Operative Airway Management and Tracheostomy

10

Anthony M. Bunnell and Rui P. Fernandes

10.1 Introduction

Tracheostomy is a commonly performed procedure for many indications including complex maxillofacial trauma, head and neck oncologic resections, airway obstruction, need for prolonged ventilator support, and obstructive sleep apnea. Tracheostomy used for treatment of obstructive sleep apnea was first described by Kuhlo et al. in 1969 [1]. Tracheostomies were performed as the main surgical therapy for obstructive sleep apnea in patients failing medical therapy well into the early 1980s until the advent of CPAP [2]. This was followed by the introduction of other surgical interventions including uvulopalatopharyngoplasty, hypopharyngeal surgery, and maxillomandibular advancement, which led to a significant change in management strategies for these patients.

While tracheostomy is often considered the last resort in the treatment of OSA, it remains a viable option in those who have failed medical management, are not surgical candidates, or refuse other surgical modalities [3]. Tracheostomy achieves successful resolution of OSA because it completely bypasses any source of upper airway obstruction. A meta-analysis by Camacho et al. [2] has shown that tracheostomy significantly decreases apnea index, oxygen desaturation index, sleepiness, and mortality in patients with OSA. It has been shown to improve and may extend the life of patients with severe OSA [4]. It can quickly reverse associated cardiovascular comorbid conditions including arrhythmias, pulmonary hypertension, and hypoxia [5, 6]. Multiple studies have suggested that aggressive treatment of OSA improves overall survival [4, 7, 8].

Patients with OSA raise concerns regarding the technical difficulty in performing tracheostomy due to differences in anatomy. These variations include difficulty

A. M. Bunnell (✉) · R. P. Fernandes
Division of Head and Neck Surgery, Department of Oral and Maxillofacial Surgery, College of Medicine, University of Florida—Jacksonville, Jacksonville, FL, USA
e-mail: anthony.bunnell@jax.ufl.edu; rui.fernandes@jax.ufl.edu

S. O. Salman (ed.), *Modern Management of Obstructive Sleep Apnea*,
https://doi.org/10.1007/978-3-030-11443-5_10

palpating anterior neck landmarks, shortened neck, excessive submental and upper thoracic tissue obstructing the surgical field, and thickness of structures overlying the trachea. The standard tracheostomy tube curvature may not conform to these anatomical differences [9]. They are often too short and too curved making them more difficult to place and more likely to become dislodged. Dislodgement of these poorly fitting tracheostomy tubes has been associated with increased morbidity and mortality [10].

These patients are often obese, as obesity is considered a major risk factor for development and progression of OSA [11]. In the adult population, the prevalence of OSA is estimated to range from 25 to 45% of obese patients [11–17]. This prevalence of OSA in obese or morbidly obese patients is nearly twice that of normal weight adults [18]. Soft tissue and skeletal surgeries for OSA are less successful in patients who are morbidly obese, and tracheostomy has demonstrated effectiveness in morbidly obese patients [19].

While the perioperative complication rate of tracheostomy among adults ranges in the literature from 4 to 40% [18], open tracheostomy in the OSA patient (obese or nonobese) presents specific challenges that can increase the overall morbidity and mortality of this operation. These challenges can be managed with modifications of the surgical technique and proper tracheostomy tube selection. The goal of the procedure is to provide a safe and effective airway that will require minimal postoperative care.

10.2 Perioperative Management

Regardless of planned surgical intervention, proper preoperative medical optimization is crucial when treating patients with OSA. The comorbidities associated with OSA are well documented and should be managed preoperatively to minimize complications. CPAP should be used in the preoperative period and, depending on surgical intervention, postoperatively as well. For some procedures, such as maxillomandibular advancement, CPAP should be avoided postoperatively due to risk of head and neck subcutaneous emphysema. In terms of medical optimization, hypertension, cardiovascular disease, and diabetes should all be optimized and well controlled prior to surgery.

Airway management and plan should be discussed with the anesthesia team in detail prior to surgery. Patients with OSA innately have difficult airways and may be challenging intubations. Adjuncts such as fiber-optic scopes and video intubation scopes should be available and utilized if needed. The surgical team should also be prepared for possible awake tracheostomy.

Regarding anesthetic care, long-acting sedative and opioid agents should be limited. Anesthetic agents promote pharyngeal collapse, reduce ventilation, blunt respiratory response to carbon dioxide, and blunt arousal from sleep. Patients with OSA have a higher sensitivity to opioids, benzodiazepines, and other sedative agents. Central opioid receptors are upregulated in patients with OSA due to recurrent hypoxia [20]; therefore, smaller doses should be used. Prior to extubation, full reversal from muscle relaxation should be confirmed.

Postoperatively, opioids and other sedative agents should be minimized, as they are the leading causes of adverse outcomes postoperatively [21, 22]. Other adjuncts, such as acetaminophen, corticosteroids, tramadol, topical agents, gabapentin/pregabalin, etc., should be used instead. Blood pressure control is essential as well, especially with base of tongue, tracheal, tonsillar, and maxillary advancement surgery to prevent postoperative bleeding. Postsurgical OSA patients should be monitored in either an intensive care or progressive (step-down) unit setting for closer observation.

10.3 Surgical Technique

Open tracheostomy is performed under general anesthesia in the operating room for the OSA patient regardless of body habitus. For the obese patient, considerable time and effort are often required to transfer and position the patient in a safe and appropriate manner [23]. To assist operating room personnel with transfer of the patient to the operating room table, a HoverMatt Air Transfer System (HoverTech International, Bethlehem, PA) is used (Fig. 10.1). Often the patient's excess submental adipose and chest tissues are retracted from the neck surgical site using foam pads and silk tape. Excess adipose tissue between the sternum and trachea will cause a posterior inferior slant of the trachea. These patients may also have a short neck displacing the airway further inferiorly into the chest. Placement of a shoulder roll and neck extension will allow for maximum exposure to the anterior neck and surgical field (Fig. 10.2).

Fig. 10.1 HoverMatt® Air Transfer System (HoverTech International, Bethlehem, PA)

Fig. 10.2 Taping and positioning of the obese patient to provide maximum exposure of the anterior neck and surgical field

As in a standard open tracheostomy, all surgical landmarks are identified prior to incision. These landmarks include the sternal notch, cricoid, and thyroid cartilages. For the obese patient with OSA, the authors prefer a horizontal skin incision 3–4 cm in length. This is placed midway between the cricoid cartilage and sternal notch. Incision is made through the skin and subcutaneous tissue exposing the anterior cervical adipose tissue. A lipectomy in this area is often needed before reaching the platysma. Subplatysmal flaps are then elevated superiorly to the thyroid cartilage and inferiorly to the sternal notch. The anterior jugular veins are encountered and ligated and divided bilaterally. This helps minimize untimely bleeding later in the procedure or postoperatively. Additional excess adipose tissue that is now encountered in the central compartment of the neck is then elevated and removed from the deeper strap muscles. The strap muscles are then separated and retracted laterally exposing the thyroid isthmus. The thyroid isthmus is dissected off the pretracheal fascia, then ligated, divided, and tied with 2-0 silk sutures.

With the thyroid gland now retracted laterally, the pretracheal fascia is dissected off, allowing direct visualization of the upper trachea. Two traction or stay sutures using 2-0 Prolene are placed through the anterior aspect of the tracheal rings on either side of the site of entry into the trachea. These sutures assist with anterior and cephalad mobilization of a posterior and inferiorly displaced trachea. The stay sutures are left in place postoperatively for 1–2 weeks to assist in replacement of the tracheostomy tube in case of inadvertent dislodgement or decannulation. If needed,

a tracheal hook can also be used to mobilize the trachea in a cephalad direction, bringing the trachea closer to the skin surface. A vertical or horizontal incision is made within the trachea in between the second and third tracheal ring. The opening is dilated and the endotracheal tube is withdrawn**.** For planned lifelong tracheostomy use, an alternative option is removal or excision of the anterior aspect of 1–2 tracheal rings, providing a much larger opening. A cuffed tracheostomy tube (tube selection discussed later in this chapter) is then inserted into the airway trachea and connected to the anesthesia circuit. Assessment for end-tidal carbon dioxide and appropriate tidal volumes is completed, and the endotracheal tube is then completely removed. It is our practice to secure the tracheostomy tube to the skin with silk sutures for the initial postoperative period until the tube is changed.

10.4 Tracheostomy Tube Selection

There are a number of clinical and technical considerations associated with tracheostomy tube selection. The anatomical differences listed previously, including a posterior and inferiorly displaced airway, may not allow for use of a standard tracheostomy tube. This may necessitate the use of a Shiley™ extended-length tracheostomy tube (Medtronic, Minneapolis, MN). These are available in either proximal (Fig. 10.3) or distal extensions (Fig. 10.4). The proximal extension refers to the distance between the flange and bend of the tube accounting for the increased thickness of the anterior neck. The distal extension refers to the distance after the bend to the tip of the tube, which may assist with an inferiorly displaced trachea. Other

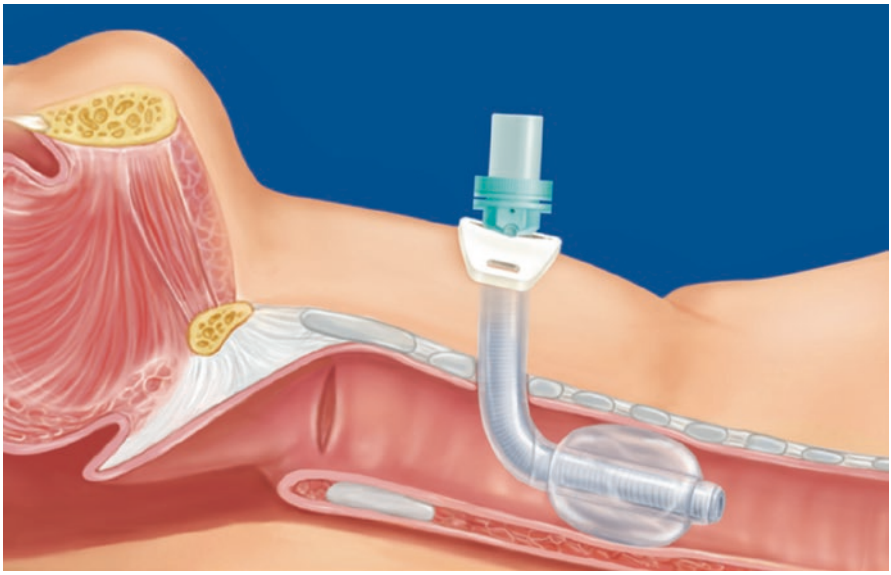

Fig. 10.3 Shiley™ tracheostomy tube with proximal extension (Medtronic, Minneapolis, MN)

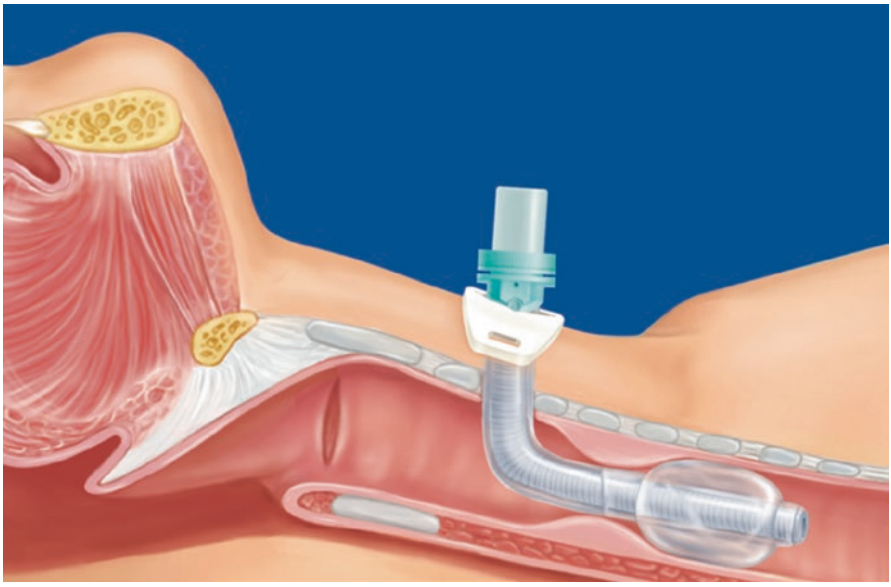

Fig. 10.4 Shiley™ tracheostomy tube with distal extension (Medtronic, Minneapolis, MN)

anatomical differences may include unanticipated significant tracheal deviation or stenosis that may be encountered during dissection or upon entering the airway. Tracheal deviation or stenosis may complicate placement, but this can be circumvented with placement of a distally extended tracheostomy tube. It is the authors' preference to have both a proximal and distal extension tracheostomy tube available until the airway is encountered surgically to determine which tube is most appropriate.

In addition to anatomical differences of the airway, other clinical considerations when selecting the correct tracheostomy tube include ventilation needs, need for supplemental oxygen, ambulation and activity needs, speech, and feeding concerns. Technical considerations include tube brand availability, need for a cuff, need for fenestration, need for inner cannula (disposable or reusable), and need to integrate with other respiratory devices. The use of a tracheostomy tube with an inner and outer cannula allows one to change or clean the inner cannula without removing the outer cannula. Frequent changing of the inner cannula helps prevent obstruction of the tube. These factors must also be considered prior to placing the tracheostomy tube.

10.5 Postoperative Tracheostomy Care

The patient is monitored in either an intensive care or step-down unit during the immediate postoperative period. The level of care will depend on the patient's comorbidities, experience of nursing staff, and bed or unit availability. Regardless

of the level of care, the nursing staff should be familiar with all aspects of tracheostomy care. This allows for nursing staff to also help educate the patient and family members with tracheostomy care. Routine care includes the need for humidification and frequent suctioning to prevent mucous plugging and airway obstruction. It is encouraged to begin educating the patient and family on the first day so they feel comfortable with routine care at the time of discharge.

There is no accepted standard for adult tracheostomy tube changes, and most tracheostomy tube exchange protocols are a result of institutional practices. If the patient does not require positive-pressure ventilation, the tube can be typically changed to a fenestrated uncuffed tube on the third postoperative day after the track is well defined. The patient is discharged with the necessary equipment to replace the inner cannula, clean the stoma, and manage the wound. They should be proficient in tube removal and insertion so they can manage a mucous plug if necessary. Common home care tracheostomy and stoma cleaning agents include hydrogen peroxide, commercial medical disinfectants, and simple soap and water. When the patient is discharged home, often one tracheostomy care cleaning kit is utilized once daily for stoma site cleaning and care. Patients are sent home once the nursing staff are confident with the patient and/or family's ability to manage the tracheostomy tube.

Regular office visits are necessary in the first 6 months in order to remove or cauterize any stomal granulation tissue. This can occur anywhere in the stoma but is most common at the superior edge of the stoma. Despite removing anterior cervical adipose tissue during tracheostomy, the distance from the trachea to the skin remains long. The tracheostomy ties pull superiorly because of the short neck and tend to worsen granulation tissue at the superior aspect of the stoma. Silver nitrate is quick and effective in removing or shrinking granulation tissue. Electrocautery is more effective for larger lesions but will require a return to the operating room.

There is, however, a subset of morbidly obese patients who may have additional requirements for ventilator support in order to improve daytime symptoms and nocturnal ventilation. Reasons for lack of improvement in obese patients include obstruction of the tracheostomy tube by redundant soft tissue, kinking of the tracheostomy tube, displacement of the tracheostomy tube, or the patients may have comorbid obesity hypoventilation syndrome [19].

Polysomnography (with CO_2 monitoring as appropriate) to assess surgical effectiveness of tracheostomy for OSA can be performed to rule out postoperative central apneas, hypopneas, and/or obesity hypoventilation syndrome that could warrant positive airway pressure therapy through the tracheostomy [18, 19].

The time frame to decannulation varies widely among patients. Decannulation process typically involves a sequential downsizing of the tube followed by capping trials if the patient can tolerate it. Reasons for decannulation include intolerance to the device, switching to CPAP, resolution of OSA after other adjunctive procedures, and significant weight loss [4]. While tracheostomy has been almost uniformly effective in relieving OSA, the chances of obstructive sleep apnea resolution allowing decannulation remain poor [4].

10.6 Complications

There have been multiple publications highlighting the inherent difficulties and complications associated with tracheostomies, but do not account specifically for OSA or the obese patient. These studies have reported a large range of potential complications from 4 to 40% [23]. Thatcher and Maisel [4] looked at 79 patients who underwent tracheostomy at a regional sleep disorder center and demonstrated that significant morbidity and mortality are low for the procedure. For the obese patient however, the rate of perioperative complications for open tracheostomy has been shown to be greater [18]. Body mass index was independently associated with increased risk of tracheostomy-related complications [24]. Multiple studies have shown not only a higher complication rate in the morbidly obese but also a higher mortality rate [23–25].

Complications can be categorized as intraoperative, early postoperative, and late postoperative. These complications can be further described as minor and major (or serious) events.

Bleeding can occur at any point of the procedure and within the early postoperative period. Minor bleeding is one of the most common early complications and can typically be controlled with local hemostasis maneuvers including the placement of Surgicel or topical thrombin. Major bleeding requires a return to the operating room and stabilization of the patient in order to prevent mortality from the procedure. An early sentinel bleed from a trachea-innominate artery fistula may provide an early warning of this devastating complication. Unfortunately, this is not always the case, and the patient may present with massive bleeding which is often associated with a high mortality rate.

The abnormal neck anatomy in the patient with OSA previously described in this chapter increases the risk of tube dislodgement or inadvertent decannulation. A cuff leak may occur due to cuff malfunctioning or due to loss of tracheal wall rigidity due to a poorly fitting tracheostomy tube. Selecting a proper tube size, as mentioned in this chapter, or exchange for a new tube will solve this issue. Tube obstruction can occur secondary to mucous plugging, blood clot within the tube, or obstruction from the tracheal wall. Infection at the stoma may occur and is managed with topical and systemic antibiotics. Drainage of multi-space infection resistant to medical management may require surgical intervention and additional IV antibiotics. Postoperative wound care is essential in order to prevent infection.

10.7 Summary

Tracheostomy continues to be a viable management option for patients with OSA who fail other interventions. One must take into consideration the anatomical differences in these patients including a posteriorly displaced airway due to increased adipose tissue and neck circumference. This patient population also has a higher likelihood of obesity, which adds to the complexity in performing tracheostomy. These challenges can be overcome with optimizing the surgical field with a proper

setup, removing excess adipose tissue during the procedure, and proper tracheostomy tube selection. Postoperative education on tracheostomy care is also a must in order to facilitate a smooth discharge and ensure long-term patient compliance.

References

1. Kuhlo W, Doll E, Franck MC. [Successful management of Pickwickian syndrome using long-term tracheostomy]. Dtsch Med Wochenschr. 1969;94:1286.
2. Camacho M, Certal V, Brietzke SE, Holty J-EC, Guilleminault C, Capasso R. Tracheostomy as treatment for adult obstructive sleep apnea: a systematic review and meta-analysis. Laryngoscope. 2014;124:803.
3. Riley RW, Powell NB, Guilleminault C. Obstructive sleep apnea syndrome: a surgical protocol for dynamic upper airway reconstruction. J Oral Maxillofac Surg. 1993;51:742.
4. Thatcher GW, Maisel RH. The long-term evaluation of tracheostomy in the management of severe obstructive sleep apnea. Laryngoscope. 2003;113:201.
5. Fletcher EC, Schaaf JW, Miller J, Fletcher JG. Long-term cardiopulmonary sequelae in patients with sleep apnea and chronic lung disease. Am Rev Respir Dis. 1987;135:525.
6. Guilleminault C, Connolly SJ, Winkle RA. Cardiac arrhythmia and conduction disturbances during sleep in 400 patients with sleep apnea syndrome. Am J Cardiol. 1983;52:490.
7. He J, Kryger MH, Zorick FJ, Conway W, Roth T. Mortality and apnea index in obstructive sleep apnea. Experience in 385 male patients. Chest. 1988;94:9.
8. Calle EE, Thun MJ, Petrelli JM, Rodriguez C, Heath CWJ. Body-mass index and mortality in a prospective cohort of U.S. adults. N Engl J Med. 1999;341:1097.
9. Harris AT, Morell D, Bajaj Y, Martin-Hirsch DP. A discussion of airway and respiratory complications along with general considerations in obese patients. Int J Clin Pract. 2010;64:802.
10. Gross ND, Cohen JI, Andersen PE, Wax MK. "Defatting" tracheotomy in morbidly obese patients. Laryngoscope. 2002;112:1940.
11. Romero-Corral A, Caples SM, Lopez-Jimenez F, Somers VK. Interactions between obesity and obstructive sleep apnea: implications for treatment. Chest. 2010;137:711.
12. Young T, Palta M, Dempsey J, Skatrud J, Weber S, Badr S. The occurrence of sleep-disordered breathing among middle-aged adults. N Engl J Med. 1993;328:1230.
13. Bixler EO, Vgontzas AN, Ten Have T, Tyson K, Kales A. Effects of age on sleep apnea in men: I. prevalence and severity. Am J Respir Crit Care Med. 1998;157:144.
14. Bixler EO, Vgontzas AN, Lin HM, Ten Have T, Rein J, Vela-Bueno A, Kales A. Prevalence of sleep-disordered breathing in women: effects of gender. Am J Respir Crit Care Med. 2001;163:608.
15. Duran J, Esnaola S, Rubio R, Iztueta A. Obstructive sleep apnea-hypopnea and related clinical features in a population-based sample of subjects aged 30 to 70 yr. Am J Respir Crit Care Med. 2001;163:685.
16. Kim J, In K, Kim J, You S, Kang K, Shim J, Lee S, Lee J, Lee S, Park C, Shin C. Prevalence of sleep-disordered breathing in middle-aged Korean men and women. Am J Respir Crit Care Med. 2004;170:1108.
17. Sharma SK, Kumpawat S, Banga A, Goel A. Prevalence and risk factors of obstructive sleep apnea syndrome in a population of Delhi, India. Chest. 2006;130:149.
18. Cordes SR, Best AR, Hiatt KK. The impact of obesity on adult tracheostomy complication rate. Laryngoscope. 2015;125:105.
19. Kumar A, Camacho M, Capasso R. Quantitative assessment of an obstructive sleep apnea patient before and after tracheostomy: a case study. J Otol Rhinol. 2013;2:2.
20. Ankichetty S, Wong J, Chung F. A systematic review of the effects of sedatives and anesthetics in patients with obstructive sleep apnea. J Anaesthesiol Clin Pharmacol. 2011;27:447.
21. Lam KK, Kunder S, Wong J, Doufas AG, Chung F. Obstructive sleep apnea, pain, and opioids: is the riddle solved? Curr Opin Anaesthesiol. 2016;29:134.

22. Wolfe RM, Pomerantz J, Miller DE, Weiss-Coleman R, Solomonides T. Obstructive sleep apnea: preoperative screening and postoperative care. J Am Board Fam Med. 2016;29:263.
23. Fattahi T, Chafin C, Bunnell A. Tracheostomy in the morbidly obese: difficulties and challenges. J Oral Maxillofac Surg. 2017;75:1372.
24. El Solh AA, Jaafar W. A comparative study of the complications of surgical tracheostomy in morbidly obese critically ill patients. Crit Care. 2007;11:R3.
25. Darrat I, Yaremchuk K. Early mortality rate of morbidly obese patients after tracheotomy. Laryngoscope. 2008;118:2125.