

DISCLAIMER: These guidelines were prepared by the Department of Surgical Education, Orlando Regional Medical Center. They are intended to serve as a general statement regarding appropriate patient care practices based upon the available medical literature and clinical expertise at the time of development. They should not be considered to be accepted protocol or policy, nor are intended to replace clinical judgment or dictate care of individual patients.

PERI-PROCEDURAL TRACHEOSTOMY COMPLICATIONS

SUMMARY

Percutaneous dilatational tracheostomy (PDT) is associated with a low complication rate and facilitates patient weaning from mechanical ventilation. The most common peri-procedural complications are hypoxemia and hemorrhage. While fatal PDT complications are rare, they are dramatic when they occur. All patients being considered for tracheostomy should be carefully evaluated pre-operatively for risk factors that predict difficult tracheostomy.

RECOMMENDATIONS

- **Level 1**
 - **None**
- **Level 2**
 - **Tracheostomy should be performed by an experienced surgeon in the following patients with increased risk of peri-procedural complications:**
 - **Short neck**
 - **Inability to extend the patient's neck**
 - **Body mass index (BMI) \geq 30**
 - **Previous neck surgery or radiation (other than previous tracheostomy)**
 - **PDT should be performed using the modified open single dilator technique**
 - **Fiberoptic bronchoscopy should be employed in patients with difficult anatomy, while surgeons are learning to perform PDT, or when questions arise regarding placement during the procedure.**
- **Level 3**
 - **Conversion of a PDT procedure to open surgical tracheostomy should be considered if the following are present**
 - **Palpable innominate artery**
 - **Short thyrosternal distance**
 - **Unusual anatomy or hemorrhage**
 - **Anticipated difficult intubation or PDT procedure**

INTRODUCTION

Tracheostomy is one of the most commonly performed surgical procedures in the intensive care unit setting. Tracheostomy-related complications occur in 3-15% of patients (1-5). These are commonly divided into early and late complications. Early complications include peri-procedural hemorrhage, hypoxemia, airway loss, pneumothorax, and infection. Late complications include tracheostomy stenosis due to granulation tissue, upper airway obstruction, tracheoesophageal fistula, tracheoinnominate artery fistula (TIF), tracheomalacia, and tracheal stenosis. Fatal PDT complications are rare, but dramatic when they occur. TIF is perhaps the most noted tracheostomy-related complication with a reported incidence of 0.1-1%, a peak incidence of 7-14 days post-procedure, and mortality rates approaching 100% (4).

EVIDENCE DEFINITIONS

- **Class I:** Prospective randomized controlled trial.
- **Class II:** Prospective clinical study or retrospective analysis of reliable data. Includes observational, cohort, prevalence, or case control studies.
- **Class III:** Retrospective study. Includes database or registry reviews, large series of case reports, expert opinion.
- **Technology assessment:** A technology study which does not lend itself to classification in the above-mentioned format. Devices are evaluated in terms of their accuracy, reliability, therapeutic potential, or cost effectiveness.

LEVEL OF RECOMMENDATION DEFINITIONS

- **Level 1:** Convincingly justifiable based on available scientific information alone. Usually based on Class I data or strong Class II evidence if randomized testing is inappropriate. Conversely, low quality or contradictory Class I data may be insufficient to support a Level I recommendation.
- **Level 2:** Reasonably justifiable based on available scientific evidence and strongly supported by expert opinion. Usually supported by Class II data or a preponderance of Class III evidence.
- **Level 3:** Supported by available data, but scientific evidence is lacking. Generally supported by Class III data. Useful for educational purposes and in guiding future clinical research.

Percutaneous dilatational tracheostomy (PDT), first described by Ciaglia et al in 1985, is the surgical insertion of a tracheostomy tube using a modified Seldinger technique (6). Initially described as truly percutaneous without direct visualization of the trachea, most surgeons performing this procedure now perform a modified open technique in which a limited dissection of the central neck is performed allowing direct palpation of the anterior trachea to ensure appropriate placement (3,7). Comparative studies and meta-analyses have shown that PDT and open surgical tracheostomy are associated with similar complication rates (3,4). PDT has largely replaced open tracheostomy in the critical care setting as it can be performed safely at the patient's bedside, does not require operating room time, and is more cost-effective (1,4,7).

Fiberoptic bronchoscopy and ultrasound have both been suggested to improve the safety of PDT. Fiberoptic bronchoscopy should always be performed when the classic Ciaglia percutaneous technique is employed to avoid iatrogenic injury to adjacent anatomic structures or paratracheal insertion. The modified open PDT approach negates many of the benefits of fiberoptic bronchoscopy as the trachea is directly palpated and commonly visualized. Bronchoscopic guidance is especially helpful while surgeons are learning to perform PDT or in patients with difficult anatomy. A bronchoscope should always be available at the bedside during a PDT procedure if not used routinely. Tracheostomy-related complication rates decrease significantly once a surgeon has performed 30 or more such procedures (3). Ultrasound facilitates identification of the tracheal midline and level of tracheal cartilages as well as identifying vulnerable adjacent anatomic structures such as the thyroid gland or blood vessels. The literature does not convincingly support using these imaging technologies routinely, but rather as an adjunct in select patients at risk for complication or during the "learning curve" of a surgeon's experience in performing PDT.

A procedural video illustrating the proper technique for PDT is available at www.surgicalcriticalcare.net

LITERATURE REVIEW

Das et al. performed a national survey of 469 otolaryngologists to estimate the incidence of four specific tracheostomy-related complications: TIF, esophageal fistula, acute tracheostomy occlusion, and obstructing granuloma (1). Although subject to potential reporting bias (only 469 out of over 10,000 otolaryngologists responded), the survey estimated that approximately 500 tracheostomy procedures result in death or permanent disability in the United States each year. They further estimated that a otolaryngologist would encounter a catastrophic tracheostomy-related complication once every ten years of practice. Over 90% of complications occur greater than one week post-procedure. Accidental decannulation (34.3%) and bleeding (31.6%) were the most common complications reported. Only 4.7% of complications were intraoperative (of note, the vast majority of respondents performed open surgical tracheostomy).

Shah et al. performed a retrospective national database review of 113,653 tracheostomies performed in the United States in 2006 (2). The overall complication rate was 3.2%. The in-hospital mortality rate was 19.2% suggesting that tracheostomy is an uncommon cause of hospital mortality. Mortality was higher among patients older than 50 years of age and those with cardiac disease.

Kost et al. performed a prospective evaluation of 500 patients undergoing PDT in an intensive care unit setting (3). One hundred ninety-one patients received the Ciaglia multiple dilator technique and 309 patients the Ciaglia Blue Rhino single dilator technique. Fiberoptic bronchoscopy was utilized in all cases. The overall complication rate was 9.2% (13.6% in the multiple dilator group, and 6.5% in the single dilator group), with more than half of these considered minor. Overall, the two most common complications were oxygen desaturation (2.8%) and bleeding (2.4%). Obese patients (BMI \geq 30) were more likely to have complications compared to patients with BMI < 30 (15% vs. 8%; $p < 0.05$). Surgeons who had performed fewer than 30 multiple dilator PDT procedures had a complication rate of 40% compared to only 9% for surgeons who had performed 30 or more such procedures ($p < 0.0001$). Surgeons who had performed fewer than 30 single dilator PDT procedures had a complication rate of 10% compared to only 6% for surgeons who had performed 30 or more such procedures ($p = ns$). The multiple dilator PDT technique was associated with a non-significantly higher rate of complications compared to the single dilator method (14% vs. 6%; $p = ns$).

Gilbey reported a fatal PDT-related complication (airway loss) and reviewed the literature on reported fatal PDT complications (4). Common causes of fatal complications included airway loss, major hemorrhage, previous neck surgery, inappropriately low tracheostomy placement, posterior tracheal

perforation or injury. Gilbey suggested that any vascular pulsation palpated over the tracheostomy site mandates preoperative ultrasound or conversion to open surgical tracheostomy. Tracheostomy should be performed with caution in patients with previous neck surgery, radiation, or unclear surgical anatomy. If a difficult intubation or PDT procedure is anticipated, it may be preferable to not attempt PDT, but instead to perform surgical tracheostomy in the controlled setting of the operating room where significant tracheostomy-related complications may be more easily managed.

Halum et al. performed a retrospective review of 1,175 tracheotomies performed at eight institutions (5). 77.8% of the procedures were open surgical tracheostomy while 16.9% were PDT (5.4% unknown). Intraoperative, early (<1 week), and late complication rates were 1.4%, 5.6%, and 7.1% respectively. The intraoperative mortality rate was 0.4%. Postoperative bleeding was the most common complication (2.6%) and airway stenosis the most common late complication (1.7%). The use of large endotracheal tubes and obesity were associated with the development of airway stenosis ($p<0.05$). PDT was associated with a significantly higher rate of postoperative bleeding (6.1% vs. 1.9%; $p<0.05$). Tracheostomy requirement was a poor prognostic sign for hospital survival due to the patient's comorbid conditions.

ORMC PRACTICE

An invasive procedure cart dedicated to PDT is available and brought to the bedside for each procedure. A fiberoptic bronchoscope is similarly available at bedside. Bronchoscopy is not performed routinely, but rather for complex patients with risk factors for peri-procedural complications. An experienced surgical intensivist is present and directly supervises and participates in each procedure. The surgeon directly palpates the trachea after anterior dissection and confirms the appropriateness of the proposed site before tracheal puncture is performed. An experienced respiratory therapist manages the patient's airway and withdraws the endotracheal tube prior to tracheal puncture. The patient's critical care nurse administers narcotics, sedatives, and neuromuscular blocking agents, under the surgeon's direction, and monitors the patient's vital signs.

Patients found during pre-procedure evaluation to be at increased risk for peri-procedural tracheostomy complications are considered for open surgical tracheostomy. If PDT is still felt to be appropriate, an additional surgical intensivist and a respiratory therapy supervisor are commonly included in the procedural team.

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