Laryngoscopic evaluation with the Airway Cam® laryngoscopy video system

[Évaluation laryngoscopique avec le système de laryngoscopie vidéo Airway Cam®]

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Purpose: The Airway Cam® is a head-mounted direct laryngoscopy video system which uses a prismatic sighting system that aligns with the operator's line of sight. This study evaluated intra- and inter-observer consistency in laryngoscopy grading comparing direct laryngoscopy to the laryngoscopy grade obtained with the Airway Cam®.

Methods: Twenty-seven patients receiving a general anesthetic for elective surgery had laryngoscopy performed by an anesthesiologist wearing the Airway Cam®. Each video was duplicated, then randomized and reviewed in a blinded fashion by the original laryngoscopist and a second anesthesiologist. Intra- and inter-observer correlations were identified.

Results: There was good intra-observer agreement of the Cormack-Lehane scale between direct laryngoscopy and laryngoscopy recorded with the Airway Cam® ($\kappa = 0.63$). The corresponding intra-observer correlation of the percentage of glottic opening score was strong at $r = 0.83$. There was good inter-observer agreement of the Cormack-Lehane scale between direct laryngoscopy and that observed by the second anesthesiologist during Airway Cam® video review ($\kappa = 0.70$). There was moderate correlation of the inter-observer percentage of glottic opening scores ($r = 0.73$).

Conclusion: This study validates that the view recorded by the Airway Cam® reflects the view of the laryngoscopist. The Airway Cam® may introduce an additional level of objectivity into airway management research and teaching.

Objectif *: Le Airway Cam® est un système vidéo de laryngoscopie directe monté sur casque qui utilise un système de vision prismatique qui s'aligne sur la vision de l'opérateur. Nous avons évalué la cohérence intra-observateur et inter-observateur pour classifier la laryngoscopie en comparant la laryngoscopie directe au grade de laryngoscopie obtenue avec le Airway Cam®.*

Méthode *: Vingt-sept patients recevant une anesthésie générale pour une opération réglée ont subi une laryngoscopie par un anesthésiologiste portant un Airway Cam®. Chaque vidéo a été dupliquée, puis randomisée et revue de façon objective par l'examinateur et un second anesthésiologiste. Les corrélations intra-observateur et inter-observateur ont été déterminées.*

Résultats *: Il y a eu une bonne concordance intra-observateur de l'échelle de Cormack-Lehane entre la laryngoscopie directe et l'enregistrement du Airway Cam® ($\kappa = 0,63$). La corrélation intra-observateur correspondante du pourcentage d'ouverture glottique a été importante à $r = 0,83$. Il y a eu une bonne concordance inter-observateur à l'échelle de Cormack-Lehane entre la laryngoscopie directe et l'observation par le second anesthésiologiste pendant la revue vidéo du Airway Cam® ($\kappa = 0,70$). Il y a eu une corrélation modérée du pourcentage inter-observateur des scores d'ouverture glottique ($r = 0,73$).*

Conclusion *: Cette étude certifie que la vision enregistrée par le Airway Cam® correspond à la vision de l'examinateur. Le Airway Cam® peut ajouter un degré d'objectivité à la recherche sur le contrôle des voies aériennes et à son enseignement.*

CLINICAL airway research requires an accurate method of documenting the view of the larynx during direct laryngoscopy.[1,2] The Airway Cam® (AC) direct laryngoscopy video system (Airway Cam Technologies Inc., Wayne, PA, USA) is a head-mounted micro-video system that aligns with the laryngoscopist's line of sight from the dominant pupil.[3] It displays and records laryngoscopy and intubation as visualized by the laryngoscopist, overcoming visual restrictions inherent to laryngoscopy.

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Since 1996, the AC has been used as a research tool and educational adjunct for teaching laryngoscopy.[3–5] However, the degree of agreement between laryngoscopy views obtained with the AC compared to views obtained by direct laryngoscopy has not been rigorously evaluated. We therefore undertook a study to test the hypothesis that the laryngoscopic view obtained during direct laryngoscopy, as measured with the Cormack-Lehane (CL)[6] and percentage of glottic opening (POGO) scores,[4] accurately reflects the view recorded by the AC.

Methods

With Research Ethics Board approval, written informed consent was obtained from 27 ASA physical status I–III adults, undergoing elective surgery. Excluded were patients with a body mass index > 40, those with a history of difficult intubation, and anyone with a preoperative evaluation that warranted an awake intubation or rapid sequence induction.

After standard supine positioning for laryngoscopy with mild cervical flexion and atlanto-occipital extension, all subjects received a standardized anesthetic induction consisting of *iv* midazolam, fentanyl, propofol, and rocuronium. Muscle relaxation was confirmed by train-of-four monitoring, and direct laryngoscopy was performed with a Macintosh #3 blade by the same laryngoscopist (J.A.L.) while wearing the AC. The laryngoscopist was blinded to the digital readings, and immediately recorded the CL grade and POGO scores obtained from direct laryngoscopy.

All laryngoscopy images were duplicated and assigned a randomization number. The blinded digital recordings were presented in random order to the original laryngoscopist and an independent anesthesiologist, each with greater than five years' clinical experience. Each recording was viewed once at normal speed, and graded independently. The investigators were asked to approximate the "best view" seen during the recording, independently using the CL scale and POGO score. Investigators were blinded to the original direct laryngoscopy view, as well as to the AC view assigned by the other investigator.

The primary outcome was the intra-observer agreement between the CL grade assigned by the original laryngoscopist at direct laryngoscopy, and the laryngoscopy grade subsequently assigned by the same laryngoscopist during the video review (Figure 1A). Percentage of glottic opening, a secondary outcome, corresponded to the percentage of glottis visualized, the distance extrapolated from the inter-arytenoid notch to the anterior commissure of the vocal cords.[4] The score ranges from 0% when none of the glottic opening is visualized, to 100% where the anterior commissure is visible.

TABLE I Patient characteristics

Female / Male (*n*)	14 / 12
Age (yr)	58 ± 29
Body mass index ($kg \cdot m^{-2}$)	29 ± 9
Preoperative airway assessment*	
Modified Mallampati 1/4	5 (19)
Modified Mallampati 2/4	19 (70)
Modified Mallampati 3/4	3 (11)
Thyromental distance	5.3 ± 2.2 cm
Inter-incisor distance	5.5 ± 2.0 cm

n (%), mean ± 2 SD. *Each subject was evaluated by the same investigator (J.A.L.) in the sitting position and without phonation.

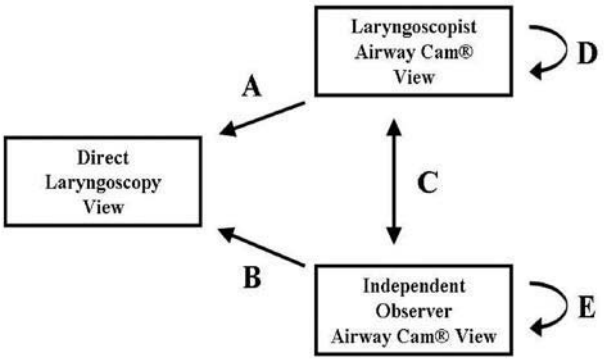

FIGURE 1 A schematic representation of the statistical comparisons.

Statistical analysis

The agreement between the laryngeal grades using the CL scale was analyzed using the kappa (κ) statistic. The degree of agreement deemed to be clinically significant was $\kappa > 0.6$. The Pearson correlation coefficient (r) was used to assess the correlation between continuous POGO score data.

The is no generally accepted method to calculate sample size for the kappa statistic. Therefore, the correlation coefficient was used to calculate sample size using the continuous data model (POGO). Approximately ten patients would provide 90% power to detect a 90% intra-rater correlation with a two-sided α error of 0.05. As larger numbers are needed in

TABLE II Cormack-Lehane and POGO correlations with Airway Cam® view

Comparison (Figure 1)	*Cormack-Lehane (κ)*	*POGO (r)*
A	0.63*	0.83†
B	0.70*	0.73‡
C	0.61*	0.90†
D	0.64*	0.96†
E	0.74*	0.94†

POGO = percentage of glottic opening. *Good strength of agreement;[7] †Strong positive correlation;[8] ‡Moderate positive correlation.[8]

general for categorical data, we empirically increased our sample size from ten to 25 subjects.

Results

Twenty-seven patients aged 29 to 81 yr were enrolled (Table I). One patient was excluded due to a protocol violation. Cormack-Lehane grades and POGO scores are shown in Figure 2. Kappa values and correlation coefficients are summarized in Table II.

Intra-observer agreement

There was good intra-observer agreement between the CL grade assigned at direct laryngoscopy and values from the AC as observed by the original laryngoscopist (Figure 1A), (κ = 0.63). The intra-observer correlation of the POGO score was high (r = 0.83). Comparison of each investigator's laryngoscopy views of the same duplicated video showed good intra-observer agreement between the two random assessments for the original laryngoscopist using the CL scale (κ = 0.64). These views also correlated with the POGO score (Figure 1D), (r = 0.96). Similar results were obtained for the second observer (Figure 1E), (κ = 0.74; r = 0.94).

Inter-observer correlation

There was good inter-observer agreement between the CL grade assigned at direct laryngoscopy with that observed by the independent observer (Figure 1B) during AC video review (κ = 0.70). The inter-observer correlation for the POGO score was r = 0.73. Lastly, when comparing the laryngoscopy grades assigned during review of the AC video by both anesthesiologists (Figure 1C), there was good inter-observer agreement for the CL scale (κ = 0.61) and strong correlation for the POGO score (r = 0.90).

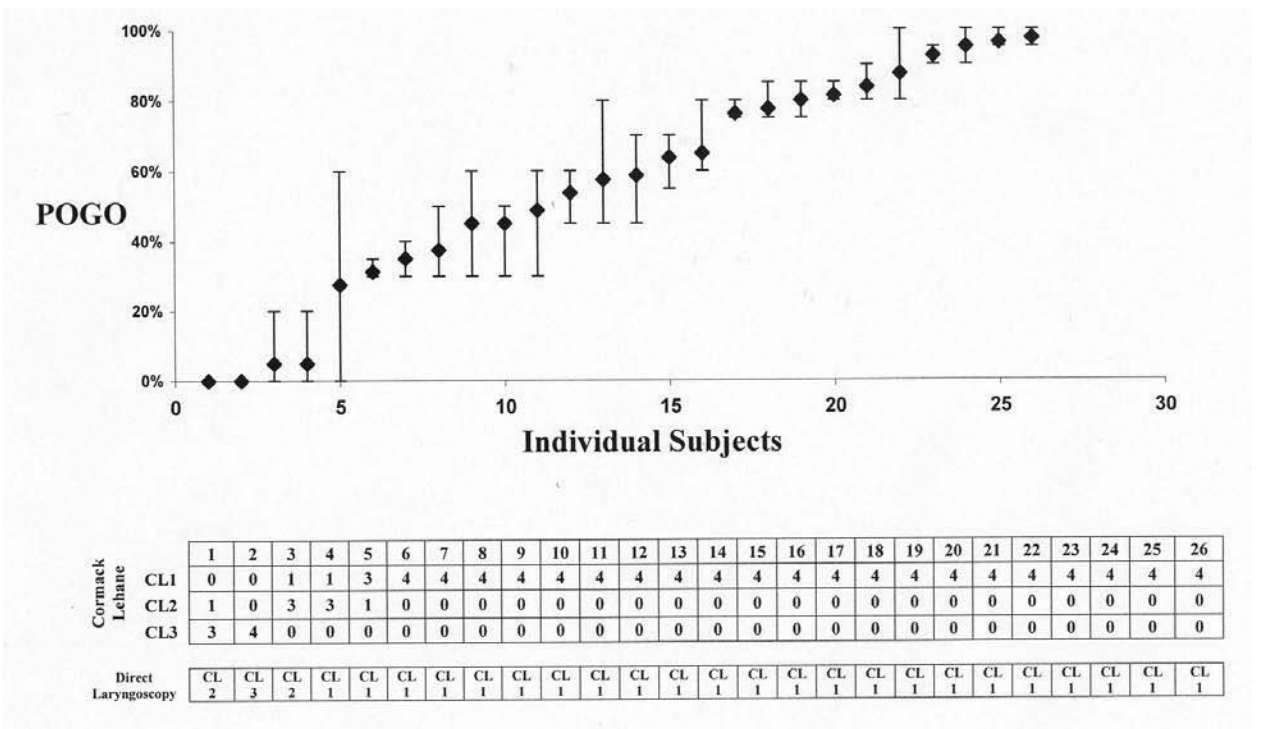

FIGURE 2 Frequency distribution of percentage of glottic opening (POGO) scores and Cormack-Lehane grades for the Airway Cam® view. The bars represent ranges of POGO scores. The views have been arranged from the lowest to highest mean POGO scores. The direct laryngoscopy Cormack-Lehane grade for each slide is shown beneath the graph.

Discussion

Direct laryngoscopy presents inherent visual restrictions to anyone but the laryngoscopist. An accurate record of view is therefore essential to airway research involving direct laryngoscopy.[1,2] If the AC is to be used as a research tool, then the accuracy of this system requires validation. Our study demonstrates that the view obtained at direct laryngoscopy by the laryngoscopist is similar to that seen with the AC recordings ($\kappa = 0.63$, $r = 0.83$), thus validating the clinical accuracy of the AC device.

This study has several limitations. First, the majority of views were CL grades 1 and 2, and these results may not be generalizable to patients with CL grade 3 and 4 airways. Given the lack of controversy regarding the definitions of CL grades 3 and 4, it is our opinion that the addition of more CL 3 and CL 4 views would have had minimal impact on these results. Patients with a history of prior difficult tracheal intubation, and morbidly obese patients were excluded, due to the likelihood that an alternative intubation technique would be necessary. Including such patients would have precluded evaluation of the AC in the setting of a standardized intubation technique.

Some critics have questioned the clinical significance of, or need for scoring systems designed to quantify different degrees of the partially visualized laryngeal aperture. However, the POGO scoring system may provide a useful tool in laryngoscopy research to help quantify the change in laryngeal view, enabling objective assessment of different laryngoscopy blades and maneuvers. Figure 2 demonstrates the variability of a CL grade 2. The use of CL laryngoscopy grading system requires clear distinction of CL grades 1 and 2, or perhaps the addition of a fifth, intermediate grade. A validated research tool such as the AC should assist airway research using the CL scale and POGO score, or an alternative laryngoscopy grading scale.

Lastly, the sample size calculation was based upon a secondary outcome. Although we were unable to show an intra-observer correlation $r > 0.90$ ($r = 0.83$), the sample size was of sufficient magnitude to demonstrate that intra-observer agreement was $\kappa > 0.60$ ($\kappa = 0.63$), our primary goal.

In conclusion, when used according to the manufacturer's guidelines, the AC laryngoscopy video system provides an accurate record of the laryngoscopist's view during direct laryngoscopy. The AC system should facilitate objective evaluation for future research and teaching purposes.

References

1 *Charters P.* Analysis of mathematical model for osseous factors in difficult intubation. Can J Anaesth 1994; 41: 594–602.

2 *McCoy E.* The McCoy laryngoscope in infants and children. Can J Anesth 2004; 51: 101–5.

3 *Levitan RM.* A new tool for teaching and supervising direct laryngoscopy. Acad Emerg Med 1996; 3: 79–81.

4 *Levitan RM, Ochroch EA, Kush S, Shofer FS, Hollander JE.* Assessment of airway visualization: validation of the percentage of glottic opening (POGO) scale. Acad Emerg Med 1998; 5: 919–23.

5 *Ochroch EA, Hollander JE, Kush S, Shofer FS, Levitan RM.* Assessment of laryngeal view: percentage of glottic opening score vs Cormack and Lehane grading. Can J Anesth 1999; 46: 987–90.

6 *Cormack RS, Lehane J.* Difficult tracheal intubation in obstetrics. Anaesthesia 1984; 39: 1105–11.

7 *Altman DG.* Practical Statistics for Medical Research, 1st ed. London: Boca Raton, FL: Chapman & Hall/CRC Press; 1991.

8 *Zou KH, Tuncali K, Silverman SG.* Correlation and simple linear regression. Radiology 2003; 227: 617–22.