# Surgical Tracheostomies: A Retrospective Chart Analysis Comparing ENT Specialists and Residents

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AIM: The primary aim of our retrospective chart review is to compare open surgical (OS) tracheostomies performed by specialist and supervised resident surgeons, focusing on surgical time and post-surgical complications. The secondary objective was to compare these data based on the years of surgical experience for both specialists and residents.

METHODS: All patients undergoing surgical tracheostomy at the Unit of Otorhinolaryngology, Head & Neck Department, University of Verona between 1 January 2017, and 31 December 2022, were subjected to a retrospective analysis. A total of 385 OS tracheostomies were included in the study. Procedures conducted by supervised residents across various training years were compared with those performed by junior and senior specialists, focusing on surgical duration and postoperative complications. Subsequently, these data were stratified based on the surgical experience of subgroups: residents were categorized into 4 years of training, and specialists were categorized into junior (with less than 5 years of experience) and senior (with at least 5 years).

RESULTS: Statistical analysis concerning patients' anatomy revealed a significant increase in operative times among those with no palpable neck landmarks (p = 0.006) and those with previous neck surgery (p = 0.039). Among patients' comorbidities, only anticoagulant or antiaggregant therapy was found to prolong operative time (p = 0.018), while the ASA score did not correlate with the duration of surgery. Finally, no statistically significant differences in surgical time were observed (p = 0.287), and no significant differences in complication frequency were reported between supervised residents and specialists (p = 0.908), regardless of years of experience.

CONCLUSIONS: Under appropriate supervision, OS tracheostomy has demonstrated safety for residents as early as their first year of residency. Residents can perform tracheostomies without significantly prolonging the duration of the operation or increasing the risk of peri- and post-operative complications.

Keywords: tracheostomy; resident; surgery; airway management; surgical training

#### Introduction

Tracheostomy is a common surgical procedure in Ear, Nose, and Throat (ENT) surgery, playing a vital role in head and neck surgery by providing immediate airway control when urgent access to the trachea is necessary. It is commonly indicated for acute respiratory failure, such as iatrogenic vocal cord paralysis, and for preventing upper airway obstruction in major head and neck oncologic procedures. Furthermore, it is used in weaning patients from long-term mechanical ventilation or those with challenging airways, such as maxillofacial trauma, angioedema, or obstructing tumors in the upper airway. Tracheostomy promotes oral hygiene and pulmonary toilet, contributing to increased patient comfort during long-term support [1]. The operative technique was perfected in the early 20th century by Chevalier Jackson [2], who standardized the procedure, greatly reducing mortality. From a surgical point of view, the novelty was the extreme attention to tissue and wound hemostasis before opening the trachea for proper skin contact, the maintenance of surgical site asepsis and the use of the Trendelenburg position during surgery [3].

Tracheostomy can be performed in two different ways: percutaneous dilational tracheotomy, or open surgical (OS) tracheostomy.

OS tracheostomy, though considered a simple and quick procedure, is not without complications. Immediate postoperative complications may include bleeding, tracheal ring rupture, soft tissue infections of the neck or mediastinum, posterior tracheal wall injury, or subcutaneous emphysema [4, 5]. Late complications, occurring after prolonged tube placement, can include laryngotracheal stenosis, weakening of the tracheal wall resulting in dynamic expiratory collapse and airway obstruction, and fistulas between the trachea and the esophagus, skin, or innominate artery [5].

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Specialists (n)	Tracheostomies (n, %)	Residents	Tracheostomies (n, %)
8 seniors (at least 5 years' experience)	79 (20.52%)	1st year residents	15 (3.90%)
7 juniors (less than 5 years' experience)	89 (23.12%)	2nd year residents	48 (12.47%)
		3rd year residents	85 (22.08%)
		4th year residents	69 (17.93%)
Total (n)	Total (n, %)	Total (n)	Total (n, %)
15	168 (43.6%)	39	217 (56.4%)

 Table 1. Number and percentage of OS tracheostomies performed by different operators, senior and junior specialists, and residents divided by year of training.

OS, open surgical.

OS tracheostomy is among the initial surgical procedures taught to ENT residents, as it is a crucial skill in their training [6]. It enables timely access to the patient's airway in emergencies. Residents typically start by studying textbooks, multimedia resources, and observing experienced physicians. They then progress to assisting specialists during the procedure and eventually performing it themselves under guidance. Anatomical dissection is integral to preparation before surgery. Currently, there is no established algorithm for OS tracheostomy training in Italian ENT residency programs.

Several studies have been conducted comparing the outcomes of procedures performed by residents and specialists. The results showed that the resident's inexperience does not affect the outcome of the procedure [7, 8, 9]. The majority of these works concern general surgery training [8, 9]. There are several papers on tracheostomy, tonsillectomy, and thyroidectomy training in the ENT field [10, 11, 12]. Fiorini *et al.* [7] compared outcomes, in terms of early and late postoperative complications, between tracheostomy performed by residents and specialists. They have shown that tracheotomies supervised by experienced surgeons are safe and do not pose an increased risk of complications or adversely affect the quality of care [7].

The primary purpose of our retrospective chart review is to compare OS tracheostomies performed by specialist and supervised resident surgeons, in terms of surgical time and post-surgical complications. The secondary purpose is to compare these data in relation to years of surgical experience for both specialist physicians and residents.

## **Materials and Methods**

A retrospective analysis was performed on all patients who underwent OS tracheostomy at the Unit of Otorhinolaryngology, Head & Neck Department, University of Verona, between 1 January 2017 and 31 December 2022.

Inclusion Criteria: (1) Elective tracheostomy; (2) Tracheostomy under general anesthesia; (3) Tracheostomy performed in patients over 16 years of age; (4) Tracheostomy performed in the operating room.

Exclusion Criteria: (1) Bedside tracheostomy (not transportable patient); (2) Emergency tracheostomy with immediate need of airway management or in not ideal setting; (3) Tracheostomy under local anesthesia; (4) Tracheostomy performed in conjunction with other surgical procedures; (5) Revision of percutaneous tracheostomy and tracheostomy reopening; (6) Tracheostomy performed in patients under 16 years of age.

Using the electronic patient record, we collected the following information: patient age and sex, ASA score, indication for surgery, date and duration of surgery, type of surgeon, and a detailed description of the surgical procedure, including intraoperative complications.

Data on comorbidities and early post-operative complications were collected from clinical records.

These data were then compared in relation to years of surgical experience for both specialist physicians and residents. For specialists, a comparison was made between procedures performed by senior (at least 5 years' experience) and junior (less than 5 years' experience) surgeons. Since our department is part of a University Hospital, tracheostomies are performed either by specialist surgeons or residents under supervision. In Italy, ENT residency programs last four years, for this reason the residents were divided into 4 groups.

A standard technique that preserved the isthmus (subisthmic OS tracheostomy) was performed in the great majority of cases: a median cervicotomy 2 cm above the jugular notch followed by a sharp dissection to locate the laryngotracheal axis. Superior retraction of the thyroid isthmus and horizontal incision somewhere between the  $2^{\circ}$  and  $4^{\circ}$ tracheal ring. Anchorage of the trachea to the skin with 3 lower and 2 upper interrupted sutures.

## Statistical Analysis

Data were analyzed using Stata Software ( $\mathbb{C}$  version 18, 1996–2023 StataCorp LLC, College Station, TX, USA). Two-sample Student's *T* test with equal variances and Chi-square test were used. A *p*-value < 0.05 was considered statistically significant.

# Results

A total of 385 surgical procedures were selected. specialists conducted 168 tracheostomies (43.6%), while 39 residents, divided into different years of training, performed 217 procedures (56.4%). For completeness and clarity of

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Fig. 1. Mean OS tracheostomy time in minutes.

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Table 2. Indications to US tracheostomy.				
Indications	Patients, n (%)			
Weaning from Mechanical ventilation	235 (61.04)			
Weaning from Mechanical ventilation in pa-	29 (7.53)			
tients with severe acute respiratory syndrome				
coronavirus 2 (SARS-CoV-2)				
Acute airway obstruction	17 (4.42)			
Chronic airway obstruction	29 (7.53)			
Airway protection	37 (9.61)			
Airway protection in oncologic patient	38 (9.87)			

presentation, Table 1 reports the number and percentage of OS tracheostomies performed by different operators, senior and junior specialists, and residents divided by year of training.

Mean surgical times are illustrated in Fig. 1.

Surgical indications for performing an OS tracheostomy are reported in Table 2.

We compared procedures performed by residents under supervision during various training years with those carried out by junior and senior specialists. No statistically significant differences in surgical time were observed (p = 0.287). Statistical analysis related to patients' anatomy showed a significant increase in operative times in patients with no palpable neck landmarks (p = 0.006) and in those with previous neck surgery (p = 0.039). Neck stiffness did not correlate with a statistically significant increase in surgical time (p = 0.679).

Among patients' comorbidities, only anticoagulant or antiaggregant proved to prolong operative time (p = 0.018), while ASA score did not correlate with the duration of surgery (Table 3).

363 (94.29%) tracheostomies were sub-isthmic, while trans-isthmic and supra-isthmic approaches were performed only in 11 (2.86%) of cases, respectively. Sub-isthmic tracheostomy required shorter operative time compared to trans-isthmic procedure (p = 0.043), while no difference was shown with respect to supra-isthmic technique (p = 0.227).

The second part of the analysis focused on complications: 23 (5.97%) minor and 7 (1.8%) major complications were recorded (Table 4).

Analysis of postoperative complications showed no significant differences between supervised residents and specialists in terms of frequency (p = 0.908).

Patients' characteristics, including age at surgery, neck anatomy, comorbidities and ASA score did not show a significant correlation with an increased likelihood of postoperative complications.

Likewise, surgical technique (supra, trans or sub-isthmic tracheostomy) and number of operators (two or three) do not significantly influence the risk of developing complications.

#### Discussion

Worldwide, one of the first procedures taught to ENT residents is OS tracheostomy [6]. When doing elective surgery, it's important to understand proper and adequate airway management in order to prepare for potential airway emergencies. Training in a controlled environment allows resi-

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	Mean surgical time $\pm$ standard d	t test	
	Present	Absent	<i>p</i> -value ( <i>t</i> value)
Neck anatomy			
Neck stiffness	$40.85 \pm 14.47 - 364  (94.5)$	$39.52 \pm 10.85 - 21 \ (5.5)$	0.679 (-0.414)
Presence of scars	$47.05 \pm 19.77 - 364  (94.5)$	$40.42 \pm 13.86 - 21 \ (5.5)$	0.039 (-2.075)
Palpable neck landmarks*	$40.46 \pm 13.91 - 375~(97.4)$	$52.90 \pm 22.54 - 10~(2.6)$	0.006 (2.740)
Patient comorbidities			
Cardiovascular disease	$41.28 \pm 14.15 - 225~(58.4)$	$40.08 \pm 14.50 - 160~(41.6)$	0.418 (-0.811)
Lung disease	$44.16 \pm 13.92 - 44~(11.4)$	$40.35 \pm 14.30 - 341 \ (88.6)$	0.096 (-1.669)
Neurologic disease	$41.76 \pm 14.46 - 63~(16.4)$	$40.59 \pm 14.27 - 322 \ (83.6)$	0.552 (-0.595)
Diabetes	$42.41 \pm 13.75 - 79  (20.5)$	$40.36 \pm 14.42 - 306~(79.5)$	0.258 (-1.133)
Anticoagulant/antiaggregant therapy	$44.64 \pm 14.82 - 64  (16.6)$	$40.01 \pm 14.08 - 321 \ (83.4)$	0.018 (-2.380)
Chronic kidney disease	$43.25 \pm 9.54 - 4  (1.0)$	$40.76 \pm 14.34 - 381~(99.0)$	0.073 (-0.347)

Table 5. Mean surgical time in relation to datients' characterist	Table 3	3. Mean	surgical	time in	relation t	o patients'	characteristi
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In the table, the parameters that were statistically significant with p < 0.05 are indicated in bold, while those with even greater significance with p < 0.01 are marked with "\*".

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Complications	Cases, n (%)			
Minor complications				
Bleeding without the need for surgical revision	14 (3.6)			
Local infections	2 (0.52)			
Wound dehiscence	6 (1.56)			
Tracheal ring fracture	1 (0.26)			
Total	23 (5.97)			
Major complications				
Pneumothorax	1 (0.26)			
Bleeding with the need for surgical revision	6 (1.56)			
Total	7 (1.8)			

Table 4.	Minor	and	major	comp	lications.

dents to learn without endangering patients and fosters confidence and competence in performing surgeries. Therefore, a well-structured surgical program is vital for ENT resident training, ensuring safe and effective surgical care for all patients and opportunities for skill consolidation among trainees.

The statistical analysis of 385 surgical procedures shows that the mean surgical time for tracheostomy is 40.78 minutes, with no statistical difference between supervised residents and specialists. Moreover, there is no difference in the mean surgical time in the subgroups (p = 0.287). Therefore, according to our data, OS tracheostomy can be performed as early as the first year of residency without a substantial impact on the surgical time.

Statistically significant factors on surgical time are related to the anatomy of the neck and the presence of anticoagulant/antiaggregant drugs. Patients with neck's scars or absent palpable neck landmarks (e.g., large neck circumference) underwent longer surgical procedures (respectively p = 0.039 and p = 0.006).

The use of anticoagulant or antiaggregant drugs, such as aspirin, can also prolong surgical time due to increased bleeding during the procedure (p = 0.018). This requires additional time to perform adequate hemostasis, thus impacting the overall surgical time.

According to the most recent experience in performing tracheostomies during the pandemic era of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), two operators are sufficient to safely perform a surgical tracheostomy [13, 14, 15].

Analyzing the collected data, we found no substantial differences in post-operative complications between tracheostomies performed by supervised residents or specialists. We investigated major and minor complications and found no statistically significant difference between the two populations (p = 0.908).

Our results are consistent with studies in literature that investigate complications for tracheostomies and other surgical procedures. An Italian study by Fiorini *et al.* [7] compares tracheostomy outcomes in terms of postoperative complications and mortality, between supervised residents and specialists. No differences emerged between the two groups of surgeons, emphasizing the safety of the procedure performed by supervised residents [7]. These results are in agreement with those obtained by Ulkumen *et al.* [16]. They stated that OS tracheostomies performed by supervised residents are as safer as the ones performed by the attending surgeons. Both studies show concordant conclusions that overlap with ours.

Although tracheostomy should be one of the most usable and accessible procedures for ENT surgeons, some studies point out that this is not always true. Lesko *et al.* [17] pointed out that tracheostomy case volume in ENT residency has decreased steadily in comparison with general surgery residency in the United States. Therefore, ENT programs should be aware of this declining trend as well as changing procedural trends, which may affect training needs [17].

As both our study and that of Fiorini *et al.* [7] show, OS tracheotomy is taught from the first year of ENT residency in Italy. In fact, starting from the first years, residents are

exposed to basic ENT and head and neck surgery. Then they expand their training to include more advanced ENT procedures and begin to specialize in areas such as otology, laryngology or rhinology. They work with attending physicians and are given increasing responsibility in the diagnosis and treatment of patients. In the final year of the residency, residents can expect to gain a greater level of autonomy in the operating room and clinic. However, there is currently no structured algorithm for OS tracheostomy training in Italian ENT residency programs.

Muallem-Kalmovich *et al.* [6] investigated the training methods and needs of Otolaryngology-Head and Neck Surgery (OTO-HNS) residents to independently perform OS tracheostomy in Israel. The Israeli data demonstrated that there are no structured training platforms in local OTO-HNS residency programs, but ENT residents should acquire comprehensive knowledge and management of airway issues as early as possible in the residency. These considerations would lead to greater autonomy in surgery procedures and greater surgical skills for residents and young specialists, also for the management of emergency situations.

Surgical training programs are essential for the surgical growth of an ENT resident. The importance of surgical training is widely reported in the literature: surgical exercises are performed on both animal and anatomical preparations [18, 19].

Furthermore, there are other studies similar to ours that demonstrate how training is essential to acquire progressively stronger skills in ENT surgery. Leader *et al.* [10] evaluated the impact of resident participation in pediatric tonsillectomy. They demonstrated that operative times decreased as the surgeon's level of experience increased, but no difference in readmission or postoperative hemorrhage rates were observed between residents and attending surgeons or among residents at various levels of training [10]. The outcomes and complications of near-total thyroidectomy and total thyroidectomy performed by residents were analyzed in two different studies [11, 12]. Both demonstrated that there were no statistically significant differences in outcomes between residents and specialists.

Finally, surgical skills development is a real challenge during resident training. Tracheostomy is a fundamental intervention in the training of an ENT resident. Although there is currently no structured algorithm for OS tracheostomy training in Italian ENT residency programs, it is essential that ENT residents are trained to perform this procedure from their first year. For the teaching surgeon, putting a scalpel in the hands of a resident requires patience, expertise, wisdom and an act of trust in the resident [19, 20, 21, 22, 23]. It would be beneficial for residents to receive surgical training progressively throughout each year of their residency. This would ensure that once specialized, they are fully proficient in basic ENT procedures as well as lifesaving interventions such as tracheostomy [24].

To the best of our knowledge, this is the first study that show that a surgical tracheotomy procedure can be safely performed from the first year of residency if supervised by experienced surgeons, without an increase in surgical time or peri-procedural complications.

#### Limitations of the Study

This study has several potential sources of bias. The limitations of this study include its monocentric and retrospective nature, with the risk of missing contributing factors, especially complications. There is also heterogeneity among surgeons, both residents and specialists. Even among residents in the same year, there are different degrees of preparation that is impossible to evaluate.

Another major limitation of this study is the difficulty in retrieving post-operative data. Many patients were cared for in the intensive care or neurosurgical ward, so some data on the post-operative course were not recorded.

#### Conclusions

As demonstrated by the results of our study, no statistically significant differences in surgical time were observed, and no significant differences in complication frequency were reported between supervised residents and specialists, regardless of years of experience. Therefore, OS tracheostomy has been validated as a procedure that can be safely performed by residents as early as the first year of residency with appropriate supervision. This procedure constitutes a fundamental aspect of training for ENT surgeons. Residents can perform OS tracheostomy without significantly prolonging operative time or increasing the incidence of peri- and post-operative complications. Anatomical dissection and supervised surgery remain cornerstones of surgical training program.

#### Availability of Data and Materials

The data that support the findings of this study are available from the corresponding author upon reasonable request.

#### **Author Contributions**

VD conceived the study and wrote the paper; FDC, CL, MM, AEA and VA acquired the data and wrote the paper; DM, LS and GM supervised the work, helped in analysis and interpretation of data and corrected the paper. All authors revised the manuscript critically for important intellectual content. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

#### **Ethics Approval and Consent to Participate**

As the study was retrospective, the ethical approval and informed consent have been exempted by the Ethics Committee for clinical trials of the Provinces of Verona and Rovigo. The research was conducted ethically, with all study procedures being performed in accordance with the requirements of the World Medical Association's Declaration of Helsinki.

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# **Conflict of Interest**

The authors declare no conflict of interest.

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