A Grading System for Transnasal Flexible Laryngoscopy

*Hamdi Tasli, †Omer Karakoc, and †Hakan Birkent, *Sanliurfa, and †Ankara, Turkey

Summary: Objective. Transnasal flexible laryngoscopy (TFL) is becoming more popular in laryngology clinical practice. There has not been any grading system for TFL to help the physician document and communicate the laryngeal view yet. In this study, we aimed to classify the laryngeal view based on the visualization of the glottic aperture with TFL performed on conscious patients.

Methods. The TFL videos of 920 randomized patients were evaluated by three blind observers experienced with laryngology. The laryngeal view, consisting of the basic anatomic landmarks of the glottis, arytenoids, and epiglottis, was examined, and the glottic aperture was classified with a five-point grading system. Interobserver agreements for the grading system scores were assessed by using the kappa (k) statistic.

Results. Nine hundred and twenty subjects were enrolled in the study. Six hundred and thirty-eight (69.3%) were men, and 282 (30.6%) were women, and the mean age was 40.13 ± 15.08 (18−89 years). The number of patients constituting grade 1 was 737 (80.1%), while grade 2a was 122 (13.2%), grade 2b was 32 (3.4%), grade 3 was 24 (2.6%), and finally, grade 4 was only 5 (0.5%). The k score was 0.945 ($P < 0.001$) between the ratings of observer 1 and observer 2, 0.933 ($P < 0.001$) between observer 1 and observer 3, and 0.91 ($P < 0.001$) between observer 2 and observer 3.

Conclusion. This new grading system for the laryngeal view can help physicians assess the upper airways, and it can also help visualize how much of a glottic opening there is.

Key Words: Transnasal flexible laryngoscopy−Endoscopy−Larynx−Direct laryngoscopy−Grading system.

INTRODUCTION

Transnasal flexible laryngoscopy (TFL) is becoming more popular in laryngology clinical practice, with the advantages of advanced technological developments, especially in optics and lightening. TFL provides a reliable image of the laryngeal structures, such as the tongue base, epiglottis, glottic aperture, and arytenoids, and has been crucial in the diagnosis of upper-airway pathologies. This is an easy and well-tolerated procedure performed with topical anesthesia that allows for the dynamic assessment of the laryngeal structures during respiration or phonation.[1]

For the purpose of endotracheal intubation, direct laryngoscopy (DL) is the gold standard for securing the airways and is routinely used in a variety of patient populations and operations.[2] To avoid possible airway failure, many classifications have been developed to assess laryngeal appearance during DL.[3,4] But all of the current grading systems were designed to be performed while the patient was under general anesthesia in a supine position, so that the tongue base was manipulated by a rigid laryngoscope during DL.

TFL, however, now allows physicians to examine the laryngeal view before general anesthesia is administered and then take the required precautions before the intended procedure. Nevertheless, a grading system for TFL has yet to be developed to help the physician document and communicate the laryngeal view. The proposal of this study is to classify the laryngeal view based on the visualization of the glottic aperture with TFL performed on conscious patients.

METHODS

Video assessment

The study was carried out according to the Declaration of Helsinki and was previously approved by the local review board. The TFLs were performed by the same physician. At first, the most appropriate nasal passage was selected by anterior rhinoscopic examination, and two sprays of topical 4% lidocaine were given in the same nostril. A 3.7-mm transnasal flexible laryngoscope (Karl Storz Telepack 200430-20; Karl Storz GmbH & Co., Tuttlingen, Germany with CMOS Video-Rhino-Laryngoscope 11101 CMK kit) was then inserted 5 minutes after instillation. During TFL, the images were obtained by bringing the tip of the endoscope just above the level of the hypopharynx. The sniffing position is thought to be an ideal head and neck position that allows for an appropriate laryngeal view,[5] while there is no definitive study about the ideal head and neck position to be applied during TFL. In the sniffing position, the patient's neck should be flexed at a 35° angle on the chest and the head should be extended at the atlanto-occipital joint to produce a 15° angle between the facial and horizontal planes.[6] The sniffing position and the level of hypopharynx were preferred means of providing an optimal laryngeal view during laryngoscopy.

The TFL videos of 920 randomized patients were evaluated by three blind observers experienced with laryngology. The observers were blind to the clinical history, and the preassigned

Accepted for publication February 21, 2018.
Each of the authors has contributed to, read, and approved this manuscript.
This manuscript is original and it, or any part of it, has not been previously published; nor is it under consideration for publication elsewhere.
All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.
Informed consent was obtained from all individual participants included in the study.
This work was prepared in Gulhane Medical School, Department of Otolaryngology, Head and Neck Surgery, Ankara, Turkey.
From the *Birecik State Hospital, Department of Otolaryngology, Head and Neck Surgery, Sanliurfa, Turkey; and the †Gulhane Medical School, Department of Otolaryngology, Head and Neck Surgery, Ankara, Turkey.
Address correspondence and reprint requests to Hamdi Tasli, Birecik State Hospital, Department of Otolaryngology, Head and Neck Surgery, 63400, Birecik, Sanliurfa, Turkey. E-mail: hamditasli@gmail.com
Journal of Voice, Vol. 33, No. 5, pp. 712−715
0892-1997

https://doi.org/10.1016/j.jvoice.2018.02.019

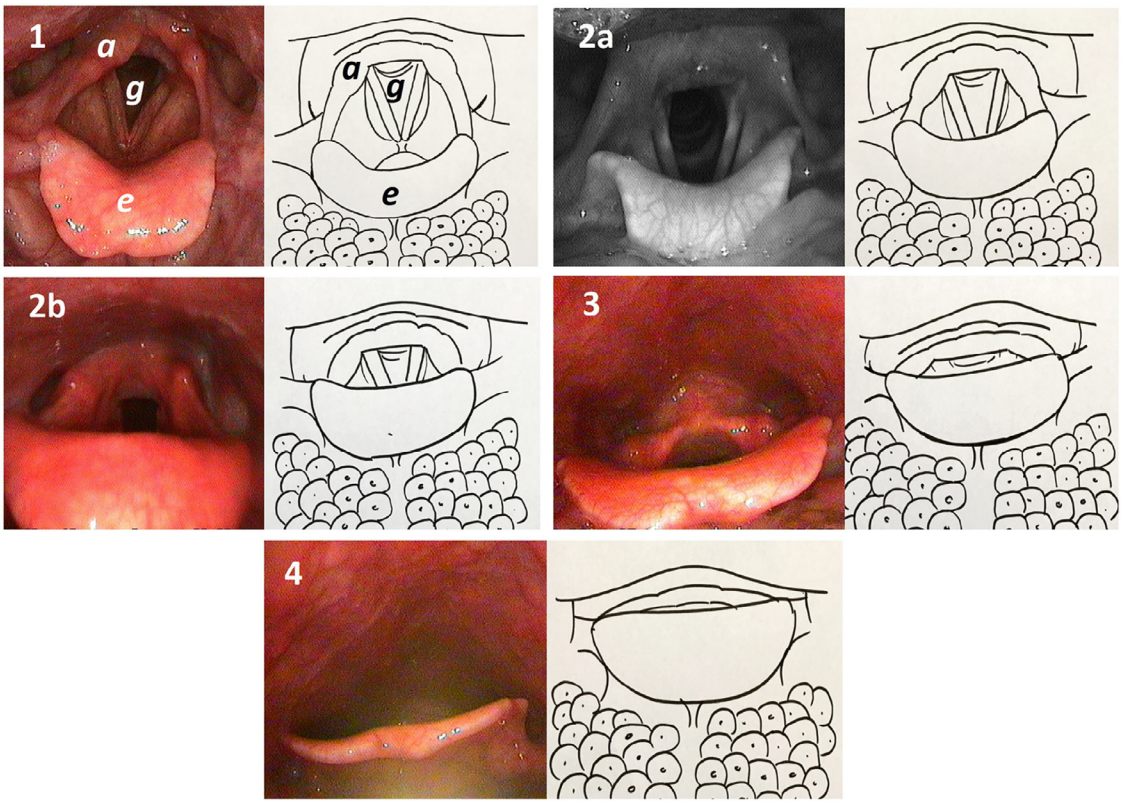

FIGURE 1. Images of the five-point grading system with both photographs and illustrations. a, arytenoids; g, glottis; e, epiglottis.

grade patients underwent laryngoscopy for a variety of indications, including dysphonia and dysphagia. The videos were shown to the observers in a random order. Demographic data, including age and sex, were also collected.

Grading system

The laryngeal view, consisting of the basic anatomic landmarks of the glottis, arytenoids, and epiglottis, was examined, and the glottic aperture was classified with a five-point grading system. The scoring was performed according to the following classifications: (1) the entire glottis, arytenoids, and epiglottis are all visible; (2a) more than 50% of the glottis and the entire arytenoids and epiglottis are visible; (2b) less than 50% of the glottis and the entire arytenoids and epiglottis are visible; (3) the glottis is no longer visible, but the entire arytenoids and epiglottis are visible; and (4) neither the glottis nor the arytenoids are visible; only the epiglottis is visible (Figure 1; Table 1).

Inclusion/exclusion criteria

Only adult patients who had undergone TFL were recruited. The exclusion criteria included anyone below 18 years of age, diagnosis of obstructive sleep apnea, any case of benign or malign tumors, trauma, previous laryngeal surgery, inflammatory or infectious diseases that may alter the anatomy of the larynx, epiglottis, pharynx, or/and tongue base, any cervical pathology that restricts head and neck movement, head and neck radiotherapy history, pregnancy, and illiteracy.

Statistical analysis

Interobserver agreements for the grading system scores were assessed by using the kappa (k) statistic.[7] The k value was interpreted according to guidelines by Landis and Koch.[8] Scores of 0 indicate that agreement is no better than if based on chance. A k score of 1 indicates a perfect agreement, and negative scores can be found with consistent disagreement between observer ratings. Values of 0.00−0.19 represent slight agreement; 0.20−0.29, fair agreement; 0.40−0.59, moderate agreement; 0.60−0.79, substantial agreement; and ≥0.80, nearly perfect agreement.[7] Values of $P < 0.05$ were considered statistically significant. All statistical analyses were performed using *SPSS 16* statistical software (IBM Corporation).

TABLE 1.
The Laryngeal View Consisting Basic Anatomic Landmarks; Glottis, Arytenoids, and Epiglottis Were Examined and the Glottic Aperture Were Classified with a Five-Point Grading System

		Anatomic Landmarks		
Classification		Glottis	Arytenoids	Epiglottis
Grade 1		100% visible	100% visible	100% visible
Grade 2	2a	50% <		
	2b	50% >		
Grade 3		Not visible		
Grade 4			Not visible	

TABLE 2.
Number of the Patients Evaluated According to the New Laryngeal Grading System

Classification		*n*	%
Grade 1		737	80.1
Grade 2	2a	122	13.2
	2b	32	3.4
Grade 3		24	2.6
Grade 4		5	0.5
Total		920	100%

RESULTS

Nine hundred and twenty subjects were enrolled in the study. Six hundred and thirty-eight (69.3%) were men and 282 (30.6%) were women, and the mean age was 40.13 ± 15.08 (18−89 years).

The number of patients constituting grade 1 was 737 (80.1%), while grade 2a was 122 (13.2%), grade 2b was 32 (3.4%), grade 3 was 24 (2.6%), and finally, grade 4 was only 5 (0.5%) (Table 2).

Kappa scores were calculated with the inclusion of the grades assigned to all videos from three laryngologists. No data were missing. The k score was 0.945 ($P < 0.001$) between the ratings of observer 1 and observer 2, 0.933 ($P < 0.001$) between observer 1 and observer 3, and 0.91 ($P < 0.001$) between observer 2 and observer 3 (Table 3). These values denote nearly perfect agreement. A complete agreement was seen in 890 of the 920 videos.

Given that the *k* coefficient only denotes agreement between raters, the percentage of agreement with this study's designated "correct" grade was calculated. There was 99.45% agreement with grade 1, 92.6% agreement with grade 2a, 68.75% agreement with grade 2b, 75% agreement with grade 3, and 80% agreement with grade 4. The number of cases that the observers could not reach a consensus on was 7 between grades 1 and 2a, 12 between grades 2a and 2b, 9 between grades 2b and 3, and only 2 between grades 3 and 4. According to this result, any of the cases scored with two upper grades were not confused by the authors.

DISCUSSION

TFL is a simple, safe, cost-effective, and commonly used diagnostic procedure for the evaluation of the upper aerodigestive tract that does not result in any major discomfort for the patient.[9] It actually provides an excellent and dynamic visual examination of the epiglottis, glottis aperture, arytenoids, tongue base, and essentially, the entire upper airway to the glottis.[9] The other important feature of this procedure is that the patient can be awake and in a seated position for its duration. However, despite TFL's fairly frequent use by laryngologists, a grading system to assess glottic aperture has yet to be developed.

TABLE 3.
The Interobserver Agreements for the Grading System *(Kappa)* Scores of Three of the Laryngologists

Observer	Kappa Score *(k)*		*P*
1−2	0.945	≥0.80	<0.05
1−3	0.933		
2−3	0.910		

The incidence of difficult endotracheal intubations can reach up to 30%, depending on variations in anesthesiologists' expertise and experience, as well as the need for additional equipment.[10−12] The management strategy for securing the airway depends on evaluating the upper airway and diagnosing possible anatomic variations that may lead to airway failure risk during the endotracheal intubation. TFL is widely available and a familiar technique for the anesthesiologist to evaluate the upper airway before providing airway management decisions to laryngology patients.[13−15] It can help anesthesiologists to choose the proper management strategy. Rosenblatt et al[16] evaluated 138 patients presented for elective diagnostic or therapeutic airway procedures, and the airway management plan was changed in one-quarter of the patients. They concluded that TFL improves the safety of managing both known or unpredictably difficult airway patients. Moorthy et al[13] performed routine endoscopy in their examinations of patients with upper-airway pathologies over a 10-year period and concluded that their airway management plan was influenced by the patient's history, physical examination, imaging, and indirect laryngoscopy or fiberoptic endoscopy.

There are several grading systems used to assess the upper airways in the literature. The Cormack-Lehane (CL) classification is a commonly used grading system to evaluate the laryngeal view during DL.[3] CL classification was first published in 1984 with drawings and descriptions describing a four-step grading system (CL grades 1−4) for the laryngeal view. Some studies have modified CL classification to create a more sensitive grading system to evaluate glottic aperture.[17−19] A quantitative staging system, "percentage of glottic opening," was first reported in 1998 and can distinguish small changes in glottic visualization.[20] It is described as a useful outcome parameter for assessing glottic visualization. But these studies also have some handicaps. All of the current grading systems were performed by anesthesiologists while the patient was under general anesthesia in a supine position, and the tongue base was manipulated by a rigid laryngoscope. But this new grading system is performed on conscious, seated patients who were evaluated before the operation. There also was not any manipulation performed to the tongue base, as in DL techniques, so that the physicians could easily assess the upper airways before the operation and plan the appropriate approach accordingly. In the future, this staging system will affect decisions about airway management before anesthesia.

Another goal of this study was to allow laryngologists to identify the glottic aperture by examining the main anatomic landmarks, namely the glottis, arytenoids, and epiglottis. Although TFL is now used fairly often, a standardized grading system has not been developed to allow for the identification of

glottic aperture and laryngeal anatomy—until now. This grading system can help laryngologists identify the glottis aperture and laryngeal anatomy, so that any of the pathologies can be diagnosed and described. This grading system will be able to categorize the glottic aperture and generate a terminological description that can be easily applied during airway evaluation.

When the three laryngologists' kappa scores were evaluated in pairs, they were found to show higher interobserver agreement. Despite the perfect agreement values and high number of patients, the percentages of agreement with the designated "correct" grade were variable. The percentages of grades 1, 2a, and 4 were 99.45%, 92.6%, and 80%, respectively. This can be explained by the fact that the end-stage patients are more easily identified and successfully categorized by TFL. The high percentages of grades 1 and 2a can also be explained by the high number of patients. The percentages of grades 2b and 3 were 68.75% and 75%. The number of cases that the observers could not reach a consensus on was 30, and the disagreement was mostly between grades 2a and 2b and grades 2b and 3. The evaluation of the images is entirely subjective, and there may be a disagreement between closer anatomical structures. The disagreement may also be due to the fact that the authors did not perform numerical measurements, and to difficulties in assessing snapshots. The gradual decrease in the number of patients with an increase in grades may also have contributed to this result. In the future the disagreements between groups may be reduced by the help of possible revisions in this grading scale.

Limitations

The body mass indexes of the patients and the role of obesity on the TFL were unknown. The grading system does not differentiate the visualization of the tongue base, posterior pharyngeal wall, and laryngeal ventricles. This limitation indicated that there may be a need for some subgroups in the future. Although it is still not possible to standardize which nasal passage should be used during TFL today, studies in which the examination performed for each patient twice, through each side, may contribute these results in the future.

CONCLUSION

This new grading system for the laryngeal view can help physicians assess the upper airways, especially before the operation. It can also help visualize how much of a glottic opening there is. This new grading system may provide a basis for future studies of how the TFL preoperatively impacts the decisions of physicians.

REFERENCES

1. Rosen CA, Amin MR, Sulica L, et al. Advances in office-based diagnosis and treatment in laryngology. *Laryngoscope*. 2015;125:2630.
2. Cormack RS. Cormack-Lehane classification revisited. *Br J Anaesth*. 2010;105:867–868.
3. Cormack RS, Lehane J. Difficult tracheal intubation in obstetrics. *Anaesthesia*. 1984;39:1105–1111.
4. Benumof JL. Definition and incidence of difficult airway. In: Benumof JL, ed. *Airway Management: Principles and Practice*. 1996121–125 St Louis Mosby.
5. Lee JH, Jung HC, Shim JH, et al. Comparison of the rate of successful endotracheal intubation between the "sniffing" and "ramped" positions in patients with an expected difficult intubation: a prospective randomized study. *Korean J Anesthesiol*. 2015;68:116–121.
6. Benumof JL. Management of the difficult adult airway. With special emphasis on awake tracheal intubation. *Anesthesiol*. 1991;75:1087–1110.
7. Tan M, Bryson PC, Pitts C, et al. Clinical grading of Reinke's edema. *Laryngoscope*. 2017;127:2310–2313.
8. Friedman M, Yalamanchali S, Gorelick G, et al. A standardized lingual tonsil grading system: interexaminer agreement. *Otolaryngol Head Neck Surg*. 2015;152:667–672.
9. Akça O, Lenhardt R, Heine MF. Can transnasal flexible fiberoptic laryngoscopy contribute to airway management decisions? *Anesth Analg*. 2011;112:519–520.
10. Walls RM, Brown CA, Bair AE, et al. Emergency airway management: a multi-center report of 8937 emergency department intubations. *J Emerg Med*. 2011;41:347–354.
11. Sagarin MJ, Barton ED, Chng YM, et al. Airway management by US and Canadian emergency medicine residents: a multicenter analysis of more than 6,000 endotracheal intubation attempts. *Ann Emerg Med*. 2005;46:328–336.
12. Martin LD, Mhyre JM, Shanks AM, et al. 3,423 emergency tracheal intubations at a university hospital: airway outcomes and complications. *Anesthesiology*. 2011;114:42–48.
13. Moorthy SS, Gupta S, Laurent B, et al. Management of airway in patients with laryngeal tumors. *J Clin Anesth*. 2005;17:604–609.
14. Ehrenwerth J, Escobar A, Davis EA, et al. Can the attending anesthesiologist accurately predict the duration of anesthesia induction? *Anesth Analg*. 2006;103:938–940.
15. Leder SB, Ross DA, Briskin KB, et al. A prospective, double-blind, randomized study on the use of a topical anesthetic, vasoconstrictor, and placebo during transnasal flexible fiberoptic endoscopy. *J Speech Lang Hear Res*. 1997;40:1352–1357.
16. Rosenblatt W, Ianus AI, Sukhupragarn W, et al. Preoperative endoscopic airway examination (PEAE) provides superior airway information and may reduce the use of unnecessary awake intubation. *Anesth Analg*. 2011;112:602–607.
17. Wilson ME, Spiegelhalter D, Robertson JA, et al. Predicting difficult intubation. *Br J Anaesth*. 1988;61:211–216.
18. Roberts JT, Ali HH, Shorten GD. Using the bubble inclinometer to measure laryngeal tilt and predict difficult laryngoscopy. *J Clin Anesth*. 1993;5:306–309.
19. Takahata 0, Kubata M, Mamiya K, et al. The efficacy of the "BURP" maneuver during a difficulty laryngoscopy. *Anesth Analg*. 1997;84:419–421.
20. Levitan RM, Ochroch EA, Kush S, et al. Assessment of airway visualization: validation of the percentage of glottic opening (POGO) scale. *Acad Emerg Med*. 1998;5:919–923.