the selected site. The syringe plunger was aspirated frequently while advancing the needle until air bubbles entered the syringe, indicating that the tip of the needle had entered the tracheal lumen. The endotracheal tube was then moved up and down several times to determine whether it had been impaled by the needle. If the needle had impaled the tube, the needle was removed completely and reinserted after the endotracheal tube had been withdrawn at least 2 cm.

After the needle was satisfactorily positioned, the remaining lidocaine was injected into the trachea. While the needle was held securely in position, the syringe was removed and the J-tipped guidewire inserted through the

needle into the tracheal lumen. The introducer needle was removed, leaving the guidewire in place. A scalpel was then used to make a vertical stab incision in the skin, enlarging the cutaneous puncture site to approximately 1 cm. Pressure was applied with a gauze sponge to minimize blood loss. A short 10 F dilator was inserted over the guidewire and into the trachea to begin dilating the soft tissue at the tracheotomy site. The short dilator was removed, and a long 8 F guiding catheter was inserted over the guidewire. The stoma was then serially enlarged by passing the range of dilators (size 17 to 34 F), one at a time, over the guiding catheter into the trachea. Manual sponge pressure was maintained over the insertion site between dilatations to control bleeding. The tracheotomy tube with the obturator/dilator was then passed over the guidewire and guiding catheter, through the stoma with a twisting motion. After the percutaneous tracheotomy tube was inserted, the guidewire, guiding catheter, and the obturator/dilator were removed, leaving the tracheotomy tube in place. After auscultation of the lung fields to ascertain proper tube placement, the cuff was inflated and the tube secured with silk sutures and tracheotomy ties.

CASE REPORTS

Only seven patients were enrolled before the study was terminated because of unacceptable morbidity. Selected case reports with their associated complications are presented.

Case 3

A 63-year-old woman underwent a partial glossectomy, floor of mouth resection, and right modified neck dissection for a T_2N_0 squamous cell carcinoma of the right tongue and alveolar ridge. The patient was orally intubated for the operation and, at the close of the procedure, a percutaneous tracheotomy was planned for airway support. The initial puncture and dilatations proceeded without difficulty. However, the larger dilators and the tracheotomy tube with the obturator/dilator appeared to pass through the stoma with some resistance. After the tracheotomy tube was in place, diminished breath sounds were noted bilaterally and pulse oximeter readings declined rapidly. The patient was quickly reintubated orally, and a formal tracheotomy was done. Upon opening up the stomal wound, profuse bleeding was encountered from numerous vessels. Cauterization and silk ligatures were required for control of the bleeding. A tracheal puncture site was visible slightly to the right of midline, and a false passage tract was seen in the anterior mediastinum. A tracheotomy tube was placed in the conventional fashion and the endotracheal tube withdrawn. Auscultation of the lung fields revealed diminished breath sounds on the right side. A portable chest X-ray was obtained emergently, and a right pneumothorax was discovered. A chest tube was inserted, resulting in immediate resolution of the pneumothorax. The patient recovered uneventfully, and both chest tube and tracheotomy tube were eventually removed.

Case 4

A 51-year-old man with a T_2N_0 squamous cell carcinoma of his right larynx was to undergo a right vertical partial laryngectomy. After endotracheal intubation and triple endoscopy, a percutaneous tracheotomy was attempted. The needle was introduced into the trachea and the guidewire and guiding catheter were inserted. However, because of significant resistance, it was not possible to pass the larger dilators. The wound was then opened for a formal tracheotomy. Numerous bleeding vessels from the interposed thyroid gland were encountered and required cauterization. A hard calcified tracheal ring with a large overlying vein was identified. The vein had to be divided and ligated, and Mayo scissors were required to incise the cartilage for the tracheal stoma. The remainder of the operation proceeded without difficulty and the patient recovered uneventfully.

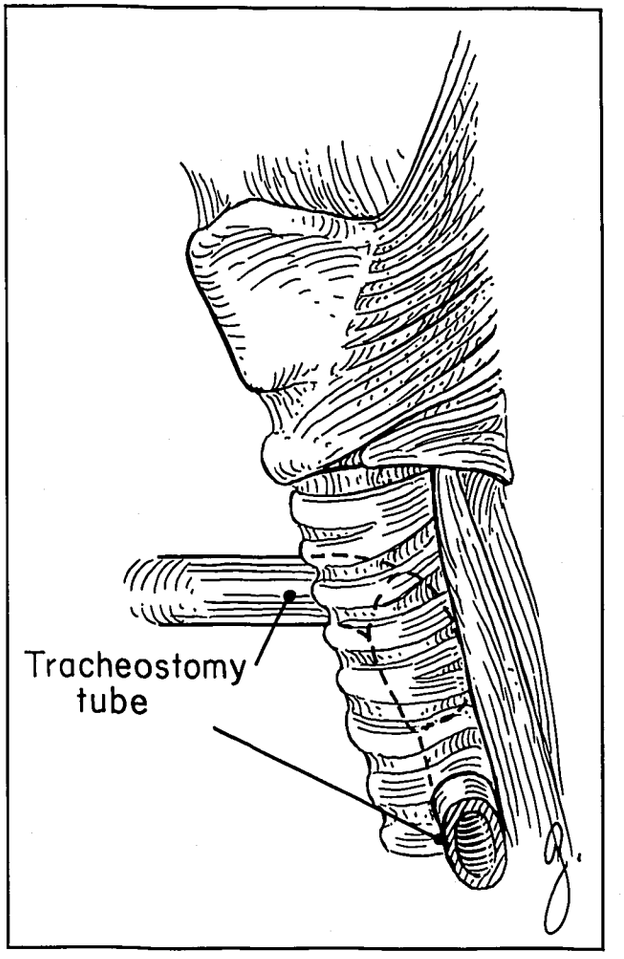

Fig. 2. Case 7. Tracheotomy tube had passed from anterior wall of trachea through posterolateral wall, resulting in placement of the tip of the tube in the tracheoesophageal groove.

Case 7

A 64-year-old woman suffered a dissecting aortic aneurysm from a motor vehicle accident. She underwent successful repair of this aneurysm and was extubated on postoperative day 2. Stridor was noted after extubation and, on indirect laryngoscopy, she was found to have both a left vocal cord paralysis and a right vocal cord paresis with a marginal airway. It was believed that the left vocal cord paralysis resulted from the aortic aneurysm repair, and the right vocal cord paresis was a longstanding condition from a

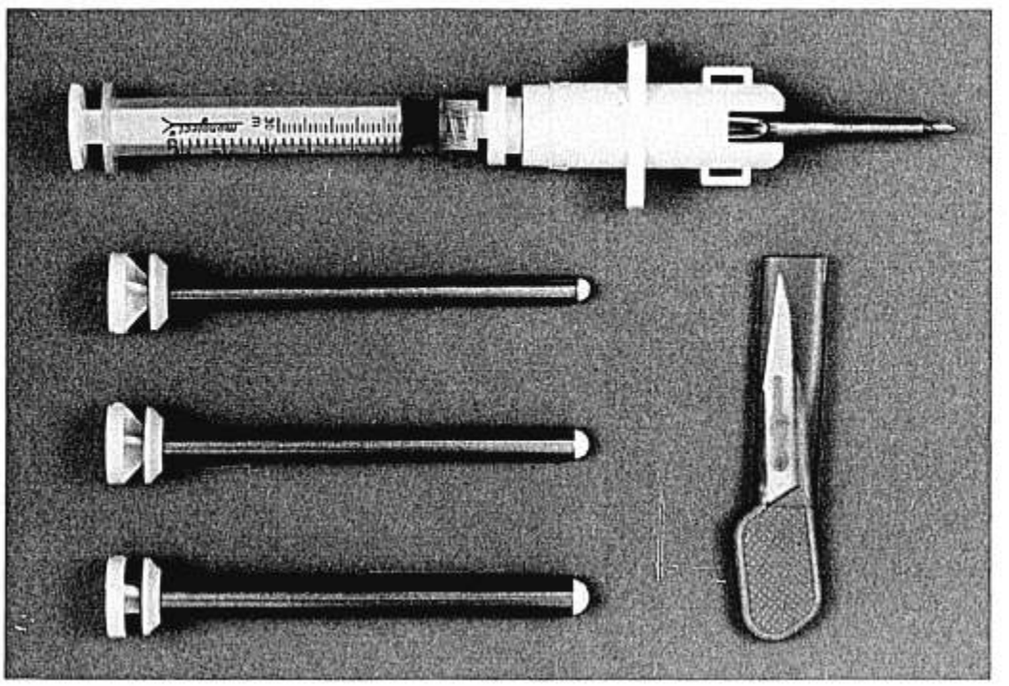

Fig. 3. Commercially available kit for emergency puncture tracheotomy, featuring syringe with needle, scalpel, and progressively larger metal trocars.

previous right carotid endarterectomy. Because of her narrow airway, a percutaneous tracheotomy was planned.

The patient was taken to the operating room and given intravenous sedation. The needle was introduced into the trachea and serial dilatations were done. The tracheotomy tube was placed, but it was noted that the patient could still phonate and breathe through her mouth. The tube was immediately removed, and attempts were made to intubate her orally. These efforts were unsuccessful, and an urgent, open tracheotomy was done. However, because of the initial period of loss of airway, the patient had become hypoxic, and was found to be cyanotic and pulseless. Cardiopulmonary resuscitation was initiated, but despite all resuscitative efforts the patient died. At autopsy, the patient was found to have a puncture in the anterior wall of the trachea and an exit site at the posterolateral wall. The tracheotomy tube had apparently traveled this false passage into the tracheoesophageal groove (Fig. 2).

DISCUSSION

Techniques for puncture tracheotomy have been used in the past, but articles describing these methods were fraught with reports of excessive morbidity, and the procedure was generally abandoned. By 1942, Chevalier Jackson, in his textbook *Diseases and Injuries of the Larynx,* had condemned "stabbing" of the trachea for tracheotomy and related numerous cases with both immediate complications and late stenosis.[10] However, even today commercially prepared kits for puncture tracheotomy are available, and they are being used for rapid airway access in emergency rooms and pulmonary intensive care units. These kits feature a syringe and needle for entrance into the trachea and progressively larger metal trocars to create a tracheostoma (Fig. 3). Use of these kits has resulted in many complications, including blind stabs above the cricothyroid membrane and disastrous punctures through the back wall of the trachea. Recently, the concept of a wire-guided percutaneous puncture technique for tracheotomy seemed promising. It was anticipated that a wire-guided technique would avoid the former difficulties with blind stabbing and false passages.

The use of a guidewire for percutaneous access to internal structures has had applications to many different procedures in medicine, including central venous catheterization, nephrostomy tube placement, and epidural catheterization for anesthetic purposes. Several authors have reported remarkable success with their series of percutaneous tracheostomies using a guidewire and serial dilatations.[7–9]

Conventional tracheotomy carries a significant risk of complications, including stomal infection, local hemorrhage, pneumothorax, and death.[1–6] In recent studies, morbidity with the percutaneous technique appeared to be less than that associated with formal tracheostomies. Various authors report the virtual absence of infectious complications and bleeding, and few difficulties with pneumothorax or subcutaneous emphysema.[7–9] Although it remains to be seen whether late tracheal stenosis will develop, preliminary studies demonstrate little or no incidence of stenosis.

In contrast to these initial favorable reports, our early limited experience indicates that the percutaneous technique is not as simple or risk-free as first believed. Specifically, the possibility of false passage of the tracheotomy tube is a significant hazard,

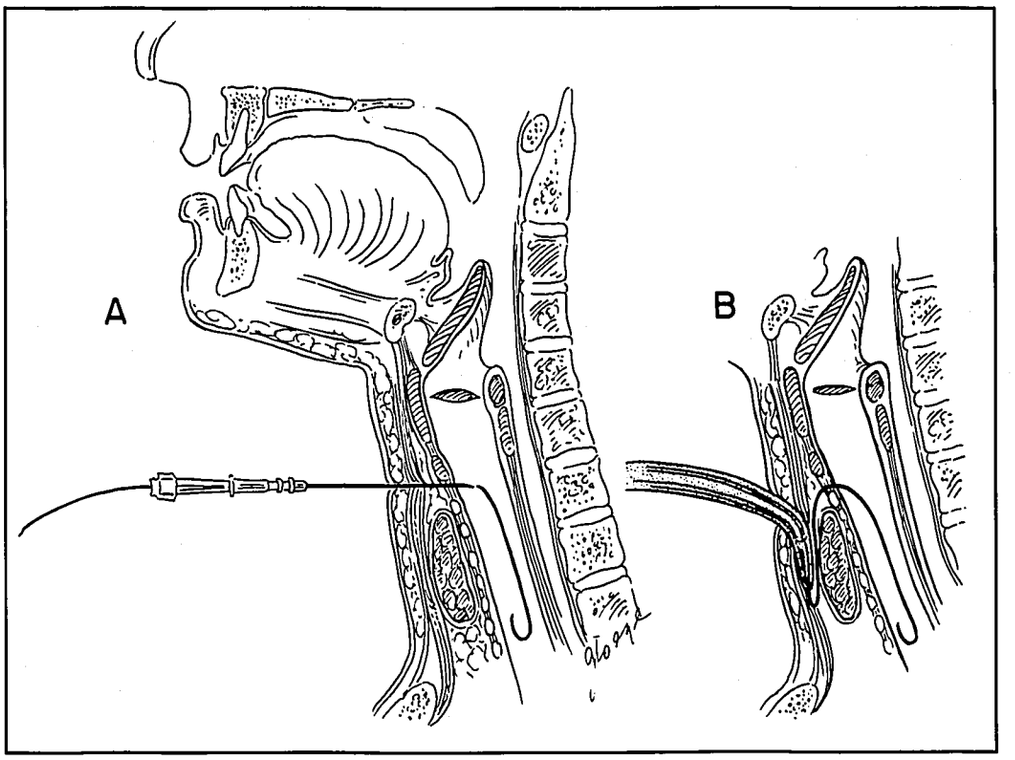

Fig. 4. False passage of percutaneous tracheotomy tube. **A.** Needle and J-tipped guidewire enter trachea correctly. **B.** Dilator encounters calcified tracheal ring and bends guidewire into the anterior mediastinum. As a result, subsequent dilators and tracheotomy also enter this false passage.

especially in patients with calcified tracheal rings. Despite proper placement of the needle and guidewire into the tracheal lumen, a calcified cartilage will tend to deflect the dilators and bend the guidewire. As a result, the dilators and tracheotomy tube can create a false passage into the anterior mediastinum, as in case 3 (Fig. 4). Blind passage of the dilators and tube may also result in punctures through the side or back wall of the trachea, as in case 7 (Fig. 2). Such haphazard tube placement can have disastrous consequences, as evidenced by the complications in the current series.

In addition, excessive bleeding appears to be a significant danger with this technique. The cases in our series that required conventional tracheotomy after failure of the percutaneous procedure were plagued by numerous bleeding vessels during the open tracheotomy. Verbal reports from surgeons who have attempted the puncture tracheotomy at other institutions have confirmed the hazards of bleeding and false passage.

When a patient is a good candidate for the procedure, *i.e.*, noncalcified tracheal rings, relatively long, thin neck, and easily palpable landmarks, the percutaneous technique is unquestionably rapid and simple. In those cases, the entire procedure can take only 1 to 2 minutes and clearly has advantages over conventional tracheotomies.

It is certainly possible that our complication rate reflects the experience of a teaching hospital situation and, with further training, morbidity can be minimized. However, that observation is true of any technique, and nullifies the purported advantage of the percutaneous method as being simple and readily mastered. Indeed, original plans for widespread distribution of these percutaneous tracheotomy kits to emergency rooms and intensive care units would have allowed nonsurgical specialists access to the technique. It is likely that complications such as ours would be encountered in those situations also.

In summary, the percutaneous tracheotomy technique was initially hailed as a rapid, safe method for immediate airway access. With reports of technical ease and infrequent complications, it appeared to be a technological breakthrough with widespread application in the hospital setting. However, as demonstrated by the previous case studies, this method is not fail-safe. Indeed, in untrained hands, percutaneous tracheotomies can be dangerous and even fatal. Although the puncture technique initially appeared to have merit, because of our experience and reports from other institutions of severe complications and deaths in the hands of supervised surgeons in training,[11,12] this investigation by Shiley Incorporated has been abandoned. The authors believe that this technique should be relegated to the wastepile of the many other previously failed puncture techniques for tracheotomy.

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BIBLIOGRAPHY

1. McClelland, R.M.: Complications of Tracheostomy. *Br Med J,* 2:567–569, 1965.
2. Mulder, D.S. and Rubush, J.L.: Complications of Tracheostomy: Relationship to Long Term Ventilatory Assistance. *J Trauma,* 9:389–402, 1969.
3. Head, J.M.: Tracheostomy in the Management of Respiratory Problems. *N Engl J Med,* 264:587–591, 1961.
4. Andrews, M.J. and Pearson, F.G.: Incidence and Pathogenesis of Tracheal Injury Following Cuffed Tube Tracheostomy With Assisted Ventilation: Analysis of a Two-Year Prospective Study. *Ann Surg,* 173:249–263, 1971.
5. Stauffer, J.L., Olson, D.E. and Petty, T.L.: Complications and Consequences of Endotracheal Intubation and Tracheotomy: A Prospective Study of 150 Critically Ill Adult Patients. *Am J Med,* 70:65–76, 1981.
6. Heffner, J.E., Miller, K.S. and Sahn, S.A.: Tracheostomy in the Intensive Care Unit. Part 2: Complications. *Chest,* 90:430–436, 1986.
7. Hazard, P.B., Garrett, H.E., Adams, J.W., *et al.*: Bedside Percutaneous Tracheostomy: Experience With 55 Elective Procedures. *Ann Thorac Surg,* 46:63–67, 1988.
8. Ciaglia, P., Firsching, R. and Syniec, C.: Elective Percutaneous Dilatational Tracheostomy. *Chest,* 87:715–719, 1985.
9. Schachner, A., Ovil, Y., Sidi, J., *et al.*: Percutaneous Tracheostomy—A New Method. *Crit Care Med,* 17:1052–1056, 1989.
10. Jackson, C. and Jackson, C.L.: *Diseases and Injuries of the Larynx.* The Macmillan Co., New York, pp. 89–93, 1942.
11. Pelausa, E.O.: Percutaneous Tracheostomy: Ready or Not? *J Otolaryngol,* 20:88–92, 1991.
12. Skowronski, G.A., Bersten, A.D. and Vedig, A.E.: Bleeding Risk With Percutaneous Tracheostomy. *Anaesth Intensive Care,* 18:273, 1990.

DISCUSSION

HASKINS K. KASHIMA, MD, Baltimore: The presentation by Dr. Wang was very nice. It included, in the written form, a very carefully detailed description of the technique for performing wire-guided tracheostomy. The evaluation in this case was carried out in the most favorable circumstances. In other words, the conditions were ideal; the people performing the tracheostomies were otolaryngology residents familiar with the anatomy and technique of the tracheotomy. It was regrettable that such an adverse experience was found.

There were some modifications that might possibly preserve this alternate technique. Firstly, the authors have indicated that a skin incision, and they specified approximately 1 cm in length, was made and that the trachea was entered using the 16-gauge needle only. If the tracheal opening could have been made with scalpel, which would be possible, the risk of a blunt laceration of the tracheal rings could be reduced, and possibly the false passage, as well as the necessary force that would invite the risk of a posterior and lateral penetration might have been reduced. A larger guidewire might avoid the risk of buckling as well as the false passage.