Nazir et al. Sri Lankan Journal of Anaesthesiology 34 (3): 348-357 (2026)

doi: https://doi.org/10.4038/slja.v34i3.9595

Published date: 20th November 2026

SLJA

ORIGINAL RESEARCH

Improvement in Glottic Visualization in Patients with Limited View on Macintosh Laryngoscope with the Use of Channeled King Vision® Video-laryngoscope and Channeled BPL® Video-laryngoscope: A Comparative Study

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ABSTRACT

Background: We compared the King vision® video-laryngoscope (KV VL) and BPL® video-laryngoscope (BPL VL) with channeled blades in patients with limited glottic view (percentage of glottic opening [POGO] score <50%).

Material and Methods: This was a single-centre, prospective, comparative, interventional, randomized study. All patients underwent initial laryngoscopy with a Macintosh laryngoscope. In patients with a POGO score less than 50% on Macintosh laryngoscopy, channeled KV VL was used in Group 1 (n=50) and channeled BPL VL in Group 2 (n=50). The groups were compared for the Cormack-Lehane Grade (CLG) of the laryngeal view obtained, the time required to obtain the best glottic view, and the time required to place the endotracheal tube using either video-laryngoscope.

Results: Based on the shift analysis, Group 1 showed greater improvement in the desirable classification (CLG I) and a greater reduction in the less desirable classifications (CLG II and CLG III). The intergroup comparison of the POGO Scoring was statistically significant. Time to achieve

Received: 18th April 2025 **Accepted:** 28st June 2026

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the best glottic view and time to place the ETT were significantly shorter in Group 1 (p-values = 0.043 & <0.001, respectively). The mean score for Intubation Difficulty in Groups 1 and 2 was not statistically significant.

Conclusion: Although both video laryngoscopes improved glottic visualization compared with the Macintosh laryngoscope, the KV VL demonstrated superior performance in reducing CL grade and achieving higher POGO scores in patients with limited glottic view.

Keywords: Glottic visualization, Macintosh laryngoscope, Channeled King Vision® video-laryngoscope, Channeled BPL® video-laryngoscope, POGO Score, Cormack-Lehane Grade (CLG)

INTRODUCTION

Managing a difficult airway can be challenging, especially in patients with a limited glottic view on laryngoscopy.[1] It may be anticipated from pre-assessment, allowing time for proper planning and preparation. However, it can also present unexpectedly in an emergency situation or during routine anaesthesia. The key lies in timely airway management using algorithms before hypoxia occurs.[2]

During airway management, glottic vision is essential. Anatomical abnormalities such as a large tongue, limited cervical movement, cervical injuries, protruding incisors, or small mandibles may make it difficult to achieve a direct line of sight to the glottic opening.

Video laryngoscopy has emerged as an advancement over the Macintosh laryngoscope to overcome challenges in patients with limited glottic visibility.[3] Studies have shown that video laryngoscopy can provide more Cormack-Lehane grade (CLG) I and II views than direct laryngoscopy.[3,4] The evolution of devices and techniques in video-laryngoscopy has led to improvements in the ease and success of endotracheal intubation. The King Vision™ video-laryngoscope incorporates advanced technology to provide a clear, magnified view of the glottis and surrounding structures. It is equipped with a channeled blade design that provides a dedicated path to guide the endotracheal tube, allowing for more direct and potentially easier intubation[5] (Figure 1A). The BPL Channeled Video-laryngoscope features a high-definition camera, an anti-fog lens, an ergonomic design, and screen rotation capabilities, providing a clearer view of the glottis than traditional laryngoscopy (Figure 1B). Few comparative studies have evaluated these two models against the Macintosh laryngoscope. This study aims to compare the improvement in glottic visualization, assessed using Cormack-Lehane grading, achieved by two video laryngoscopes in patients with a POGO score <50% on Macintosh laryngoscopy. This study will fill this gap by clarifying the effectiveness of each device across diverse contexts. The primary objective was to compare improvements in laryngeal view, assessed by Cormack-Lehane grading, with the KV VL and BPL VL in patients with a POGO score <50% on Macintosh laryngoscopy. The secondary objectives were to compare the time required to obtain the best glottic view with the two devices, the time required to place the endotracheal tube with the channeled blade of each video-laryngoscope, the modified intubation difficulty score, and airway complications, if any, between the two groups.



Figure 1A: Kingvision videolaryngoscope with endotracheal tube through channeled blade

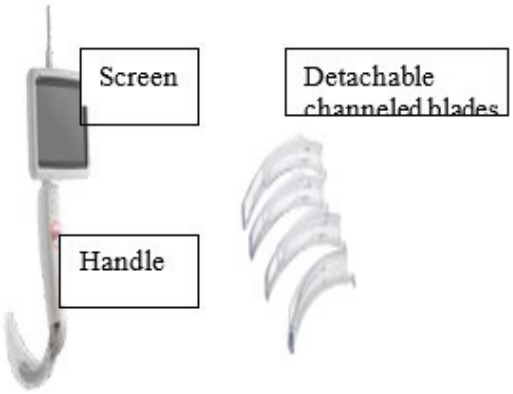


Figure 1B: BPL videolaryngoscope with channeled blades

MATERIALS AND METHODS

After obtaining Ethical approval from the Institutional Ethics Committee (No. GIMS-IEC-ECR/1224/Inst/2019), we obtained written informed consent from all participants before enrollment. We provided a patient information sheet (in English and Hindi) before enrollment and gave participants an opportunity to ask further questions. This single-centre, prospective, comparative, interventional, randomized study was conducted following the Good Clinical Practice guidelines from September 2022 to February 2024.

Inclusion & exclusion criteria

Adult patients scheduled for elective surgery under general anesthesia with an American Society of Anesthesiologists (ASA) grade I, II & III, of either sex and 18 to 70 years of age, requiring endotracheal intubation, were screened. During laryngoscopy, we recruited patients with a POGO (percentage of glottis opening) score of less than 50%.

The exclusion criteria included patient refusal, pregnancy, high risk of aspiration (hiatus hernia, gastro-oesophageal reflux), and predicted difficult airway (oropharyngeal pathologies, body mass index >35 kg/m^2, limited cervical spine mobility, restricted mouth opening, history of difficult laryngoscopy or intubation). Patients with predicted difficult airways were excluded to ensure patient safety and to maintain homogeneity of the study population. In anticipated difficult-airway cases, advanced airway planning and alternative intubation strategies are recommended per guidelines. Including such patients could have introduced significant confounding variables and ethical concerns, potentially affecting the validity of device comparison. Therefore, exclusion allowed a more accurate assessment of the comparative effectiveness of the two video laryngoscopes in improving glottic visualization in patients with initially limited views on Macintosh laryngoscopy.

Sample size calculation & Statistical Analysis

We performed a sample size estimation before recruitment. The previous study estimated the prevalence of a POGO score below 50% at 8%.[6] To obtain a 95% confidence interval with a 6% improvement in POGO score precision, we found that a minimum of 48

participants were required in each group. The final planned recruitment was 100 (50 in each group) to ensure adequate power for the primary outcome. We collected the data and entered them into a computer-based spreadsheet for analysis using SPSS statistical software (version 28) (IBM Corp., NY, USA). Prior to applying parametric tests, normality was assessed for continuous variables (POGO score, time to best glottic view, time to ETT placement, and IDS) using the Shapiro–Wilk test and visual inspection of histograms and Q–Q plots. Although the POGO score is a bounded variable (0–100%), its distribution in both groups approximated normality; therefore, Student's independent t-test was appropriate for intergroup comparisons. In cases where the normality assumption was not satisfied, non-parametric tests (Mann–Whitney U test) were planned and applied as appropriate. Data are presented as mean ± standard deviation for normally distributed variables and median (interquartile range) for non-normally distributed variables. Although the CL grade is ordinal, we performed a chi-square test to compare the distribution of categorical shifts between groups, as our primary objective was to assess proportional changes in classification rather than model ordinal trends.

Because we performed multiple intergroup comparisons for POGO score, Cormack–Lehane grading, and time variables, we adjusted for multiplicity to control Type I error. We applied a Bonferroni correction for pairwise comparisons and used an adjusted p-value threshold for statistical significance. A p-value < 0.05 was considered statistically significant.

Grouping and Randomization

The 100 patients, as per the inclusion/exclusion criteria, were randomly allocated to two groups (randomization was performed using computer-generated random numbers).

Group 1: laryngoscopy with Macintosh (blade size 3/4) followed by channeled KV VL (n= 50)

Group 2: laryngoscopy with Macintosh (blade size 3/4) followed by channeled BPL VL (n= 50)

Laryngoscopy and intubation were performed by an experienced senior anaesthesiologist familiar with Macintosh and VL use (with >25 intubations with VL).

Procedure

A detailed pre-anaesthetic airway evaluation was carried out for each patient prior to enrolment into the study. In the operating theatre, we attached standard ASA monitors to each patient. After pre-oxygenation, induction was carried out with intravenous 2 μg/kg fentanyl and 2-2.5 mg/kg propofol. We confirmed adequate mask ventilation and administered 0.6 mg/kg atracurium. Direct laryngoscopy was performed, and the best view of the larynx was obtained without any external laryngeal manipulation. The POGO score (100% POGO score = full view of glottis from anterior commissure to inter-arytenoid; 0% = complete absence of the glottis opening; all partial views are expressed as a proportion of a full view)[6] and CLG[7] were noted. Laryngoscopic assessments were initially performed using a Macintosh laryngoscope with an appropriately selected blade size (3 or 4), based on patient anatomy and the anaesthesiologist's discretion. Blade size selection followed standard institutional practice. No change in Macintosh blade size was attempted after the initial laryngoscopic assessment, for study recording purposes.

For video laryngoscopy, we used the standard channeled blade supplied with the respective

device (King Vision or BPL), per manufacturer recommendations. No blade size adjustment was required as both devices have fixed channeled blade configurations suitable for adult patients.

The study included patients with POGO scores below 50%. An appropriately sized endotracheal tube was loaded into the channeled KV VL/BPL VL. The blade was inserted from the midline, and once the tip crossed the base of the tongue, it was lifted to visualise the glottis. The best laryngeal view obtained without external laryngeal manipulation was recorded for KV VL and BPL VL.

The time required to obtain the best glottic view was taken as the time elapsed from the introduction of the laryngoscope blade past the lips to the best possible visualisation of the glottis. Thereafter, the endotracheal tube was advanced through the glottis under vision, and the time from initiation of tube insertion to the first end-tidal carbon dioxide trace was recorded as the time required for tube placement.

Failure to intubate was defined as more than two intubation attempts, oxygen saturation < 95%, or failure to intubate within 60 seconds. If intubation failed, we performed further airway management in accordance with the All-India Difficult Airway Association (AIDAA) guidelines[8], and excluded these patients from the study.

The ease of intubation was assessed using the modified intubation difficulty score (IDS), where N1 = number of intubation attempts, N2 = no. of operators, N3 = alternative technique used, N4 = glottic exposure (CL grade), N5 = lifting force applied, N6 = external force applied, and N7 = vocal cord position at intubation.[9] Haemodynamic parameters are recorded at regular intervals during airway management.

RESULTS

The two groups were comparable with respect to age, weight, gender, and ASA grading distribution as depicted (Table 1).

Comparison of CL Grading among the groups revealed that Group 1 experienced a larger increase in CLG (CLG I = 84%) than Group 2 (54%) among patients with CL I classification. In patients with CLG II Classification, Group 1 again had a greater percentage reduction in CL Grade II (from 82% to 16%) compared to Group 2 (from 74% to 46%). However, for CLG III Classification, both groups reduced to 0%, although Group 2 had a slightly higher number of patients with CLG III (26%

Table 1: Demographic & haemodynamic details

Parameter	Group 1	Group 2	*p*-value
Age (years) (mean ±SD)	44.1±10.91	46.0±11.56	0.416
Weight (kg) (mean ±SD)	66.8±11.58	68.7±10.39	0.419
Gender (M/F)	18/32	21/29	0.414
ASA grade (I, II, III)	22, 28,0	20,22,8	0.228

ASA= American Society of Anaesthesiologists

compared to 18% in Group 1). Based on the analysis, Group 1 (MacIntosh to KVVL) showed greater improvement in the desirable classification (CLG I) and a greater reduction in less desirable classifications (CLG II and CLG III). Therefore, Group 1 is the better-performing group (Table 2).

The mean POGO scores in MacIntosh, Group 1, and Group 2 were 30±17.40, 89.2±23.28, and 72.4±30.2, respectively. The intergroup POGO scoring comparison (i.e., MacIntosh and Group 1, MacIntosh and Group 2, and Group 1 and Group 2) was statistically significant. ($p<0.001$) (Figure 2).

The difference in the mean Intubation Difficulty score between Groups 1 and 2 was not statistically significant. However, time to achieve the best glottic view and time to place the ETT were significantly shorter in Group 1 ($p = 0.043$ & $p < 0.001$, respectively; Table 3). No airway complications were observed during the procedure in either group.

Table 2: Comparison of CL grading between groups

Classification	Group 1				Group 2			
	Macintosh		KVVL		Macintosh		BPLVL	
CLG I	0	0%	42	84%	0	0%	27	54%
CLG II	41	82%	8	16%	37	74%	23	46%
CLG III	9	18%	0	0%	13	26%	0	0%
Total	50	100%	50	100%	50	100%	50	100%

CLG I/11/111 = Cormack-Lehane Grades
KVVL= King Vision Video-laryngoscope
BPL VL=BPL Video-laryngoscope

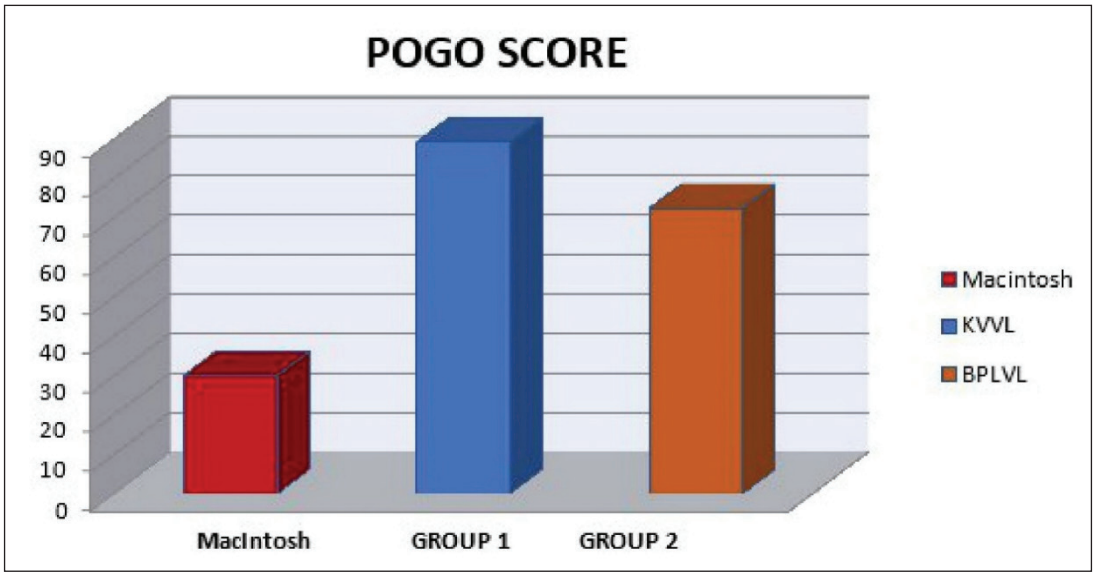


Figure 2: Comparison of POGO Scores *(POGO – Percentage of glottic opening).*

Table 3: Comparison of intubation parameters between groups

Parameter	Group 1 (mean± SD)	Group 2 (mean± SD)	*p*-value
IDS	0.56±0.67	0.56±0.67	1.000
Time to best glottis view	13.2±3.33	14.5±3.41	0.043
Time to ETT placement	6.1±1.39	9.6±0.77	<0.001

IDS =Intubation Difficulty Score; ETT= Endotracheal tube placement

DISCUSSION

Limited glottic visualization during direct laryngoscopy remains a significant challenge in airway management.[1,2] Although the Macintosh laryngoscope is widely used, its effectiveness may be restricted in patients with suboptimal laryngeal exposure. Video-laryngoscopy was introduced to overcome this limitation by improving visualization without requiring direct alignment of airway axes.[4] The present study specifically evaluated the improvement in glottic visualization in patients who demonstrated a POGO score <50% on Macintosh laryngoscopy and compared two channeled video-laryngoscopes—King Vision (KV VL) and BPL VL. We used an appropriately sized Macintosh blade in accordance with standard clinical practice before switching to video laryngoscopy. Therefore, the improved glottic visualization observed with video-laryngoscopes cannot be attributed to suboptimal blade selection but reflects a true device-related advantage. Similarly, the video-laryngoscopes used in the study had standardized adult channeled blades, and no blade modifications were needed.

Improvement in Cormack–Lehane Grade

Both video-laryngoscopes significantly improved the glottic view compared to Macintosh laryngoscopy. However, the magnitude of improvement differed between devices.

In Group 1 (KV VL), 84% of patients achieved CL Grade I compared to 54% in Group 2 (BPL VL). Additionally, CL Grade II reduced from 82% to 16% in the KV VL group, whereas it reduced from 74% to 46% in the BPL VL group. Although both devices eliminated CL Grade III views (reduced to 0%), the analysis demonstrated a more pronounced favourable conversion toward CL Grade I with KV VL.

Thus, KV VL outperformed BPL VL in terms of the extent of improvement in CL grading.

These findings are consistent with prior literature demonstrating enhanced glottic visualization with King Vision VL in difficult-airway scenarios.[10,11] Dixita et al.[12] reported CL Grade I view in 94% of patients in the KV VL group and 92% in the BPL VL group, indicating comparable performance between the two devices in their study population. This differs from our findings, in which KV VL achieved CL Grade I in 84% of cases, compared with 54% for BPL VL. This discrepancy may reflect differences in study design and patient selection. Unlike Dixita et al., our study specifically enrolled patients with a POGO score <50% on Macintosh laryngoscopy, representing a subgroup with an objectively limited glottic

view. This more challenging airway subset may have accentuated performance differences between the two video-laryngoscopes.

POGO Score Comparison

The mean POGO score improved significantly in both groups compared to Macintosh (30 ± 17.4). However, KV VL achieved a higher mean POGO score (89.2 ± 23.28) compared to BPL VL (72.4 ± 30.2), with a statistically significant intergroup difference ($p < 0.001$).

This indicates that while both devices enhance visualization, KV VL provides a more complete glottic exposure in patients with initially limited views. The result obtained is in accordance with a previous study done by Jaya Choudhary et al.[6,13]

Time to Best Glottic View and Time to Intubation

Time to achieve the best glottic view was significantly shorter with KV VL (13.2 ± 3.33 seconds) compared to BPL VL (14.5 ± 3.41 seconds) ($p = 0.043$). More importantly, time to endotracheal tube placement was markedly shorter in the KV VL group (6.1 ± 1.39 seconds) versus BPL VL (9.6 ± 0.77 seconds) ($p < 0.001$). Therefore, KV VL outperformed BPL VL in procedural efficiency, particularly in tube placement time, which is clinically relevant for preventing hypoxia during airway management. Similar results have been reported by Channappagoudar et al.[14]

Parameters Where Both Devices Performed Similarly

Despite the above differences, certain parameters, i.e., Modified Intubation Difficulty Score[9] and airway complications, were comparable between the two devices. The Modified Intubation Difficulty Score (IDS) was identical in both groups (0.56 ± 0.67; $p = 1.000$), in concordance with the results obtained by Kumar et al.[15,16]

This suggests that although KV VL provides better visualization and faster intubation, both devices are similarly safe and associated with comparable ease of intubation. These findings indicate that both channeled video laryngoscopes effectively improve glottic visualization in patients with unanticipated limited views on Macintosh laryngoscopy. Therefore, the superiority of KV VL appears parameter-specific rather than universal.

CONCLUSION

While both VL improved glottic visualization compared with Macintosh, KV VL demonstrated superior performance in reducing CL grade and achieving higher POGO scores in patients with unanticipated limited glottic view. KV VL use resulted in greater conversion to CL Grade I, higher mean POGO score, shorter time to best glottic view, and shorter time to endotracheal tube placement.

However, both devices performed similarly with respect to the Modified Intubation Difficulty Score and airway complications

Thus, the superiority of KV VL appears to be parameter-specific, particularly in visualization and procedural efficiency, while safety and overall ease of intubation were comparable between devices.

STRENGTHS AND LIMITATIONS

A major strength of this study is the focused inclusion of patients with an objectively defined limited glottic view (POGO <50%), allowing precise evaluation of device performance in clinically relevant scenarios.

Randomization and standardized blade usage further strengthened internal validity.

Limitations include the single-centre design and exclusion of patients with a predicted difficult airway, which may limit generalizability. Additionally, blinding of the operator was not feasible, introducing potential observer bias.

Future multicentre studies including broader airway profiles would further clarify comparative performance.

AUTHORS' CONTRIBUTIONS

Conceptualization and design: NN, SSC

Literature search: SSC, NN

Data collection: SSC, NN

Data analysis: SSC, NN, AS

Manuscript drafting and critical revision: NN, SSC, AS

Proofreading and approval of the manuscript: NN

FUNDING

No external funding was received to prepare the manuscript.

DECLARATION OF CONFLICTS OF INTEREST

There are no conflicts of interest to declare.

ETHICAL CLEARANCE

Approved by the Institutional Ethics Committee of the Government Institute of Medical Sciences, Greater Noida, UP, India (No: GIMS-IEC-ECR/1224/Inst/2019); Approval date: September 14, 2022.

The study was registered with the Clinical Trials Registry – India.

(CTRI No: CTRI/2022/10/028413)

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