Elective Percutaneous Dilatational Tracheostomy*
A New Simple Bedside Procedure; Preliminary Report

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The development by the senior author (P.C.) of percutaneous tracheostomy from cricothyroidostomy and subcricoid fingertip tracheostomy is traced, and the technique and patient material of percutaneous subcricoid tracheostomy is presented. This new technique consists of inserting a tracheostomy tube by the use of a J guide wire inserted through a cannula into the tracheal lumen. Tapered dilators follow the guide wire and dilate the opening in the tracheal walls. A tracheostomy tube snugly fitted over a dilator is then passed into the trachea between the cricoid cartilage and the first tracheal ring. This procedure avoids the immediate and postoperative complications of "standard" tracheostomy. An experience of 134 tracheostomies of various types culminated in the development of the percutaneous technique. To date 26 such operations on 24 patients have been done with no significant complications due to the operation. The percutaneous technique should reduce the severity and incidence of intraoperative complications. Late complications, which have been no problem to date, are being evaluated with longer follow-up and with a greater patient population.

As a general thoracic surgeon, I began changing my technique of "standard" tracheostomy after reading the stimulating article by Brantigan and Grow in 1976 on cricothyroidostomy. Initially, we used their technique on selected patients. We did our first cricothyroidostomy on 10/1/76 and have performed a total of 42, the last one on 12/19/82.

In performing cricothyroidostomy, we were always a little reluctant (as others) about putting a tube through the traumatized larynx of a patient who had been subjected to translaryngeal intubation for more than a short time (two to three days). However, often the surgeon is asked to see a patient who has had translaryngeal intubation for well over three days.

The object of this report is to advocate and document the use of the smallest possible skin incision and tracheal stoma, with snug insertion of the smallest flexible tubes consistent with adequate air flow and effective suctioning of secretions. This principle applies to any site selected, but the level recommended in this article is the subcricoid space, that is, between the cricoid cartilage and the first tracheal cartilage or, when feasible, between the first and second tracheal cartilages. The percutaneous introduction is advocated if there is no contraindication (ie, enlarged thyroid, child, emergency). The earlier it is done, the better—within 48 to 72 hours or even earlier after translaryngeal intubation to avoid the complications of translaryngeal intubation, which increase with its duration.

To avoid traversing the larynx proper, we selected the subcricoid route. This tracheal level, which is wider and not so rigid, would be expected to be less prone to damage from a previous translaryngeal tube.

Background of Development of Percutaneous Technique

Fingertip Subcricoid Minitracheostomy

With these thoughts in mind, we developed a so-called fingertip subcricoid minitracheostomy and did 26 such procedures with no significant operative complications. With a small incision, the tip of the index finger not only palpates the lower edge of the cricoid cartilage but can also palpate the endotracheal tube through a small tracheal opening. The fingertip feels the movement of the translaryngeal tube as it is withdrawn and as it slowly passes cephalad of the palpating fingertip, the finger is withdrawn, and the tracheal tube is inserted into the trachea. This is very similar to the operation described by Roe, with our addition of palpating the indwelling translaryngeal tube with the fingertip and using this as a guide.

A small surgical tract and a small flexible tube are conducive to less trauma, less tissue reaction, and less infection because of the smaller size of the skin incision and of the tracheal stoma itself. Very important also with this approach, the tube is inserted between the

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FIGURE 1. Percutaneous tracheostomy assembly. Outer diameter of dilator should be slightly less than the inner diameter of the tracheostomy tube if single. If an inner cannula is used, this is removed and the dilator should fit inside the outer tube snugly.

cartilages without cutting them and fits snugly into the stoma and wound. As we began using smaller tubes, our incision became smaller, with a skin incision long enough to admit only the fingertip for better palpation of the cricoid cartilage.

As we gained experience, we thought that probably the entire procedure could be done percutaneously—that is, using the technique of following a guide wire with a dilator with the tracheostomy tube already threaded snugly on the dilator.

PERCUTANEOUS TECHNIQUE

All percutaneous techniques use the same underlying principles with modifications for the particular organs involved and the purpose of the procedure: drainage of a cavity, insertion of permanent pacemaker electrodes, percutaneous nephrostomy, and, in our case, the placement of a tracheostomy tube.

In developing our technique, we modified the set-up for percutaneous nephrostomy—Amplatz renal dilator set. Figure 1 shows a diagram of assembly. We are trying to get the exact sizes and proper lengths made to specifications for 6-, 7-, and 8-mm ID tracheostomy tubes.

The first step is careful inspection and palpation to identify the thyroid cartilage and especially the cricoid. Lidocaine, ½% (Xylocaine) with epinephrine is injected, and a small vertical incision is made, beginning below the lower edge of the cricoid cartilage and going downward about 1 cm to 1½ cm. A vertical incision has been used, since, if necessary at any time, it could be extended further downward to perform a so-called standard tracheostomy. This has not been necessary to date. Then a mosquito clamp is inserted to spread gently the tissues in the midline below the cricoid cartilage guided by palpation with the left index finger.

The respiratory therapist (RT) is asked to deflate the endotracheal tube cuff and withdraw the endotracheal tube to approximately just below the cords. FIO₂ and ventilation are increased as needed to make up for any air leakage with the deflation of the cuff.

More Xylocaine is injected into the tissues around the trachea at this level, and then a fine needle is inserted through the space below the cricoid cartilage into the tracheal lumen. If it impales the endotracheal tube, it is withdrawn and the RT is asked to withdraw the endotracheal tube about 1 cm. The needle is then reinserted and the maneuver is repeated until there is no impalement of the endotracheal tube and a free flow of air is obtained.

The impalement of the tube is verified by having the RT move the tube back and forth about 1 cm; the needle can be seen and felt to move.

When a free flow of air has been obtained, the fine needle is removed and then a catheter needle attached to a small syringe containing ½% Xylocaine with epinephrine is now carefully inserted in the midline, directing it posteriorly and slightly downwards in the space between the cricoid cartilage and the first tracheal cartilage. As soon as the tracheal lumen is entered, air bubbles are aspirated into the syringe, and about ½ ml of solution is instilled. The cannula is held in place and the syringe and the needle are removed. Through the cannula, a flexible J wire guide (.052 in) is inserted and passed downward for about an inch or two beyond the end of the catheter, which is then withdrawn, leaving the guide wire in place in the lumen of the trachea. At this time, the endotracheal cuff may be totally or partially reinflated if deemed necessary.

Over the guide wire is threaded the 8F Teflon catheter guide. A 12F dilator is then inserted over the guide at about a 45° downward angle for about 1 to 2 in. There is some resistance if the direction is too oblique, since the first tracheal cartilage usually is slightly posterior to the lower edge of the cricoid cartilage. Because of this, the skin incision should be placed low enough so that on insertion, the tip of the dilator is directed between the cricoid and the first tracheal cartilage and not against the first tracheal cartilage.

Occasionally in older individuals it may be necessary to use a mosquito clamp to dissect in front of the 18F dilator to help start its insertion into the trachea. Lately, we have started with a 12F or 14F dilator.

One next goes to a 24F dilator and replaces this with a 26F or 28F. This is usually adequate to dilate the
stoma to receive a 6-mm internal diameter tracheostomy tube snugly fitted onto an 18F dilator.

The flexible tapered dilators tend to go in easily, but there is some resistance when the tracheostomy tube itself is being inserted. If this is encountered, the dilator and tracheostomy tube can be removed, leaving the guide wire in place. Over this, a larger dilator—larger than the size of the outer diameter of the tracheostomy tube—is temporarily inserted to widen the opening. This dilator is then removed and the dilator with the tracheostomy tube is inserted.

Once the tracheostomy tube is in up to its flange, the dilator and wire guide are promptly removed and the patient is connected to the ventilator or T tube. During the insertion, the respiratory therapist has carefully withdrawn the endotracheal tube upward but not above the cords, so that if needed it may be reinserted. It is removed as soon as the tracheostomy tube has been placed. Occasionally, one suture is taken at the lower end of the incision.

To date, we have performed 26 percutaneously in 24 patients; two patients underwent the procedure twice at intervals of several months; one was a percutaneous cricothyroidostomy; 25 were percutaneous subcricoid tracheostomies. Of these 25, one patient underwent the procedure probably between the second and third tracheal cartilages, since she had had a thyroidectomy for carcinoma and the isthmus of the thyroid had been removed at the time of the operation some weeks before.

Discussion
Why Percutaneous Tracheostomy?

The standard tracheostomy, like any other operation, has certain inherent complications— intraoperative, and early and late postoperative. It is difficult to evaluate and compare the incidence, severity and causes of complications in published series of patients because of differences in surgical technique, patient populations, length of intubation, and many other important variables.

The "Standard" Tracheostomy

This operation is far from standard. In the 6th edition (1982) of the Textbook of Otolaryngology by DeWeese and Saunders, they state, "Many complications are associated with tracheostomy, both in the actual performance of the operation and in the postoperative management." In the technique, even the size of the incision varies a good deal. DeWeese and Saunders state,

A vertical incision is made in the midline of the neck from the lower border of the thyroid cartilage to one or two fingerbreadths above the suprasternal notch. The incision should not be unnecessarily long, but an incision that is too long is greatly preferable to one that is too short.

This indeed sounds like a long incision!

An incision from 3 to 5 cm is recommended by Applebaum and Bruce. 8

Besides the length of the skin incision, the size of the tracheal stoma proper and the size of the tracheostomy tube seem to vary with the specialty and the individual surgeon. The importance of the size of the tube was pointed out in 1971 by Andrews and Pearson. 6 They found, "A significant relation was observed between the diameter of the tracheostomy tube and the incidence of stricture" (larger diameter tubes were associated with a higher incidence of stenosis).

The complications of standard tracheostomy seem inordinately high in the face of a relatively small and simple surgical procedure. However, as pointed out above, the standard operation is far from standard. The differences in background, skill, and experience of the surgeon are brought out in the article by Stauffer et al. 7 In reporting the complications of 51 standard tracheostomies, the timespan and the number of surgeons who performed these operations is not given; but it is obvious that there must have been a sizable number of different surgeons involved. They were from "the surgical staff and house staff from the Departments of Surgery, Otorhinolaryngology, and Neurosurgery" of two different hospitals. This number of surgeons and the spread in skill, specialty, and experience, no doubt account for the substantial incidence of operative and postoperative complications. In a teaching hospital, it is often beneath the dignity of the senior surgeons to bother with this "minor" operation, and it is felt to be very suitable for use as a teaching experience for the surgical novice.

Tracheostomy complications are listed by Applebaum and Bruce 1976 in their monograph.

In contrast to the above, the percutaneous technique offers the smallest possible tube (and stoma) consistent with adequate air flow and suctioning ability. This minimal size aids in avoiding hemorrhage. When properly done, large vessels are avoided, and the oozing accompanying the small incision is tamponaded by the snug fit of the tube. In addition, the problem of infection is reduced, since less tissue is exposed for possible contamination. In addition, a flexible tracheostomy tube is recommended.

The procedure is done in bed (ICU) using local anesthesia, with no standby anesthetist, with the patient most of the time on a ventilator and with a translaryngeal tube in place. There is no need for transportation to the OR. These are definite advantages compared to "standard" tracheostomy.

The percutaneous technique can be used at the cricothyroid level, the subcricoid level or lower, between the first and second tracheal cartilages. When there is question of damage to the larynx by translaryngeal intubation, the lower level site is manda-
Intraoperative leak, and has not been a problem.

Results

In the period studied from the first cricothyroidostomy, 10/1/76 to 11/5/84 (eight years) we have personally performed 134 tracheostomies on 132 patients. The technique varied from a standard tracheostomy (40 patients), cricothyroidostomy (42), subcricoid fingertip tracheostomy (26), to percutaneous technique (26).

We are reviewing only the results of the percutaneous-type operations, not the other procedures, since we no longer use them except under unusual circumstances.

Percutaneous Technique

These 24 patients were seen from 4/8/82 to 11/5/84. There were 14 women and 10 men, with an age range of 21 to 85 (mean age of 61). Eleven patients, approximately 45 percent, died of progression of their underlying disease or disease with the tracheostomy functioning, with no difficulties or complications. Autopsies were not obtained. The interval from the institution of tracheostomy to death varied from two to 220 days, with a mean of 41 days. Thirteen patients survived and 12 went on to extubation and have had no late complication to date—but follow-up, of course, in some is short, and they are being followed-up clinically and radiologically. The interval between tracheostomy and extubation varied from five to 51 days with a mean of 19 days. The 13th patient still has a tracheostomy tube and has been on a ventilator for nine days as of 11/14/84.

Intraoperative Complications

There has been no intraoperative complication of any note. Occasionally there is some difficulty in inserting the tracheostomy tube, but with a little additional dilatation of the stoma using dilators several French sizes larger than the tracheostomy tube, the difficulty can be overcome.

In our 13th operation on a 58-year-old man who had had a standard tracheostomy five years before, we encountered a good deal of difficulty because the healed trachea and surrounding tissues were extremely fibrotic and distorted. A No 11 blade had to be used to make a small initial puncture. The operation was finished without any further difficulty using a No 7 SCT Shiley tracheostomy tube.

There has been no problem with hemorrhage of any kind; there have been no false passages, no injury of the esophagus, no cardiac arrests, no pneumothorax, and no subcutaneous emphysema.

Deflation of the translaryngeal tube cuff necessitates temporary use of large tidal volumes and increased rate, with increased FIO₂ to compensate for the air

Elective Percutaneous Dilatational Tracheostomy (Clogil, Fraching, Synlec)
If physicians can be shown that percutaneous tracheostomies are safe, simple, bedside operations with minimal long-term complications, they will request it to be more frequently and earlier. This would help avoid the disadvantages, and short- and long-term complications, of prolonged translaryngeal intubation.

The heavy hand of Chevalier Jackson, Sr still pushes the hand of the modern surgeon away from the larynx during tracheostomy. But as pointed out by Brantigan and Grow\textsuperscript{a} and others,\textsuperscript{3} when tracheostomy is performed for bronchopulmonary conditions with a normal larynx, cricothyroidostomy may be used with equal if not better results, if performed properly and with smaller tubes. The same is true of percutaneous subcricoid tracheostomy, which has the added safety factor of not going through a possibly traumatized larynx (due to the translaryngeal intubation).

The one patient with the temporary subglottic narrowing demonstrated on tomography went on to complete resolution as demonstrated by follow-up tomography with no special treatment. We feel that this temporary complication was due to the prolonged, traumatic translaryngeal period of intubation and was not related at all to the percutaneous subcricoid tracheostomy.

ADDENDUM

Since submission of this article, eight additional operations have been performed with no complication, bringing the total number to 34.

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REFERENCES


Update In Cardiopulmonary Medicine

This postgraduate program will be held, under the direction of Dr. Faroque Khan, in Srinagar, Kashmir, India, August 19-23 in connection with the Silver Jubilee Celebration of Srinagar Medical College. Co-sponsors are the International Academy of Chest Physicians and Surgeons of the American College of Chest Physicians, Srinagar Medical College and Institute of Medical Sciences. The faculty members are from the US and Kashmir. For further information, contact: Faroque Khan, M.B., Chief, Pulmonary Medicine, Queens Hospital Center, 82-68 164th Street, Jamaica, New York 11432 (718:990-3605).