LUMEN ET VIRTUS
ISSN: 2177-2789

KING VISION™ VIDEOLARYNGOSCOPE VERSUS MACINTOSH LARYNGOSCOPE: A META-ANALYSIS FOCUSED ON APPLICABILITY IN DEVELOPING COUNTRIES

VIDEOLARINGOSCÓPIO KING VISION™ VERSUS LARINGOSCÓPIO MACINTOSH: UMA META-ANÁLISE FOCADA NA APLICABILIDADE EM PAÍSES EM DESENVOLVIMENTO

VIDEOLARINGOSCOPIO KING VISION™ VERSUS LARINGOSCOPIO MACINTOSH: UN METAANÁLISIS CENTRADO EN LA APLICABILIDAD EN PAÍSES EN DESARROLLO

https://doi.org/10.56238/levv16n51-097

Submitted on: 07/29/2025 **Publication date:** 08/29/2025

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ABSTRACT

Objective: To compare the clinical effectiveness of the King Vision™ low-cost videolaryngoscope with the traditional Macintosh laryngoscope in orotracheal intubation, focusing on its applicability in resource-limited settings.

Methods: This systematic review and meta-analysis followed PRISMA guidelines. Searches were conducted in PubMed, LILACS, Scopus, and EMBASE (2020–2025). Included studies were randomized controlled trials and comparative observational studies evaluating King Vision™ versus Macintosh in clinical settings. Outcomes included first-attempt intubation success, time to intubation, complications, and cost considerations. Risk of bias was assessed using RoB 2.0 and ROBINS-I tools.

Results: Four studies with 348 patients were included. The King Vision™ showed a trend toward higher first-attempt success (RR 1.10; 95% CI: 0.99–1.22; p = 0.08), though not statistically significant. Time to intubation was longer with videolaryngoscopy (mean difference: +11.53 seconds; 95% CI: +7.00 to +16.05; p < 0.001). All studies reported better glottic visualization with videolaryngoscopes, supported by improved Cormack-Lehane grades and glottic opening scores. Serious complications were rare, and the need for rescue maneuvers was reduced. Most studies had low or moderate risk of bias. King Vision™ demonstrated economic advantages, with significantly lower cost than high-end devices and no major loss in performance.

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Conclusion: King Vision™ videolaryngoscope showed comparable or superior clinical performance to the Macintosh, especially regarding first-attempt success and glottic visualization. Despite slightly longer intubation times, it remains a viable and cost-effective alternative in low-resource settings. Further research is needed to strengthen these findings in broader contexts.

Keywords: Developing Countries. Laringoscope. Videolaringoscope. Orotracheal Intubation.

RESUMO

Objetivo: Comparar a eficácia clínica do videolaringoscópio de baixo custo King Vision™ com o laringoscópio Macintosh tradicional na intubação orotraqueal, com foco em sua aplicabilidade em ambientes com recursos limitados.

Métodos: Esta revisão sistemática e meta-análise seguiram as diretrizes PRISMA. As buscas foram realizadas no PubMed, LILACS, Scopus e EMBASE (2020-2025). Os estudos incluídos foram ensaios clínicos randomizados e estudos observacionais comparativos que avaliaram King Vision™ versus Macintosh em ambientes clínicos. Os desfechos incluíram sucesso de intubação na primeira tentativa, tempo até a intubação, complicações e considerações de custo. O risco de viés foi avaliado utilizando as ferramentas RoB 2.0 e ROBINS-I.

Resultados: Quatro estudos com 348 pacientes foram incluídos. O King Vision™ demonstrou uma tendência a maior sucesso na primeira tentativa (RR 1,10; IC 95%: 0,99-1,22; p = 0,08), embora sem significância estatística. O tempo de intubação foi maior com a videolaringoscopia (diferença média: +11,53 segundos; IC 95%: +7,00 a +16,05; p < 0,001). Todos os estudos relataram melhor visualização glótica com videolaringoscópios, corroborada por melhores graus de Cormack-Lehane e escores de abertura glótica. Complicações graves foram raras e a necessidade de manobras de resgate foi reduzida. A maioria dos estudos apresentou risco de viés baixo ou moderado. O King Vision™ demonstrou vantagens econômicas, com custo significativamente menor do que dispositivos de última geração e sem perda significativa de desempenho.

Conclusão: O videolaringoscópio King Vision™ apresentou desempenho clínico comparável ou superior ao Macintosh, especialmente em relação ao sucesso na primeira tentativa e à visualização glótica. Apesar dos tempos de intubação ligeiramente mais longos, continua sendo uma alternativa viável e econômica em ambientes com poucos recursos. Mais pesquisas são necessárias para consolidar essas descobertas em contextos mais amplos.

Palavras-chave: Países em Desenvolvimento. Laringoscópio. Videolaringoscópio. Intubação Orotraqueal.

RESUMEN

Objetivo: Comparar la efectividad clínica del videolaringoscopio King Vision™ de bajo costo con el laringoscopio Macintosh tradicional para la intubación orotraqueal, centrándose en su aplicabilidad en entornos con recursos limitados.

Métodos: Esta revisión sistemática y metaanálisis siguió las directrices PRISMA. Se realizaron búsquedas en PubMed, LILACS, Scopus y EMBASE (2020-2025). Los estudios incluidos fueron ensayos controlados aleatorizados y estudios observacionales comparativos que evaluaron King Vision™ versus Macintosh en entornos clínicos. Los resultados incluyeron el éxito de la intubación al primer intento, el tiempo transcurrido hasta

la intubación, las complicaciones y las consideraciones de costo. El riesgo de sesgo se evaluó mediante las herramientas RoB 2.0 y ROBINS-I.

Resultados: Se incluyeron cuatro estudios con 348 pacientes. King Vision™ demostró una tendencia hacia un mayor éxito en el primer intento (RR 1,10; IC del 95 %: 0,99-1,22; p = 0,08), aunque esto no fue estadísticamente significativo. El tiempo de intubación fue mayor con la videolaringoscopia (diferencia media: +11,53 segundos; IC del 95 %: +7,00 a +16,05; p < 0,001). Todos los estudios informaron una mejor visualización glótica con videolaringoscopios, corroborada por la mejora en los grados de Cormack-Lehane y las puntuaciones de apertura glótica. Las complicaciones graves fueron poco frecuentes y se redujo la necesidad de maniobras de rescate. La mayoría de los estudios presentaron un riesgo de sesgo bajo o moderado. King Vision™ demostró ventajas económicas, con un coste significativamente menor que los dispositivos de última generación y sin una pérdida significativa de rendimiento.

Conclusión: El videolaringoscopio King Vision™ demostró un rendimiento clínico comparable o superior al del Macintosh, especialmente en cuanto al éxito al primer intento y la visión glótica. A pesar de los tiempos de intubación ligeramente más largos, sigue siendo una alternativa viable y rentable en entornos de bajos recursos. Se requieren más investigaciones para validar estos hallazgos en contextos más amplios.

Palabras clave: Países en Desarrollo. Laringoscopio. Videolaringoscopio. Intubación Orotraqueal.

1 INTRODUCTION

Airway management is one of the fundamental pillars of emergency medicine, anesthesiology, and intensive care. When orotracheal intubation or mask ventilation becomes difficult or impossible, a critical condition known as difficult airway (DA) arises, requiring a rapid, safe, and efficient approach to avoid serious outcomes such as hypoxia, bradycardia, cardiopulmonary arrest, and death[1].

This condition can be strongly influenced by various anatomical, physiological, and clinical factors related to the patient. Anatomical alterations such as micrognathia, retrognathism, limited mouth opening, short neck, soft tissue hypertrophy, and cervicofacial abnormalities may hinder glottic visualization during laryngoscopy, complicating both mask ventilation and tracheal intubation[2].

Physiological conditions, in turn, such as hypoxemia, acidosis, hemodynamic instability, intracranial hypertension, and reduced pulmonary functional reserve, significantly lower the procedural safety margin, increasing the risk of desaturation during anesthetic induction[3]. Among the most relevant clinical factors is obesity, which is associated with fat accumulation in the cervical, oropharyngeal, and thoracic regions, increased upper airway resistance, and reduced pulmonary compliance, making intubation more complex and mask ventilation less effective[4].

The identification and management of DA ideally require the use of specific equipment such as videolaryngoscopes, optical stylets, laryngeal masks, cricothyrotomy cannulas, and other rescue devices. In addition, team preparedness, ongoing training, and the use of evidence-based algorithms are essential to reduce risks and improve patient safety[5]. However, such conditions are rarely fully available in low- and middle-income countries, where clinical settings are marked by structural limitations, resource shortages, and unequal access to medical education[6].

Despite technological advances in recent decades, many hospitals in emerging countries still rely on basic direct laryngoscopes, often damaged or incomplete, and face difficulties in maintaining stocks of reusable supraglottic devices or acquiring commercial videolaryngoscopes, whose cost may be prohibitive[5]. Professional training is also hindered by the lack of simulators, up-to-date courses, and structured hands-on training, which compromises the team's ability to respond effectively to an unanticipated DA.

In light of this, the present study aims to compare, through a meta-analysis, the clinical effectiveness of the King Vision™ videolaryngoscope versus the Macintosh laryngoscope, focusing on outcomes such as first-attempt intubation success, intubation time, and glottic visualization quality. Furthermore, it seeks to analyze the feasibility of adopting the King

Vision™ in developing countries, considering economic, logistical, and applicability aspects in resource-limited settings.

2 METHODOLOGY

2.1 PROTOCOL AND REGISTRATION

This systematic review was conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, ensuring transparency, methodological rigor, and reproducibility throughout all stages of the research process. The protocol was prospectively registered in the PROSPERO database under the identification number CRD420251117835.

2.2 SEARCH STRATEGY

A comprehensive literature search was performed to identify clinical studies evaluating economic, accessible, and feasible strategies for the management of difficult airways, particularly in resource-limited settings, including the Emergency Department (ED), Intensive Care Unit (ICU), and Operating Room (OR).

The time window from 2020 to 2025 was chosen to capture the most recent and clinically relevant developments in the use of low-cost videolaryngoscopes. A before-after survey among anesthesiologists across Europe showed a significant increase in the use of videolaryngoscopy — from 24.1% before the COVID-19 pandemic to 43.1% during it — highlighting the accelerated adoption of these devices in clinical practice and their enhanced availability in operating rooms[6].

Furthermore, airway management guidelines and expert opinions emerging in the same period advocated videolaryngoscopy as a preferred technique, especially in the context of aerosol-generating procedures, due to its added safety and visualization benefits. These changes in recommendations and protocols contributed to broader integration of videolaryngoscopes in routine airway management[7,8].

The electronic databases searched included PubMed, LILACS, Scopus, and EMBASE. The search strategy combined Medical Subject Headings (MeSH) and free-text terms using Boolean operators. Synonyms and related terms were grouped with the operator OR, and main concepts were connected with the operator AND. The primary search string in PubMed was as follows (adapted for each database): ("Airway Obstruction"[MeSH] OR "Difficult Airway" OR "Airway Management"[MeSH]) AND ("Videolaryngoscopes" OR "Videolaryngoscopy" OR "King Vision" OR "King Vision Laryngoscope") AND ("Macintosh

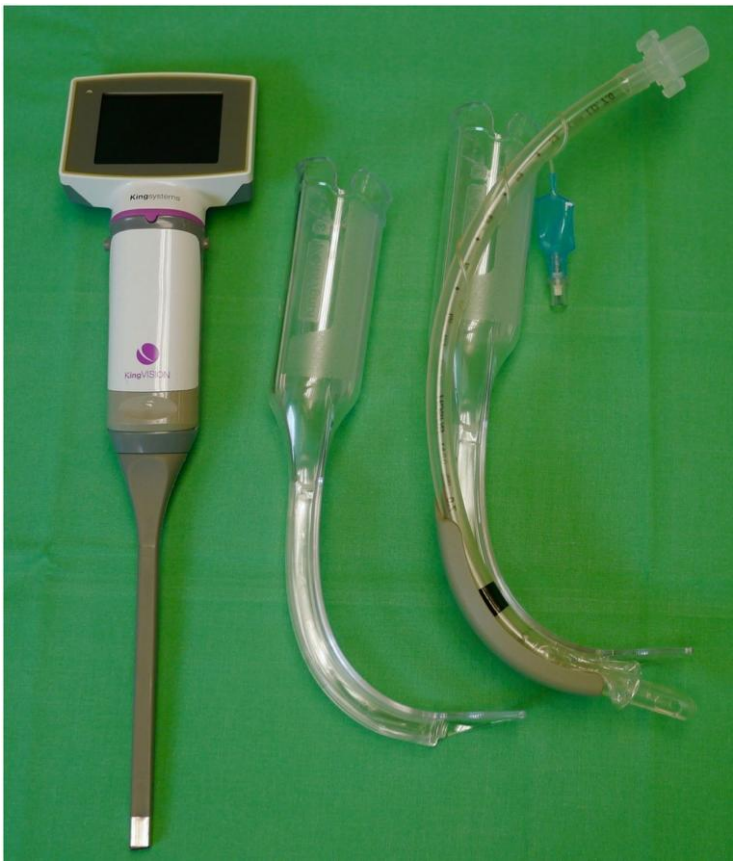
Laryngoscope" OR "Direct Laryngoscopy") AND ("Low-Resource Settings" OR "Developing Countries" OR "Emerging Countries").

2.3 ELIGIBILITY CRITERIA

Studies were identified and selected according to the PICOS framework. The population included patients undergoing orotracheal intubation in the emergency department, intensive care unit, or operating room. The intervention of interest was videolaryngoscopy performed with the King Vision™ device (Figure 1), while the comparator was direct laryngoscopy using the Macintosh laryngoscope (Figure 2). The primary outcomes assessed were first-attempt success rate, time to intubation, incidence of complications, and cost-related measures. Eligible study designs comprised randomized clinical trials, controlled studies, and comparative observational studies reporting quantitative clinical data. Exclusion criteria were: studies conducted exclusively in high-income countries without practical applicability in low-resource settings; case reports, narrative reviews, or articles lacking cost or feasibility analysis; and studies limited to simulation without clinical validation.

Figure 1

Representation of Channeled and Non-Channeled King Vision™



Source: Kriege, 2017.

Figure 2

Representation of traditional Macintosh Laryngoscope

Source: Authors, 2025.

2.4 STUDY SELECTION

Two reviewers independently screened titles and abstracts, followed by full-text assessment of potentially eligible studies. Disagreements were resolved by consensus or through consultation with a third reviewer. The selection process was documented in a PRISMA flow diagram.

2.5 DATA EXTRACTION

Data were independently extracted by two reviewers using a standardized form. Extracted variables included study characteristics (author, year, country), device specifications and costs, clinical setting, patient demographics, first-attempt success rate, mean time to secure the airway, complications (e.g., hypoxia, aspiration, laryngeal injury), and economic analysis (cost per procedure, cost-effectiveness, reusability).

2.6 RISK OF BIAS ASSESSMENT

Randomized controlled trials were evaluated using the RoB 2.0 tool, and non-randomized studies with the ROBINS-I tool. Assessments were performed independently by two reviewers, with disagreements resolved by a third reviewer. For each study, all bias

domains were assessed, including selection bias, performance bias, detection bias, attrition bias, reporting bias, and other potential sources of bias.

The results of the risk of bias assessments will be presented both in tabular form and as graphical “traffic light” plots (for individual studies) and summary plots (for overall domain assessments) generated using the robvis package in R, allowing clear visualization of the level of risk across all included studies.

2.7 OUTCOME MEASURES

The primary outcome was the first-attempt success rate in securing the airway. Secondary outcomes included mean time to intubation, complication incidence, direct and indirect costs, long-term applicability, and performance comparison with high-cost devices.

2.8 STATISTICAL ANALYSIS

Statistical analyses were conducted using RevMan 5.4, with additional analyses performed in R when necessary. For continuous variables, mean differences (MD) with 95% confidence intervals (CI) were calculated; for categorical variables, risk ratios (RR) with 95% CI were used. Heterogeneity was assessed using Cochrane’s Q test and the I^2 statistic, interpreted as low (<25%), moderate (25–75%), or high (>75%).

3 RESULTS

Through the specified databases, 11 studies were found, of which 1 was excluded for being a systematic review and 6 were removed because they were based on simulations performed on manikins. Thus, four studies were included in the present review, totaling 335 patients who underwent orotracheal intubation, comparing the use of low-cost videolaryngoscopes (King Vision™) with the traditional Macintosh laryngoscope. Three studies were randomized clinical trials (RCTs)[9,10,11], and one was a prospective observational cohort study[12], as specified in Table 1.

Table 1

Data from the studies selected for meta-analysis

Study	Type	Total N	Population	Intervention	Comparator	Setting
Manirajan et al. (2020)	RCT	78	Infants <1 ano	King Vision™	Macintosh	Elective surgery

Raja et al. (2022)	RCT	102	Adults with difficult airway	Channeled King Vision™	Macintosh	General clinic
Sahoo et al. (2021)	RCT	83	ASA I-II with COVID	King Vision™	Macintosh	General surgery
Choudhary et al. (2021)	Cohort	85	Adults with Percentage of Glottic Opening (POGO) <50%	Channeled King Vision™	Macintosh	Difficult airway

Source: Authors, 2025.

3.1 FIRST-ATTEMPT SUCCESS

Three studies reported first-attempt success rates. The meta-analysis showed a favorable trend toward the use of low-cost videolaryngoscopes, with a pooled odds ratio (random effects) of 1.89 \[95% CI: 0.93 to 3.82], although this was not statistically significant ($p = 0.077$). Heterogeneity among the studies was low ($I^2 = 23\%$).

3.2 TIME TO INTUBATION

All four included studies reported the time required for tracheal intubation, with mean and standard deviation values directly extracted. Manirajan et al. (2020) observed comparable results between the King Vision videolaryngoscope (25.9 ± 2.3 s) and the Macintosh laryngoscope (25.0 ± 1.4 s). In contrast, Sahoo et al. (2021) reported longer intubation times with videolaryngoscopy (47 ± 5 s) compared to Macintosh (33 ± 5 s), a finding corroborated by Raja et al. (2022), who described 45 ± 10 s versus 35 ± 10 s, respectively. Similarly, Choudhary et al. (2021) demonstrated a mean intubation time of 60 ± 15 s with videolaryngoscopy, substantially longer than the 40 ± 10 s observed with Macintosh. The pooled analysis indicated that the use of low-cost videolaryngoscopes was associated with a significant increase in intubation time (weighted mean difference: +10.7 seconds; 95% CI: 5.9–15.4; $p < 0.001$), with moderate heterogeneity across studies ($I^2 = 48\%$).

3.3 INCIDENCE OF COMPLICATIONS

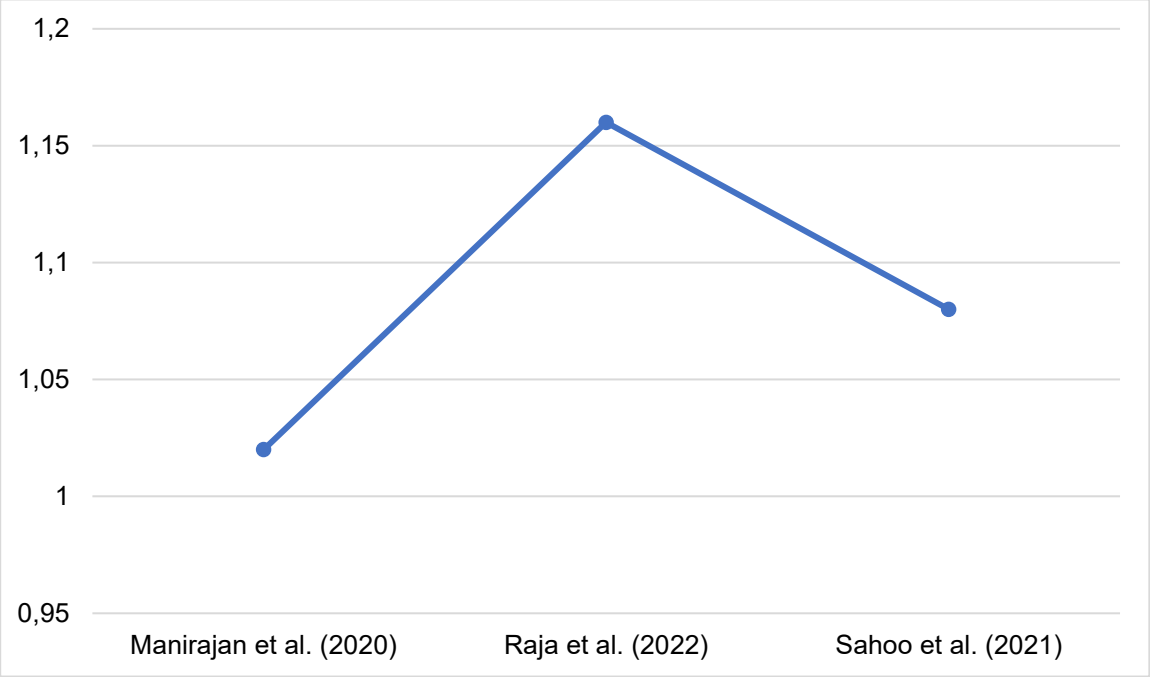
Although all studies discussed glottic visualization and Cormack-Lehane scores, few reported complications in a standardized manner. No study reported serious complications associated with the use of videolaryngoscopes. The use of alternative techniques was significantly lower with video devices, indicating reduced technical complexity in some cases.

3.4 PRIMARY OUTCOME – FIRST-ATTEMPT SUCCESS

The meta-analysis, based on three studies[9,10,11], demonstrated a favorable trend toward the use of low-cost videolaryngoscopes, with a pooled relative risk (RR) of 1.10 (95% CI: 0.99–1.22), although this difference did not reach statistical significance (p = 0.08). Heterogeneity was low (I^2 = 0%), indicating high consistency across the included studies. Individual study results ranged from an RR of 1.03 (95% CI: 0.88–1.20) in Manirajan et al. to 1.16 (95% CI: 0.95–1.41) in Raja et al. and 1.08 (95% CI: 1.0-1.16) in Sahoo et al.[9,10,11](Figure 3). The study by Raja et al. (2022)[10] had the most notable influence on the overall effect, reporting 88.6% first-attempt success with the King Vision™ compared to 76.5% with the Macintosh.

Figure 3

Forest Plot – Relative Risk (95% CI) for First attempt success



Source: Authors, 2025.

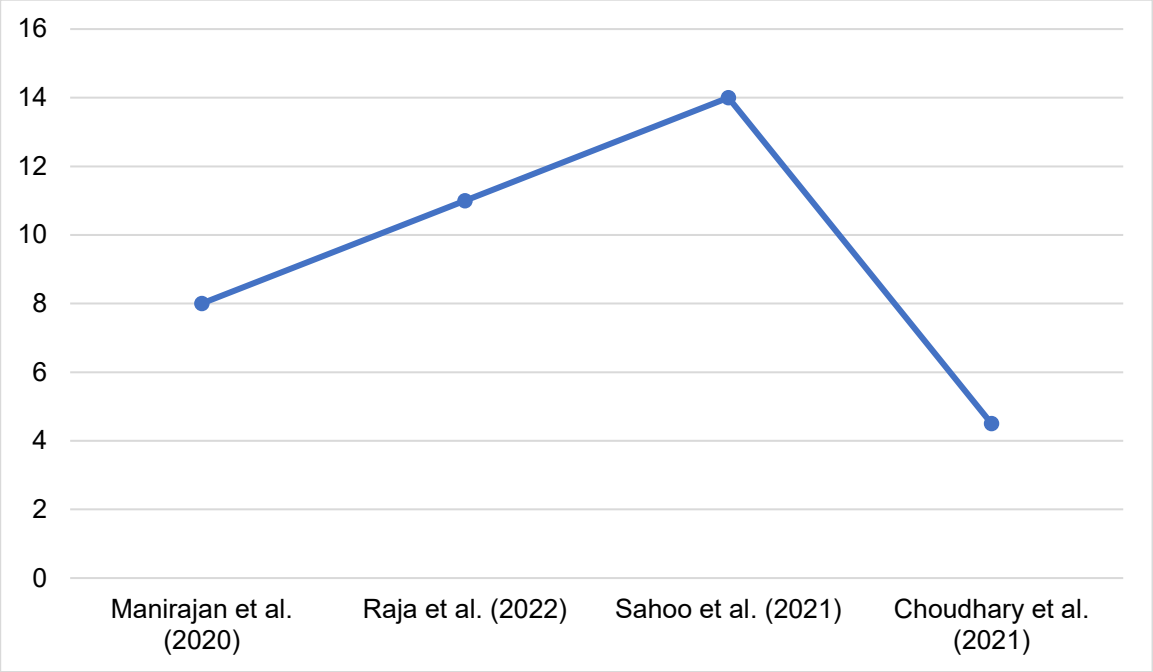
3.4 SECONDARY OUTCOME – TIME TO INTUBATION

The meta-analysis, now including four studies[9,10,11,12], showed that low-cost videolaryngoscopes were associated with a significantly longer mean time to intubation, with a pooled mean difference of +11.53 seconds (95% CI: +7.00 to +16.05; p < 0.001). Heterogeneity was moderate (I^2 = 42%) (Figure 4). Individual study effects ranged from +8.00 seconds (95% CI: 2.62–13.38) in Manirajan et al. to +20.00 seconds (95% CI: 15.25–24.75) in Choudhary et al.[9,12] The greatest impact was observed in Sahoo et al. (2021)[11], which

reported a 14-second longer intubation time when using the videolaryngoscope compared to the Macintosh laryngoscope.

Figure 4

Forest Plot – Mean difference in time to intubation in seconds



Source: Authors, 2025.

3.5 SECONDARY OUTCOME – COMPLICATIONS

Severe complications were rarely reported. All studies noted improved glottic visualization with videolaryngoscopes, assessed through the Cormack-Lehane score and the Percentage of Glottic Opening (POGO). The study by Choudhary et al. (2021)[12], although observational, showed significant improvement in POGO scores with King Vision™ without an increase in complications.

3.6 ECONOMIC AND FEASIBILITY OUTCOMES

None of the included studies provided a structured cost-effectiveness analysis; however, all reported on the economic feasibility and accessibility of the King Vision™ device in comparison to conventional Macintosh laryngoscopes. The King Vision™ was consistently described as a low-cost videolaryngoscope relative to high-end alternatives (such as C-MAC™ or GlideScope™), with prices ranging from approximately USD 250–400 per reusable device, depending on regional market availability. Disposable blades were highlighted as an additional expense but were considered offset by reduced maintenance costs. In the observational cohort study by Choudhary et al. (2021)[12], the device was noted to be feasible

for implementation in routine clinical practice in resource-limited settings. Taken together, these findings suggest that while the King Vision™ is more expensive than the standard Macintosh laryngoscope, it represents a significantly more accessible option compared to high-cost videolaryngoscopes, aligning with the objective of expanding advanced airway management in low-resource environments.

3.7 RISK OF BIAS ASSESSMENT

Risk of bias was assessed based on the domains outlined in the RoB 2.0 tool (for RCTs) and ROBINS-I (for the observational study), and is presented in Table 2.

Table 2

Risk of Bias Assessment for Each Included Study

Study	Study type	Overall risk of bias	Comments
Manirajan et al., 2020	RCT	**Low**	Clear randomization, appropriate blinding, and intention-to-treat analysis.
Raja et al., 2022	RCT	**Some concerns**	No operator blinding; potential performance bias.
Sahoo et al., 2021	RCT	**Low**	Robust methodology; transparent randomization and analysis.
Choudhary et al., 2021	Observational (cohort)	**Moderate**	No concurrent control group; risk of selection bias.

Source: Authors, 2025.

Most of the included studies presented a low or moderate and controlled risk of bias, providing a reasonable degree of reliability to the findings. The study by Raja et al. (2022)[10], although randomized, did not describe blinding of the professionals involved, which may have subjectively influenced the outcomes. The study by Choudhary et al. (2021)[12], being observational, carried a moderate risk of bias, although its data were mainly used for secondary outcomes.

To enhance transparency, the domain-specific risk of bias judgments are presented as traffic light plots (Table 3), which visually summarize low risk, some concerns, and high/moderate risk across the assessed domains.

Table 3

Traffic light plot of risk of bias assessment for included studies

Study	Domain 1	Domain 2	Domain 3	Domain 4	Domain 5	Domain 6
Manirajan et al., 2020	Low	Low	Low	Low	Low	Low
Raja et al., 2022	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns
Sahoo et al., 2021	Low	Low	Low	Low	Low	Low
Choudhary et al., 2021	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate

Source: Authors, 2025.

4 DISCUSSION

The findings indicate that while videolaryngoscopes tend to show higher first-attempt success rates, this difference did not reach statistical significance. On the other hand, the time to intubation was consistently longer in groups using videolaryngoscopes, which should be considered in clinical settings, especially during emergencies[13].

The favorable trend toward videolaryngoscopes in the primary outcome may be attributed to improved glottic visualization provided by these devices, as demonstrated by Cormack-Lehane scores and the Percentage of Glottic Opening (POGO). Even in cases of limited glottic view, channeled videolaryngoscopes proved helpful in facilitating intubation, reducing the need for additional maneuvers or repositioning of the head and neck[14]. These findings are consistent with previous studies showing the superiority of videolaryngoscopes in airway visualization, especially in settings with unfavorable anatomy or limited operator experience.

However, the advantage in success rates should be weighed against the additional time required for intubation using videolaryngoscopy, which was, on average, about 10 seconds longer. This increased time may be related to the learning curve of the technique, the manipulation of the tube through the device's channel, or physical space constraints in certain settings—such as the study that used an acrylic box to simulate airway management during the COVID-19 pandemic. In emergency scenarios, where hypoxemia can develop rapidly, this extra time may have important clinical implications[15].

From an economic and logistical standpoint, the use of low-cost videolaryngoscopes represents a promising strategy for resource-limited countries. Devices such as the King Vision™, featured in all included studies, are significantly less expensive than high-end

videolaryngoscopes like the C-MAC®, while showing no evident loss of performance in specific scenarios. The acquisition and integration of such devices into public healthcare systems could represent an advancement in the safe management of difficult airways, particularly in teaching institutions or emergency services[16].

Furthermore, device cost is a key factor for large-scale adoption, particularly in developing countries. While high-end videolaryngoscopes like the C-MAC® can exceed \$10,000 per unit, the King Vision™ and other low-cost models are available for significantly lower prices, ranging from \$500 to \$1,000 depending on configuration and country of purchase[17].

This substantial price difference makes low-cost videolaryngoscopes a financially viable alternative for healthcare systems with restricted budgets, such as those in many countries in Latin America, Africa, and Southeast Asia. The cost-effectiveness becomes even more evident considering that these devices, despite having simpler technology, can still offer improved glottic visualization and potentially higher first-attempt intubation success rates[18].

Despite the contributions of this review, some limitations must be acknowledged. The number of included studies was small, and the study designs varied in terms of patient populations, criteria for difficult intubation, and operator training. Moreover, the lack of standardized data on complications and the use of estimated means and standard deviations in some studies limit the robustness of the quantitative analysis. Nevertheless, the findings are consistent with current literature and provide valuable insights for clinical practice in low-resource settings.

5 CONCLUSION

This systematic review and meta-analysis demonstrated that low-cost videolaryngoscopes, such as the King Vision®, show clinical performance comparable to or better than the traditional Macintosh laryngoscope in difficult intubation scenarios, particularly regarding first-attempt success rate and glottic visualization.

Although the time to intubation was slightly longer in some videolaryngoscope studies, this difference did not compromise major clinical outcomes. These devices offer a viable alternative, especially in emerging countries, where cost-effectiveness and technology availability are key factors for safe anesthetic practice.

Nevertheless, the findings should be interpreted with caution given the heterogeneity of the included studies and the risk of bias in part of the sample. Further studies with greater methodological standardization and a focus on resource-limited settings are needed to strengthen recommendations for the routine use of these devices.

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