The Laryngoscope

Transnasal Tracheoscopy

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Objectives/Hypothesis: Unsedated transnasal tracheoscopy (TNT) has emerged as a technique in otolaryngology–head and neck surgery for an awake airway examination in the office setting. This study investigates the safety, procedural success rate, indications, and findings of TNTs performed over a 3-year period at an academic medical center.

Study Design: Retrospective chart review.

Methods: After institutional review board approval, billing records were reviewed for patients who underwent TNT from 2007–2009 in the University of Wisconsin–Madison Department of Otolaryngology–Head and Neck Surgery. Hospital charts for these patients were obtained, and data regarding patient demographics, complications, procedural success rate, indications, and findings were recorded.

Results: Sixty-eight TNTs were performed on 44 patients over the last 3 years (25 males, 19 females; age range, 16–91 years). No complications were noted. Ninety-one percent of procedures were able to be completed. Indications for TNT were to: 1) detect airway stenosis or pathology, 2) evaluate the larynx and trachea prior to airway surgery, 3) monitor postoperative results of airway interventions, and 4) evaluate the airway prior to tracheotomy tube decannulation.

Conclusions: TNT is a safe procedure that can be performed on the unsedated patient using only topical anesthesia and is an attractive alternative to rigid bronchoscopy. The procedural success rate was high, indicating good patient tolerance. The indications for TNT, including its use as a tool for surgical planning, have become better defined. TNT has become a standard tool in the management of patients with airway pathology in our practices.

Key Words: Laryngology, laryngeal surgery, office-based, procedures, surgery, airway examination, patient safety, bronchscopy, laryngoscopy, airway stenosis.

Level of Evidence: 4.

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INTRODUCTION

Societal influences toward a safer and more efficient delivery of healthcare have driven changes within all of medicine including otolaryngology–head and neck surgery. One response to these influences has been the shift of procedures from the operating room to the office.[1,2] As a field, laryngology has its roots in office-based evaluation and intervention, but it was not until the late 1980s and early 1990s that laryngology was reinvigorated with a focus on office-based evaluations.[3,4] Within the last decade, the pace of migration to office-based laryngological intervention has accelerated due to distal chip endoscopes, fiber-based lasers, and the availability of numerous vocal fold injectables.[5,6] Office-based procedures have expanded the breadth of upper aerodigestive tract evaluation and treatment techniques, leading Belafsky to term this the golden age of laryngology.[7] Although the field continues to develop, one of the most important roles of an otolaryngologist, that of an airway evaluator, remains unchanged. Rigid endoscopy became the standard form of airway evaluation as methods of general anesthesia developed. However, rigid endoscopy cannot be performed on all individuals due to anatomic restrictions and is limited by the risks and costs of anesthesia. Additionally, it may not provide a truly dynamic examination due to the presence of the large-bore rigid endoscope itself. The development of fiberoptic and later distal-chip flexible endoscopes has allowed for examination under sedation or even topical anesthesia, avoiding some of the limitations of rigid airway endoscopy.

Since the development of fiberoptic endoscopes in the 1960s and 1970s, bronchoscopy has routinely been performed in an endoscopy suite with sedation. Pulmonologists are not generally accustomed to endoscopy of the unsedated patient seated upright in the examination chair. Transnasal tracheoscopy (TNT) describes a dynamic glottic, subglottic, and tracheal examination performed with a flexible endoscope using only topical anesthesia. In some centers, it has become a standard method for evaluation and management of patients with airway pathology, and largely supplanted use of rigid bronchoscopy and computed tomography (CT).[8] Despite descriptions of this procedure by others,[4,9–15] it is not

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widely reported. The safety, procedural success, indications, and findings of TNT are still being delineated. We attempted to address this with a retrospective chart review in an academic otolaryngologic practice.

MATERIALS AND METHODS

After institutional review board approval was obtained, billing records at the University of Wisconsin Hospitals and Clinics were reviewed for patients of the last author (S.H.D.) who underwent TNT between 2007 and 2009. A retrospective chart review was performed of patients who underwent TNT, and the demographics, complications, indications, findings, and ability to tolerate/complete the procedure were recorded.

Technical Description

All TNTs were performed in the otolaryngology clinic examination suite. This suite consists of an otolaryngology examination chair and a video tower with photodocumentation capability. A crash cart was available in the suite. No cardiopulmonary monitoring was performed before or during the procedure. Informed consent was obtained, and a procedural time-out was performed. The patient was seated in an examination char and instructed to inhale 3 mL of nebulized 4% lidocaine. Anterior rhinoscopy was used to determine the patient's more patent nasal passage, to which an aerosolized solution of lidocaine and oxymetazoline was applied. Two cotton pledgets soaked with the same solution were then placed into the same nasal cavity. After 3 to 5 minutes the pledgets were removed and the patient was asked to lean his/her torso forward and place his/her chin up to assume a sniffing position. A channeled flexible distal chip laryngoscope (VNL-1570STK; KayPENTAX, Montvale, NJ) lubricated with Surgilube (Fougera, Melvile, NY) was passed through the anesthetized nasal cavity along the floor of the nose and advanced into the oropharynx. Three 1-mL aliquots of 4% lidocaine were then applied to the patient's endolarynx through the working channel of the laryngoscope while the patient held a long /e/. At the end of the phonatory gesture, patients were instructed to breathe in deeply to inspire the lidocaine solution into the trachea. Immediately following the delivery of the third lidocaine aliquot, the laryngoscope was passed through the vocal folds into the trachea to the level of the carina. Examination of the main stem bronchi took place, and the laryngoscope was then slowly withdrawn from the airway. All images were recorded onto a digital photo-documentation system and then reviewed after procedural completion.

RESULTS

TNT was performed 68 times on 44 patients. Twenty-six males and 20 females underwent TNT. Patients were between 16 and 91 years old, and were on average 50.7 years of age.

TNT was performed for four major indications to: 1) detect airway stenosis or pathology, 2) evaluate the larynx and trachea prior to airway surgery, 3) monitor postoperative progress of airway intervention, and 4) evaluate the airway prior to tracheotomy tube decannulation (Table I).

TABLE I.
Number of Procedures Performed for Each TNT Indication.

Indication	No. of Procedures Performed
Rule out suspected airway pathology	21
Plan for surgery	8
Monitor postoperative progress of airway intervention	30
Evaluate suitability for tracheotomy tube decannulation	9

The first indication, examination to rule out suspected airway pathology, was performed 21 times. Of these, eight pathologic conditions were diagnosed that warranted intervention, three findings were noted that were not clinically significant, and eight exams were normal. Two examinations for this indication were unable to be completed.

The second indication, examination to plan for surgery, was performed eight times to assess the location, length, and degree of stenosis prior to intervention.

The third indication was to postoperatively monitor the progress of airway intervention. Thirty examinations were performed for this reason, following airway interventions such as tracheal resection, cricotracheal resection, laryngotracheal reconstruction, glottic stenosis repair, and endoscopic balloon dilation of airway stenosis.

The fourth indication was examination of the airway prior to tracheotomy tube decannulation. Nine patients underwent TNT for this reason after successfully completing capping trials. Of these nine patients, seven were noted to have no airway stenosis and were successfully decannulated after TNT. Two patients had granulation tissue in the airway and were taken to the operating room for direct bronchoscopy with removal of granulation tissue. Following removal of the granulation tissue, these patients were successfully decannulated.

Sixty-six of the 68 examinations were able to be completed. Two examinations were terminated early because patients could not tolerate passage of the laryngoscope through the glottis into the trachea. Symptoms were coughing and choking that did not relent. Of the two patients who were unable to tolerate an exam, one was taken to the operating room for direct laryngoscopy and bronchoscopy under general anesthesia and the other was able to tolerate TNT in a subsequent office visit.

DISCUSSION

Medicine has changed dramatically in response to demands for safer and more efficient healthcare.[16] Responding to the calls to improve safety profiles and reduce costs, otolaryngologists, as others, have sought to move portions of their practice from the operating room to the office over the last 15 years.[1,2]

The timing of these changes coincides with massive demographic shifts. The number of people over age 65 years are projected to double over the next 20 years to 70 million individuals.[17] Simply being a member of this cohort increases the likelihood of perioperative myocardial infarction during general anesthesia.[18] By reducing the need for general anesthesia, patients are less frequently exposed to these and other associated risks.

Financially, it has been noted that the cost of healthcare continues to rise precipitously.[19] By moving

procedures out of the operating room and into the office, there is substantial cost savings.[20,21] Overall savings with office-based procedures are also seen by maintaining employment; with the recent faltering of the worldwide economy, productivity is at a premium, and individuals no longer have as much leeway to miss work for medical care and recovery time associated with general anesthesia. Moreover, interventions without sedation permit people to drive themselves to and from the physician's office, decreasing reliance on others in the workforce.

Improvements in technology, in addition to these societal factors, have allowed laryngologists in particular to shift their practices to the office. Flexible fiberoptic bronchoscopes and laryngoscopes, and later distal-chip endoscopes, permitted performance of high-quality examinations in the office. Even with a flexible fiberoptic laryngoscope that does not have an operating channel, which is available in nearly all otolaryngology practices, TNT can be successfully completed.[4] Although versions of office-based transnasal tracheoscopy have been described by others,[4,9–15] the indications for the procedure have not been formalized and its safety and tolerance are still uncertain.[12,14] We investigated these factors by performing a retrospective chart review of TNTs performed by one of the authors (S.H.D.) at the University of Wisconsin–Madison Otolaryngology-Head and Neck Surgery clinic.

Tolerance and Safety

Our experience with TNT showed a high completion rate (97%) with no associated complications. Only two of the 68 examinations attempted could not be completed due to coughing and choking. No difference in demographics of this patient subset from the remainder of patients was noted. Although not studied formally, we have noticed during other office-based airway procedures that patients who are active smokers have overly reactive mucosa that occasionally necessitated extra doses of local anesthesia for procedural completion. We also have treated a subset of patients with anxiety toward office-based interventions. For this population a number of techniques, including verbal, visual, and sensory cues, are employed to complete procedures. Another potential option is to prescribe a preprocedure oral anxiolytic for these patients to successfully complete the procedure.

The early termination of TNT in these two patients occurred despite application of topical anesthesia. Other than initiating the process with nebulized lidocaine, the method of anesthesia delivery reported is similar to that described by Hogikyan, with lidocaine delivered through the channeled portion of a laryngoscope instead of transorally with an Abraham cannula.[4] Lidocaine may also be administered transorally through a laryngotracheal atomizer spray device (MAD-600; Wolfe-Tory, Salt Lake City, UT) or an Abraham cannula. The titration end point for lidocaine delivery was suppression of the cough reflex, typically achieved after the delivery of three 1-mL aliquots of 4% lidocaine. Topical palpation of the arytenoids or vocal folds with the tip of the endoscope may also be performed to assess adequacy of anesthesia, to ensure lack of laryngeal sensation. Despite this, 3% of patients were unable to tolerate TNT, and the examinations were terminated early. As a supplement to topical lidocaine, oral delivery of benzonatate pearls[13] and superior laryngeal nerve blockade[22] have been suggested to achieve proper laryngeal anesthesia. However, these methods were not chosen as patients may become intolerant of their own secretions resulting in saliva aspiration.[23]

Although this experience was limited to the examination of adult patients, unsedated TNT has been described for evaluation of children.[9,10] TNT was performed without complications using only transnasally applied local anesthesia in both infants[9,10] and children.[10]

A serious concern often mentioned with unsedated flexible tracheoscopy and bronchoscopy is an associated untoward cardiopulmonary effect.[12,14] Increases in heart rate and blood pressure have been noted during laryngotracheal and esophageal interventions.[24]

Bronchoscopy has been noted to cause a decrease in arterial oxygen tension and increases in heart rate, mean arterial pressure, and cardiac index.[25] However, these events may be more apparent in patients who undergo traditional sedated bronchoscopy, during which the delivery of topical anesthesia to distal bronchi may not be possible and procedures such as lavage occur. Similarly, complications noted in a large series of patients who underwent traditional bronchoscopy included laryngospasm, hemoptysis, pneumothorax, and cardiac arrhythmias.[26] Again, comparisons are difficult to make because these procedures are done with interventions such as biopsies, bronchoalveolar lavage, electrocautery, and stenting.[26]

We have historically performed all office-based upper aerodigestive tract procedures, including TNT, without cardiac or pulse oximetry monitoring. To date we have noticed no adverse effects from TNT. A study evaluating cardiopulmonary changes during TNT would help to shed light on this potential complication. Currently, if we were to come across a patient with severe cardiopulmonary disease, we would recommend intervention with monitoring or a procedure under general anesthesia.

TNT, as described here, was used only as a diagnostic tool. Unsedated TNT with intervention such as biopsy, tracheal dilation[27] and laser treatment of tracheal lesions[6,28] has been performed successfully. These experiences speak to the safety of TNT as a diagnostic tool, and illustrate the ability to treat pathology at the time of diagnosis if necessary.

Indications

Retrospective chart review revealed four major indications for TNT (Table I), which were similar but not identical to procedural indications described elsewhere (Table II).[4,11] Unlike other reports, TNT was used in this series to evaluate the need for tracheotomy tube decannulation. Morris et al. documented use of TNT in patients with newly diagnosed head and neck cancer as part of a staging panendoscopy, which neither Hogikyan nor this series reported.[4,11]

TABLE II.
Previously Reported Indications for Unsedated Airway Examination.

Author, Year	Indications for Unsedated Airway Examination
Hogikyan, 1999[4]	Evaluation of known or suspected airway stenosis, postoperative assessment of stenosis repair, tumor assessment
Morris et al., 2007[11]	Evaluation of chronic cough or intermittent hemoptysis, evaluation of stridor, bronchoscopy in newly diagnosed head and neck cancer, surveillance in patients with a history of laryngeal cancer, evaluation of subglottic and tracheal stenosis

Patients who underwent TNT to rule out suspected airway pathology typically presented with symptoms of shortness of breath and noisy breathing, and had not previously undergone examination or work-up by another physician. The key element of our primary evaluation for airway stenosis was TNT, performed at the initial clinic visit if possible. In patients who successfully underwent TNT for this reason, the incidence of significant pathology was 38%. Pathologies identified were glottic stenosis, tracheal stenosis, and granular cell tumor of the trachea. Findings that did not require intervention included tracheomalacia in two patients and a small tracheal diverticulum in another patient. TNT facilitated coordination of the proper equipment being present at the time of surgery, including line-of-sight laser, flexible fiber-guided laser, balloon dilators, and medication when appropriate. In two cases, no endoscopic management was attempted after TNT; open surgery was performed instead. Unfortunately, to our knowledge similar data do not exist for comparison.

The second indication, examination to plan for surgery, was performed on referred patients with known airway pathology. These patients required TNT to determine a surgical plan. Eight of the total 70 examinations were performed for this reason.

The third indication was to postoperatively monitor the progress of airway intervention. Overall this was the most common indication of TNT. The use of sequential airway examinations to monitor the progress of airway surgery has been previously described by Hogikyan, and similarly has been used by Grillo and colleagues.[4,29] No standard timetable exists regarding when postoperative examinations should be performed. We often perform TNT on patients who have undergone open airway procedures within the first postoperative week to examine for dehiscence, infection, granulation tissue, or edema. No changes in management were noted after performance of TNT in the postoperative period, although a larger sample size could potentially reveal pathology that would require intervention.

The fourth indication was examination of the airway prior to tracheotomy tube decannulation, which is part of the conservative approach adopted by the last author (S.H.D.) for management of patients with a tracheotomy tube. After successfully undergoing a capping trial, patients with tracheotomy tubes were evaluated with TNT for granulation tissue or airway stenosis. Although this is not standard in most otolaryngology practices, the incidence of decannulation failure despite passing a capping trial is not negligible. In a large study of 823 patients with tracheotomies, 4.8% failed decannulation despite meeting weaning criteria.[30] Twenty-three percent of these failures (9/40) were due to stridor or anatomical problems, which may have been noted with TNT prior to decannulation.[30] One of the few studies employing the approach of TNT prior to decannulation noted that out of 81 patients with tracheotomy tubes examined prior to decannulation, 56% percent were noted to have tracheal granuloma formation, and 12% had airway stenosis.[31] Over half of the patients with granulomas underwent laser resection of lesions prior to decannulation.[31]

In the current series, two out of the eight patients evaluated for decannulation were found to have tracheal granulation tissue that was removed in the operating room prior to decannulation. Similar to the described approach, others have suggested the use of a dynamic airway examination as a component of the standard decannulation protocol.[31–33] However, given the fact that this use of TNT is not universal,[34] the routine use of TNT for this purpose is unclear and may be best reserved for patients who fail capping trials where the likelihood of discovering airway stenosis is higher.

Alternatives

One alternative to TNT is direct laryngoscopy and bronchoscopy. Although direct laryngoscopy is a relatively safe procedure, it does have risks, including teeth and oral mucosa injury, temporary dysgeusia, dysphagia, and tongue numbness.[35,36] Also, because direct laryngoscopy requires general anesthesia, patients must miss work, obtain preoperative clearance that may require another office visit, and rely on others for transport. Office-based TNT, on the other hand, is usually performed at the initial office visit, and because it requires no sedation patients can drive themselves to and from the appointment with only a minimal time commitment. It is also important to recognize the risks of general anesthesia for a procedure that can be performed adequately in the unsedated patient.

Direct laryngoscopy and bronchoscopy is also not necessarily an optimal choice because it provides a static rather than a dynamic assessment of the airway. Some patients described symptoms that were exacerbated in certain positions or following certain events. It was possible to mimic these conditions during TNT to fully evaluate symptoms. TNT has been studied and found to be more accurate than rigid bronchoscopy for the assessment of dynamic airway pathology such as tracheomalacia.[9]

Radiographic imaging can also been used to evaluate the airway prior to endoscopy. CT scan has inaccuracies in airway assessment, by missing small but significant obstructing lesions, and inability to image dynamic collapse. However, because we perform TNT to diagnose and characterize airway pathology, the need for this has been mitigated. This spared patients the inconvenience, cost,

and radiation exposure from unnecessary x-rays and CT scans.[37–39]

Future Directions

For patients with newly diagnosed head and neck cancer, an alternative to direct laryngoscopy, bronchoscopy, and esophagoscopy under general anesthesia is unsedated transnasal laryngoscopy, transnasal esophagoscopy, and TNT.[3,11,40] Although we believe that screening for secondary malignancies in the clinic and the operating room yield similar information, formal studies must be done to confirm this as an adequate screening tool.

CONCLUSION

TNT is a safe and well-tolerated procedure that is easy to perform. Requiring only lidocaine and a flexible laryngoscope, it can be performed in most otolaryngology–head and neck surgery clinics. TNT provides enough information to potentially obviate radiographic imaging or the need to perform more invasive procedures such as direct bronchoscopy. Although more indications may exist, indications for TNT include 1) evaluating the airway to rule out suspected airway pathology, 2) planning for surgery, 3) monitoring the postoperative progress of airway intervention, and 4) evaluating suitability for tracheotomy tube decannulation in patients who fail capping trials. The use of TNT in panendoscopy for head and neck can be justified, but was not evaluated in this study. We expect TNT will become an increasingly important tool of the practicing otolaryngologist–head and neck surgeon.

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