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ORIGINAL RESEARCH

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Early postoperative complications following tracheotomy: Does suturing technique influence outcomes?

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Abstract

Introduction: Tracheotomy is one of the most commonly performed procedure by otolaryngologists, but no consensus exists on the effect of suturing techniques on postoperative complications. Stay sutures and Bjork flaps are utilized frequently for securing the tracheal incision to the neck skin in order to create a tract for recannulation.

Methods: Retrospective cohort study of tracheotomies performed by Otolaryngology-Head and Neck Surgery providers (May 2014 to August 2020) was conducted to determine the effect of suturing technique on postoperative complications and patient outcomes. Patient demographics, medical comorbidities, indication for tracheostomy, and postoperative complications were analyzed with a statistical alpha set of .05.

Results: Out of 1395 total tracheostomies performed at our institution during the study period, 518 met inclusion criteria for this study. Three hundred and seventeen tracheostomies were secured by utilizing a Bjork flap, while 201 were secured with up and down stay sutures. Neither technique was noted to be more commonly associated with tracheal bleeding, infection, mucus plugging, pneumothorax, or false passage of the tracheostomy tube. One mortality was noted following decannulation during the study period.

Conclusion: Though various techniques exist; adverse outcomes are not associated with the manner in which a new tracheostomy stoma is secured. Medical comorbidities and the indications for tracheostomy likely play a more significant role in postoperative outcomes and complications.

Level of evidence: Level 3.

KEYWORDS
Bjork flap, stay sutures, tracheostomy, tracheostomy complication, tracheotomy

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1 | INTRODUCTION

Tracheotomy is one of the most commonly performed procedure by otolaryngologists, indicated in instances of upper airway obstruction, elective head and neck cancer surgery, and ventilator dependence. Though generally safe, numerous short- and long-term risks exist with varying degrees of severity.[1] Complications with higher mortality rates in the intra-operative and early postoperative period include pneumothorax, hemorrhage, accidental decannulation and false passage, mucus plug, whereas, pneumonia and infections are typically less severe.[1–4] Late postoperative complications include subglottic stenosis, tracheal stenosis, tracheocutaneous fistula, tracheoesophageal fistula, tracheoinnominate artery fistula, accidental decannulation, and infection.[4–7]

Studies have reported that complications occur in 5%–40% of tracheostomies, but the vast majority are minor.[1,4,8] Severe desaturations, bleeding and pneumothorax are the most common complications in the peri-operative period, but together occur in fewer than one percent of cases.[1,9] Early postoperative bleeding, mucus plug, tracheal infection and accidental decannulation occur in 2.6%, 1.0%, 0.9%, and 0.8% of cases respectively. However, infection and accidental decannulation are more common in the late postoperative period. Airway stenosis occurs in 0.8%–2.6% of patients and tracheocutaneous fistula develops in less than one percent.[2,7,8,10]

Tracheotomies are performed with either a percutaneous or open surgical approach. The percutaneous method, more recently introduced, involves dilation of the trachea. The major advantage of this technique is the ability to be performed at bedside in a critically ill patient, who otherwise would not be stable for transport to the operating theater. Additionally, the utilization of the Seldinger technique utilized in many bedside procedures enables multiple specialties to efficiently master the required steps.[11,12] The open surgical method, popularized in 1909 by Chevalier Jackson, has traditionally been performed in operating rooms.[13] Surgical tracheostomies can be secured utilizing stay sutures passing through the superior and inferior tracheal cartilage (Figure 1) or through the creation of a cartilage flap secured to the anterior portion of the stoma called a Bjork flap (Figure 2). Both techniques aim to aid in the ability to recannulate the stoma for tracheotomy tube changes or in the instance of an accidental decannulation in the early postoperative period. Though both techniques are well described in the literature, no consensus exists on the effect either technique has on postoperative complications in comparison to each other.[14–17] This study was conceptualized due to two near-misses (false passage) during initial tracheotomy change following surgery. Both patients had stay sutures and difficult recannulation at bedside. This lead us to ponder whether the technique utilized to secure the tracheotomy stoma has an effect on early postoperative complications, especially false passage rates and patient outcomes.

2 | METHODS

2.1 | Patient selection

Following Institutional Review Board (IRB # 261211) approval, a retrospective cohort study of all tracheotomies performed at a tertiary referral center was performed. All adult patients (>18 years old) undergoing open surgical tracheotomy with either Bjork flap or stay sutures from May 2014 to August 2020 were included in the study. Patients undergoing percutaneous tracheotomy or open surgical tracheotomy by a non-otolaryngology-trained provider were excluded for standardization of surgical technique, as well as the low-volume tracheotomy performing otolaryngology surgeons. From the otolaryngology department, the patients with multiple tracheotomies performed within a 3-month period were excluded except for the first instance of tracheotomy. Electronic medical records were reviewed for basic demography, indication for tracheotomy, utilization of stay sutures or Bjork flap for securing of tracheotomy, length of hospital stay, early postoperative complications (defined as 30 days), and time to decannulation. Patients were subcategorized based on the method in which the tracheotomy was secured (Bjork flap vs. stay suture).

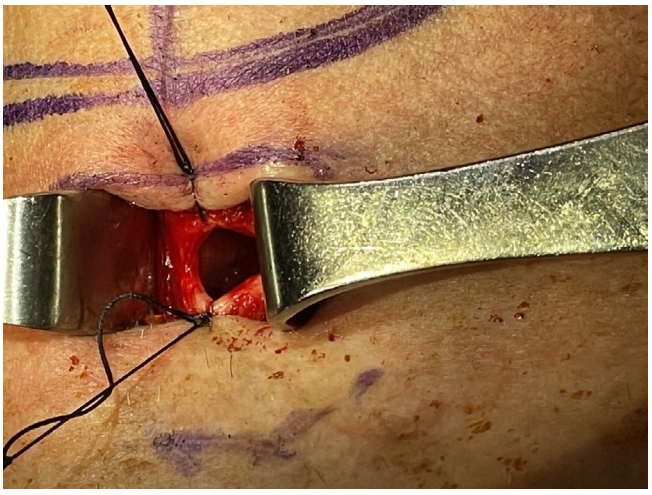

FIGURE 1 Up and down stay suture technique

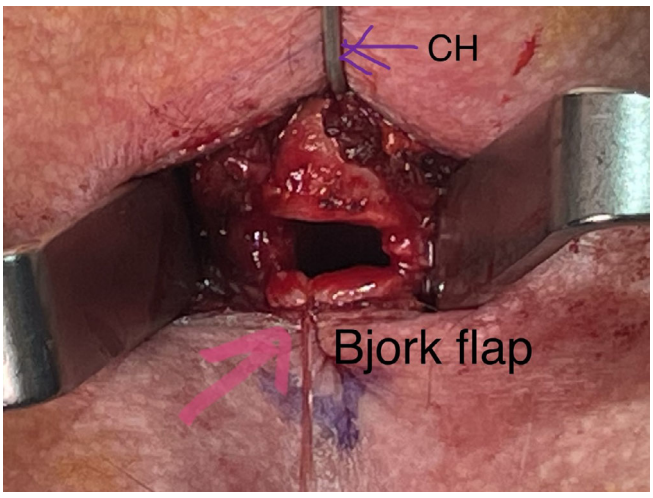

FIGURE 2 Bjork flap securing technique. CH, cricoid hook (up)

2.2 | Data analysis

Statistical analysis was performed using IBM SPSS Statistics v27. For categorical variables, Chi-square analysis or Fisher exact test in the case of rare outcomes (expected count less than 5) was performed. *T*-tests were performed for continuous variables. Categorical characteristics were summarized as frequency counts and percentages. Statistical alpha was set at $p < .05$.

3 | RESULTS

Out of 1395 total tracheotomies performed at our institution during the study period, 518 met inclusion criteria for this study. The overall cohort was predominately white males aged 59 years old (Table 1). Three hundred and seventeen tracheotomies were secured by utilizing a Bjork flap, while 201 were secured with up and down stay sutures. The mean length of stay (LOS) was 9.98 for the overall cohort, with a mean LOS of 2.5 days for those requiring intensive care unit monitoring. Overall, the patients within this cohort were decannulated 63.6 days following their tracheotomy. While the body mass index (BMI) for the Bjork flap group was 27.19 and the stay suture group 26.67. In the stay suture group 48 (24.9%) had chronic obstructive pulmonary disease, 39 (20.2%) diabetes mellitus, 40 (20.8%) hypothyroidism. These numbers were 55 (18%), 56 (18.3%), 60 (19.7%) respectively for the Bjork flap group.

More than half of all tracheotomies were planned and performed during an oncologic ablative or reconstructive surgery ($n = 267$) (Table 2). Other notable indications demonstrating the heterogeneity of this population were exophytic/bleeding airway mass ($n = 101$), respiratory failure ($n = 53$), airway stenosis ($n = 23$), trauma ($n = 22$). Forty-four patients underwent remote total laryngectomy for definitive management of the etiology of their airway compromise.

Within the early postoperative period, defined as 30 days, there were no significant differences in the incidence of tracheotomy-related complications (Table 3). Eleven cases of bacterial infection of the tracheal stoma were encountered in the early postoperative period, most commonly caused by *Staphylococcus aureus*, *Streptococcus* species, and *Pseudomonas aeruginosa*. Tracheitis was diagnosed 21 times based on resident endoscopy. None of these were determined to be of a bacterial etiology, indicating that this diagnostic code was used likely due to drying, crusting, inflammation, or excess secretions in the trachea, which was managed with humidification and further tracheostomy-care education.

Mediastinitis occurred in two patients within the cohort during their initial inpatient encounter. In both instances, these infections resulted from disease progression of the initial indication for tracheotomy.

Neither Bjork flap or Stay suture technique was noted to be associated with a higher incidence of complications. Tracheal bleeding (four vs. four, respectively), hematoma (four vs. four), pneumothorax (three vs. two) with two necessitating emergent chest tube placement, false passage upon tracheostomy tube change (one vs. two), or severe mucus plugging requiring a resident physician to be called to the bedside (two vs. one).

TABLE 1 Demographic data for cohort ($n = 518$)

	n (%)
Sex	
Male	343 (66.2)
Female	175 (33.8)
Age	59.2 yo (range = 18–96)
Race	
White	379 (73.2)
African American	119 (23)
Native American or Alaskan	3 (0.6)
Asian	3 (0.6)
Other	11(2.1)
Method of securing tracheostomy	
Bjork flap	317 (61.2)
Superior and Inferior Stay Sutures	201 (38.8)
LOS (days)	9.98
Days to decannulation	63.6

Abbreviation: LOS, length of stay.

TABLE 2 Indication for tracheotomy

	Bjork flap ($n = 317$) *n* (%)	Stay suture ($n = 201$) *n* (%)
Ablative/reconstructive surgery	163 (51.4)	105 (52.2)
Trauma	14 (4.4)	8 (4)
Airway mass	63 (19.9)	38 (19)
Respiratory failure	30 (9.5)	23 (11.4)
Vocal fold paralysis	15 (4.7)	6 (3)
Subglottic stenosis	14 (4.4)	9 (4.8)
Airway edema	5 (1.6)	4 (2)
Ventilator dependence	8 (2.5)	6 (3)
Ludwig angina	3 (1)	1 (0.5)
Hematoma	2 (0.6)	1 (0.5)

While tracheocutaneous fistula (TCF) is a long-term complication, it is worth noting that it occurred in 13 patients with neither technique being significantly more predominate (Table 3). Two of these patients had obesity hypoventilation syndrome and were decannulated outside of our providers against our recommendations and were not offered closure. One patient did not want closure and one patient had a laryngectomy for nonfunctional larynx following chemoradiation. Nine patients required operative closure of the TCF.

Sixteen patients died during their hospital stay, only one of which could be attributed as a direct complication of tracheotomy/tracheotomy management. This patient died following decannulation prior to discharge. The patient, who had free flap reconstruction due to osteoradionecrosis of the anterior mandible likely had supraglottic edema leading to his demise. This patient's stoma was secured with a

TABLE 3 Complication prevalence

	Bjork flap ($n = 317$) *n* (%)	Stay suture ($n = 201$) *n* (%)	*p* value
Mortality	1 (0.3)	0	>.99
Pneumothorax	3 (1)	2 (1)	>.99
Mucus plug	2 (0.6)	1 (0.5)	>.99
False passage	1 (0.3)	2 (1)	.56
Tracheal bleeding	4 (1.3)	4 (2)	.72
Hematoma	4 (1.3)	4 (2)	.68
Pneumonia	11 (3.5)	21 (10.4)	.60
Tracheal infection	4 (1.3)	7 (3.5)	>.99
Mediastinitis	0	2 (1)	.15
Tracheitis	9 (2.8)	12 (6)	.70
Tracheocutaneous fistula	4 (1.3)	9 (4.5)	.54

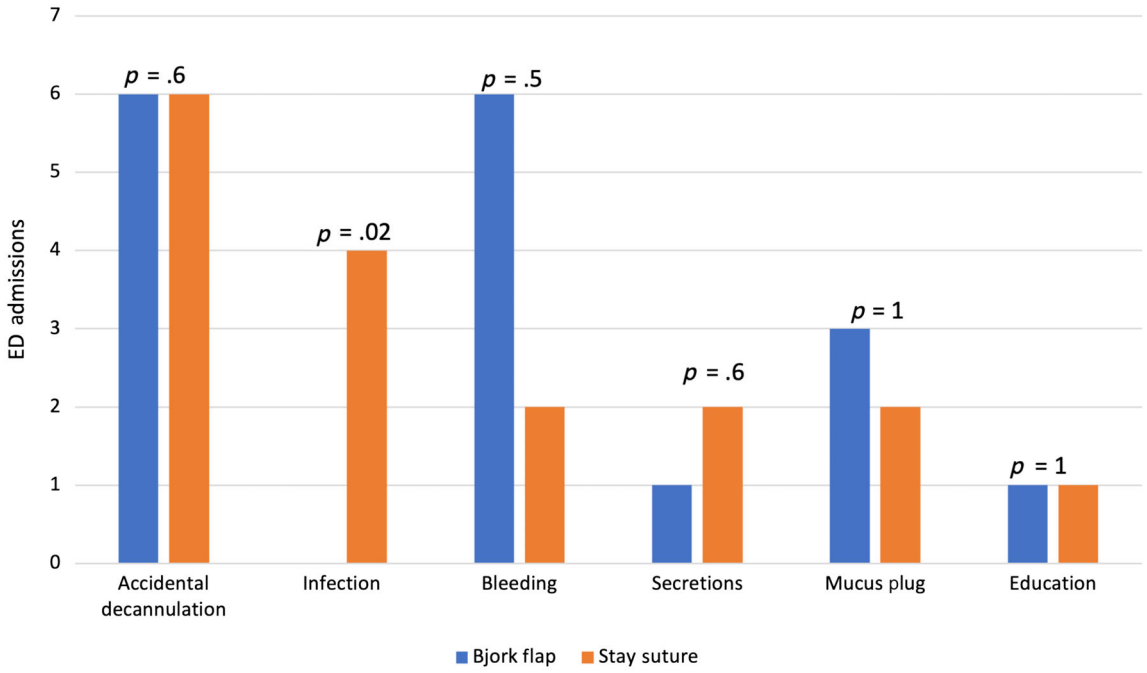

FIGURE 3 ED readmissions for tracheostomy-related causes within 30 days of discharge.

Bjork flap and he was successfully recannulated through the tracheotomy site, despite resuscitation he passed away the next day in the ICU. The family did not agree to an autopsy, so extend of upper airway changes have not been confirmed. While there was a capping protocol for head and neck surgical patients prior to this incident, this has led to the creation of a formalized decannulation protocol. This protocol involves a 24-h capping trial and endoscopic airway examination of all patients prior to decannulation.

In total, 111 (21.4%) patients were admitted to an emergency department (ED) within 30 days of discharge. Of these, 34 readmissions were for tracheostomy related reasons. Accidental decannulation was the most common reason for ED admission (12 patients), followed by tracheal bleeding (eight patients), and mucus plugging (five patients) (Figure 3). Notably, two patients returned to the ED without a medical indication and required further tracheotomy care education. Seven patients required hospital admission from the ED. Four for bleeding, two for infection, and one following management of a mucus plug.

4 | DISCUSSION

The tracheal stoma can be secured with various methods, including a Bjork flap or superior and inferior stay sutures for improved recannulation during tracheostomy tube changes or accidental decannulations. Although these techniques are widely recognized to offer good functional outcomes, literature comparing the complication rates between these two suturing methods is sparse.[15,18] This study reviewed

tracheotomy complications to determine if the technique utilized to secure the stoma affected postoperative complications, especially in the peri-operative period. At our institution, the chosen tracheotomy technique was mainly based on surgeon preference rather than patient qualities such as BMI or ventilator dependence. Bjork flaps have been recommended in obese patients and reported to improve recannulation. Obese patients are more likely to experience tracheotomy complications and mortality.[19] In this series, most patients underwent a tracheotomy due to head and neck cancer, and hence had lower BMI values. Kennedy et al. investigated Bjork flap versus window technique in 217 patients (113 patients and 104 patients, respectively). In their series, patients who received a Bjork flap had a higher BMI compared to the window technique. Bjork flap patients also were more likely to be on the ventilator, whereas patients who were undergoing head and neck cancer surgery, mostly underwent a window tracheotomy.[20] In our study, the number of ED admissions for infection was noted to be statistically significantly higher for the stay suture cohort in comparison to the Bjork flap cohort; however, a post hoc power analysis calculated an insufficient power of 67% for this outcome.

We noted that the most common indication for tracheotomy was simultaneous surgery for head and neck cancer (50.5%), which is comparable to studies evaluating surgical tracheostomies performed specifically by otolaryngologists reporting 57.6% and 45%.[3,21] Though these patients comprised the largest subset of our population, it should be noted that this cohort is a markedly heterogeneous population with all the implications that entails. The effects of the heterogeneity of this population can be seen in the ED readmission rates reported. Though a relatively large number of patients (>20%) were admitted to an ED within 30 days of discharge, the investigation of the cause for readmission showed a low overall readmission rate (6.6%) for tracheostomy-related causes. Many of these patients experienced complications from their primary disease processes: cancer, reconstructive surgery, trauma, medical comorbidities. Accidental decannulation was the most common reason for ED admission, followed by tracheal bleeding, and mucus plugging. Two patients also returned due to tracheotomy care related questions. A good percentage of ED visits can be eliminated with tracheotomy care teaching during the initial hospital stay. The clinical consensus statement on tracheostomy care by Mitchell et al. recommends tracheotomy teaching to start preoperatively. They also recommend that the patient and caregiver should be assessed for competency of tracheotomy care procedures, including care of the tube, suctioning, as well as be given a checklist of emergency supplied that should remain with the patient at all times.[22] At UAMS, there is a dedicated tracheotomy education nurse and classes for group teaching. The trach nurse starts working with the patients the day following their procedure and visits them regularly during their stay. All patients first watch an educational video, which is followed by hands on training on mannequins, then transitioning to the patient demonstrating competency of basic care, such as suctioning and changing the inner cannula. However, they do not have to be signed off prior to discharge which is standard in many Children's Hospitals. A designated family member is also trained through-out the stay.

Accidental decannulation is a life-threatening and one of the most serious complications of a tracheotomy. The prevention of this complication is one of the main reasons to use suturing techniques. In this serious on the contrary to our hypothesis we did not see a difference between the two techniques.

Tracheal infections and tracheitis were among the most common complications, occurring in approximately 7% of patients. This was much more prevalent in our cohort than those described by Halum et al. and Lee et al., 0.9% and 2.4%, respectively.[2,18] We attribute this to our diagnoses being based on subjective evaluation of endoscopy findings by residents and denoting any type of inflammation in the airway, rather than bacterial or viral tracheitis. Malata et al have suggested a higher rate of bacterial colonization with Bjork flaps.[17] The two techniques have not shown a difference with regards to the rate of stomal infection.

When investigating the role that a tracheotomy played in the deaths of the 16 patients that died during their hospital stay, it was noted that 15 of these patients died as a result of their medical comorbidities that contributed to their indication for tracheostomy, similar to the ED readmission rate. The one death attributable to the tracheotomy was in a patient who experienced cardiopulmonary collapse following decannulation in the hospital, which, as detailed above, led to a change in the decannulation protocol among the providers involved in this study. Previously, capping trials were the mainstay of verifying that a patient was safe to decannulate. Following this mortality, the new protocol included respiratory therapy evaluations of negative inspiratory force and vital capacity with a capped tracheostomy tube in addition to an endoscopic airway evaluation to assess the patency of the airway. This mortality was unrelated to method of tracheotomy. Of note, all patients that undergo tracheotomy at our institution by the Otolaryngology team for any indication, are admitted to a progressive care unit staffed with nursing staff trained specifically in management of Otolaryngology patients unless intensive care unit admission is indicated by the patient's specific medical status. Cohen et al have also reported on a successful single-stage decannulation technique. The immediate decannulation group which was admitted to the Intensive care unit, underwent thorough evaluation, decannulation and 24-h observation. In this group, no patients required another tracheotomy while the traditional decannulation group had four patients (out of 20) required reinsertion.[23]

The retrospective design of the study creates inherent limitations. The diagnosis of each complication relied on accurate documentation in the electronic health record system. Additionally, as a single-center review of tracheotomy complications, the overall number of complications remains low, likely indicating the providers' experience with performing and maintaining tracheostomies. All tracheostomy changes are performed by an experienced airway surgeon with the availability of suction, adequate lighting, and non-emergent indications. These factors likely introduce some level of bias compared to tracheostomy complications that must be addressed by inexperienced providers, decreasing the event rate of false passages compared to what could be expected at home, rehabilitation facility, or a small hospital in non-ideal circumstances. The findings in this study indicate that the literature would benefit from future long-term randomized, prospective studies to elucidate any causative associations between tracheostomy technique and further complications.

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CONFLICTS OF INTEREST

The authors report no personal or financial conflicts of interest.

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