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Tracheal Stenosis Based on Surgical Technique

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Abstract

Introduction: Tracheostomy is a common procedure performed for critically ill patients. Two techniques used are percutaneous dilatational tracheostomy (PDT) and open surgical tracheostomy (ST). Hemorrhage and other early complications are readily apparent after these procedures. Late complications, such as tracheal stenosis (TS), are difficult to assess due to patient discharge and poor follow-up. The prevalence of symptomatic TS is 0-10%, and is not symptomatic until 50-75% of the tracheal diameter is compromised. We aimed to define the rate of TS at our Level I trauma center and compare techniques. **Methods:** We performed a retrospective review of patients who underwent tracheostomy at our institution from 01/01/2000 to 12/31/2015 and identified patients with complications using ICD-9 codes. Medical records and operative reports were reviewed to identify surgical technique and type of complication. Prevalence of complications was calculated using frequency statistics. **Results:** Of the 2315 patients undergoing tracheostomy at our institution, 81 experienced complications for an overall prevalence of 3.5%. These included bleeding, 0.9% (n = 20), infection 0.3% (n=8), and mechanical issues at 1.3% (n=31). The prevalence of TS was 0.4% (n=10). Of these patients, 20% (n=2) had PDT and 70% (n=7) had open procedures. Complications were more prevalent in men (75.3%, n=61), especially regarding TS (70% of stenosis cases, n=7), bleeding (90% of bleeding cases, n=18), and mechanical issues (67.7%, n=21). **Conclusion:** We report a 3.47% prevalence of tracheostomy complications and 0.4% prevalence of stenosis. The PDT technique had a decreased prevalence of stenosis compared to open techniques. While there was a trend for more complications related to being a male, the limited prevalence of cases could not yield statistically significant effects. The medical records of the patients who did not experience complications are of interest to elucidate pertinent aspects of technique or procedure resulting in higher prevalence of complications. Reviews of these charts are underway.

Introduction

Tracheostomy is a common procedure performed in critically ill patients. Although a standard, open surgical tracheostomy procedure (ST) is often used, the percutaneous dilatational tracheostomy (PDT) has become increasingly popular and is widely adopted in critical care units. While short-term complications such as bleeding and infection are readily apparent in the literature, long-term complications such as tracheal stenosis (TS) are more difficult to quantify as the patients are discharged before de-cannulation and follow-up is incomplete. Per a number of prospective cohort series, subclinical disease can be found 10% of survivors [1] with clinically evident lesions in 0-.35% [2-4] highlighting the subclinical nature of disease. Recent systematic reviews cite the difficulties in ascertaining a superior surgical technique based on complication profiles due to lack of uniform reporting in addition to the fact that it is unlikely that an RCT will be performed to determine the prevalence of long-term outcome measures such as TS in the future owing to its low prevalence, high critical illness mortality, and difficulty in long term follow-up [2]. There is also little direct evidence linking perioperative complications with etiology of TS, although tracheal ring fracture is the only perioperative event that has been postulated to have a role in the genesis [5-7]. In the past, it has been postulated that the percutaneous route predisposed patients to a higher prevalence of TS due to the higher placement on the trachea with subsequent increase in trauma and granulation tissue when passing [5]. Subsequent studies have failed to show this correlation, with most displaying a trend towards a lower prevalence of TS associated with PDT compared to ST. Other studies have also shown PDT to be safe and likely more cost-effective than the traditional ST [8-10]. The purpose of this study is to compare the outcomes and complications of tracheostomy based on surgical technique with an emphasis on tracheal stenosis.

Methods

This retrospective review was carried out at The University of Tennessee Medical Center, Knoxville (UTMCK), which is a busy level-1 trauma center. The Trauma/Surgical Intensive Care Unit is a 15 bed unit with a 7 bed overflow unit. Data supplied was from a group of 20 surgeons practicing at UTMCK. After IRB approval, we performed a retrospective review of patients who underwent tracheostomy at our institution from 01/01/2000 to 12/31/2015, using the ICD-9 code 31.1 for temporary tracheostomy. Only patients who underwent tracheostomy by the general surgeons were included. Those procedures performed by other services such as Cardiothoracic Surgery, ENT, OMFS, or Medical Critical Care were omitted due to non-uniformity between the providers and service lines. We identified the patients who experienced complications using ICD-9 codes related specifically to stenosis, bleeding, infection, and mechanical issues (cuff leak, obstruction, and dislodgement). In ICD-9, the 519.00 series of codes identify unspecified complications (519.00), infection (519.01), mechanical complication (519.02), and other complication (519.09) of tracheostomies. 519.02 can be used to identify stenosis, stricture, or malfunction. 519.09 can signify granulomatous conditions, obstruction, or hemorrhage. We

found the non-uniformity of coding led to unreliable characterization of complications, such as hemorrhagic conditions placed into unspecified complications (519.00) rather than other complications (519.09). This variability required abstraction of information directly from the medical record.

These medical records and operative reports identified the surgical technique and basic demographic data. Specifically, we determined whether the patients received an ST versus PDT. The former requiring a neck incision and dissection down to the level of the trachea and direct performance of tracheotomy and placement of the treacheostomy tube. Whereas the latter is performed via a "nick incision" in the skin of the neck, approximately two finger breadths above the sternal notch, and Seldinger technique is used to dilate and advance the tracheostomy tube into the trachea. This can be performed with or without direct bronchoscopic visualization through the indwelling endotracheal tube. Prevalence of complications was calculated using frequency statistics. All analyses were conducted using SPSS Version 22 (Armonk, NY: IBM Corp.).

Results

Of the 3,744 records were identified, 2,315 patients underwent a tracheostomy with general surgeons. A total of 81 patients were noted to have complications, leading to a prevalence of 3.47%. These included bleeding (n=20, 0.9% of all cases), infection (n=8, 0.3% of all cases), mechanical issues, (n=31, 1.3% of all cases), and wounds, (n=12, 0.5% of all cases). The prevalence of TS was 0.4% (n=10). See Table 1 for frequencies and percentages.

Complications were much more prevalent in men (n=61, 75.3% of all complications), especially in regards to TS (n=7, 70% of stenosis cases), bleeding (n=18, 90% of bleeding cases), mechanical issues (n=21, 67.7% of mechanical issues), and wounds (n=9, 75% of wound cases). See Table 3 for the frequencies and percentages of gender and complications.

Outcome	Complication type	Frequency (%)
	Bleeding	20 (0.9%)
	Infection	8 (0.3%)
	Mechanical Issues	31 (1.3%)
	Tracheal Stenosis	10 (0.4%)
	Wounds	12 (0.5%)
Total Complications		81 (3.5%)

Table 1: Complications of tracheostomy performed by general surgeons (n=2,315).

Of the patients that experienced TS, 30% (n=3) had PDT and 70% (n=7) had open procedures. See Table 2 for the breakdown of procedure type and complications of tracheostomy.

Outcome	Complication type	PDT	Open
	Bleeding	2	6
	Infection	3	7
	Mechanical Issues	1	19
	Tracheal Stenosis	1	11
	Wounds	6	25
Total Complications		13 (16.0%)	68 (84.0%)

Table 2: Procedure differences association with complications of tracheostomy (n=81).

Outcome	Complication type	Male	Female
	Bleeding	18	2
	Infection	6	2
	Mechanical Issues	21	10
	Tracheal Stenosis	7	3
	Wounds	9	3
Total Complications		61 (75.3%)	20 (24.7%)

Table 3: Gender differences associated with complications of tracheostomy (n=81).

Discussion

Airway management is a cornerstone of care in intensive care units. In the primitive versions of endotracheal tubes, low volume, high pressure cuffs were required to overcome the compliance of elastic cuff material. As cartilaginous tracheal rings receive their blood supply from the overlying submucosa, the high cuff pressures caused perichondritis and ischemia leading to stricture formation and stenosis [11]. TS following tracheostomy placement appears to occur from a different mechanism as it results from excess granulation tissue and abnormal wound healing over fractured cartilage [12-15].

Tracheostomy placement is superior to long term endotracheal intubation in regards to dead space and airway resistance reduction, secretions, patient comfort [16,17] and sedative drug requirement [18]. PDT has become a popular method of performing tracheostomy since Ciaglia et al. published his technique in 1985 [19]. Since that time, PDT has become the standard in many centers around the world due to the shorter duration in time to perform the procedure, lower prevalence of complications such as postoperative bleeding and infection [20] and lower overall costs [21] with many different percutaneous techniques used. Although there are numerous systematic reviews and meta-analysis intended to uncover superiority between percutaneous techniques *vs.* standard surgical tracheostomy, only low level evidence is

supported due the lack of randomized control studies. From the limited published data available, pooled meta-analysis tend to show higher rates of TS from ST compared to percutaneous procedures with a reduced risk of bleeding and infections [22].

Another difficulty surrounding the diagnosis of TS is the lack of uniformity within the literature surrounding inclusion criteria for the diagnosis. Non-specific symptoms are reported throughout the literature such as voice changes, swallowing difficulties, cough, and shortness of breath [23,24]. It is generally agreed upon that TS is expected to become evident clinically when the tracheal narrowing reaches 50-75% [1], CT [23,24,25], MRI [26] plain linear tomography [27], spirometry with fiberoptic laryngoscopy [28] or fiberoptic laryngoscopy alone [29] have all been studied as methods of diagnosis. One of the issues with diagnosis concerning these studies is the lack of correlation between imaging findings between clinical findings and symptomatic TS.

Although the spectrum of surgical treatments for TS is outside the scope of this manuscript, Grillo et al. [30] and Pearson et al. [31] both demonstrated good outcomes with segmental tracheal resection which has become the standard management of choice. Patients who are not amenable to surgery may undergo endoscopic dilation, laser ablation, tracheal stenting, and cryosurgery [32].

Limitations to our single institutional study center around the lack of patient follow up. This is a common occurrence surrounding studies focused on the prevalence of TS which underlines the subclinical nature of the disease, the particularly frail population in which the disease occurs, as well as the lack of uniform definition and diagnostics used to identify the disease. One final limitation of this study was the lack of a cohort of patients who did not experience complications. Given the inability to differentiate ST from PDT based on coding, it was necessary to abstract operative data from the remaining 2254 medical records. This work is currently underway, and will provide us with more useful information regarding our rates of complications, and how they are possibly related to surgical approach or even specific aspects of the procedures themselves, such as using a vertical incision component for making the tracheotomy vs horizontal only.

Conclusion

Our single center reports 3.47% prevalence of tracheostomy complications and less than 0.4% prevalence of stenosis. We found the PDT technique had a decreased prevalence of stenosis compared to open techniques. While there was a trend for more complications (bleeding, infection, and mechanical issues) related to being a male, the limited prevalence of cases could not yield statistically significant effects. Many of these individuals were trauma patients, and further information within our trauma database should allow us to elucidate pertinent aspects of technique or procedure resulting in higher prevalence of complications. These reviews are underway.

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