JATI

ISSN 3090-3580

ORIGINAL ARTICLE

Bougie-First Versus Stylet-First Technique for Tracheal Intubation in Adults: A Systematic Review and Meta-analysis

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Submitted: 05-Feb-2026
Revised: 10-Mar-2026
Accepted: 19-Jun-2026
Published: 12-Aug-2026

How to cite this article:
Jati OJK, Narakusuma IPF, Oka GBSPN, Napitupulu RF, Liem JF, Amaris TF, Cruz ES. Bougie-first versus stylet-first technique for tracheal intubation in adults: a systematic review and meta-analysis. Jurnal Anestesiologi dan Terapi Intensif. 2026;2(2):77-91. doi:10.24843/8hqnbs41.

Abstract

Introduction: Bougie-first and stylet-first techniques are widely used to facilitate adult tracheal intubation, but randomized evidence remains inconsistent across emergency, intensive care, and operating room settings. This systematic review and meta-analysis aimed to compare bougie-first versus stylet-first intubation in adults, focusing on first-attempt intubation success and key procedural and airway-related safety outcomes.

Material and Methods: We conducted a PRISMA 2020–compliant systematic review registered in PROSPERO (CRD420261298317). PubMed, Scopus, Web of Science, and Cochrane CENTRAL were searched from database inception to 31 January 2026. Records were screened in duplicate, and randomized controlled trials enrolling adults (≥18 years) undergoing oral tracheal intubation comparing a planned bougie-first strategy versus a planned stylet-first strategy were included. Random-effects meta-analyses pooled dichotomous outcomes as odds ratios (ORs) and continuous outcomes as mean differences (MDs).

Results: From 1,158 records, eight randomized controlled trials involving 2,578 participants were included. Trials spanned emergency department, emergency department/intensive care unit, intensive care unit, and operating room settings. First-attempt intubation success did not differ significantly between bougie-first and stylet-first techniques (OR 0.99, 95% CI 0.37–2.65; p = 0.980), with substantial heterogeneity (I^2 = 89.05%; p < 0.001). Bougie-first was associated with longer time to successful intubation (MD 21.84 seconds, 95% CI 5.55–38.14; p = 0.010), although heterogeneity was very high (I^2 = 97.37%; p < 0.001). There were no significant differences in more than one attempt (OR 0.91, 95% CI 0.21–3.91; p = 0.900), esophageal intubation (OR 0.48, 95% CI 0.17–1.40; p = 0.180), pulmonary aspiration (OR 1.47, 95% CI 0.57–3.75; p = 0.420), or postoperative sore throat (OR 1.10, 95% CI 0.48–2.52; p = 0.830).

Conclusion: Current randomized evidence did not demonstrate a consistent difference in first-attempt intubation success between bougie-first and stylet-first tracheal intubation in adults. Bougie-first was associated with longer intubation time, but this finding should be interpreted cautiously because of very high heterogeneity and variable timing definitions. Major airway-related complications and postoperative sore throat did not differ significantly between groups.

Keywords: Airway management; Bougie; Randomized controlled trial; Stylet; Tracheal intubation

Introduction

Securing the airway is central to anesthesia, emergency medicine, and intensive care, where delays or failed tracheal

ISSN 3090-3580

intubation can rapidly lead to hypoxemia and preventable morbidity. Contemporary difficult-airway guidance therefore emphasizes structured preparation and the use of adjuncts that improve first-attempt success while minimizing harm.[1] This focus is clinically important because multiple intubation attempts are consistently associated with higher rates of peri-intubation adverse events, including severe complications in emergency airway management.[2] In everyday practice, two common and relatively low-cost adjunct strategies are the use of a tracheal tube introducer ("bougie-first") and an endotracheal tube preloaded with a stylet ("stylet-first"). However, practice patterns vary widely across operators, devices, laryngoscopy modalities, and clinical environments.

Randomized evidence comparing these techniques remains mixed. In a single-center emergency department trial, bougie-first intubation increased first-attempt success compared with stylet-first intubation,[3] whereas a large multicenter trial in critically ill adults did not demonstrate a significant difference between the two strategies.[4] More recent randomized trials in settings such as hyperangulated videolaryngoscopy, anticipated difficult airway, and intensive care suggest that device- and context-specific effects may influence comparative performance.[5] A recent systematic review and meta-analysis concluded that bougie use may improve first-attempt success overall, but it also highlighted substantial heterogeneity and included both randomized and observational studies with variable outcome definitions.[6] Consequently, uncertainty persists regarding the comparative effectiveness, procedural efficiency, and safety of bougie-first versus stylet-first techniques when evidence is restricted to randomized trials.

Accordingly, this systematic review and meta-analysis aimed to compare bougie-first versus stylet-first tracheal intubation in adults. The primary outcome was first-attempt intubation success. Secondary outcomes included more than one intubation attempt, intubation time, and airway-related complications, including esophageal intubation, pulmonary aspiration, postoperative sore throat, and narratively summarized hypoxemia-related outcomes.

Material and Methods

Protocol and Registration

This systematic review and meta-analysis was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guideline. The protocol was developed a priori and registered in PROSPERO (CRD420261298317). As this study synthesized data from previously published reports and did not involve the collection of individual identifiable data, institutional ethical approval and informed consent were not required.

Search Strategy

A comprehensive literature search was conducted in PubMed/MEDLINE, Scopus, Web of Science, and Cochrane CENTRAL from database inception to 31 January 2026. The search strategy combined controlled vocabulary, including MeSH terms where applicable, and free-text terms related to tracheal intubation and airway adjuncts. Core concepts included tracheal or endotracheal intubation, bougie or tracheal tube introducer, stylet, and randomized

trials. Reference lists of eligible trials and relevant review articles were manually screened to identify additional studies. The complete database-specific search strategies are provided in Supplementary Table S1.

Eligibility Criteria

Eligibility was defined using the PICO framework. We included randomized controlled trials enrolling adult patients (≥18 years) undergoing oral tracheal intubation in any clinical setting, including the emergency department, intensive care unit, or operating room. The intervention was a bougie-first strategy, defined as planned use of a bougie or tracheal tube introducer as the primary adjunct on the first intubation attempt. The comparator was a stylet-first strategy, defined as planned use of an endotracheal tube preloaded with a stylet on the first attempt. The primary outcome was first-attempt tracheal intubation success. Secondary outcomes included more than one intubation attempt, intubation time, and airway-related complications, including esophageal intubation, pulmonary aspiration, postoperative sore throat, and hypoxemia-related outcomes. Studies were excluded if they enrolled pediatric populations, were conducted only in simulation/manikin or animal models, did not directly compare bougie-first versus stylet-first techniques, or did not provide extractable outcome data.

Screening Process

All retrieved records were imported into a reference manager, and duplicates were removed. Two reviewers independently screened titles and abstracts, followed by full-text assessment of potentially eligible articles. Disagreements were resolved through discussion and, when required, adjudication by a third reviewer. The selection process and reasons for full-text exclusion were documented in a PRISMA flow diagram.

Data Extraction

Two reviewers independently extracted data using a piloted standardized extraction form. Extracted information included study characteristics (author, year, country, and clinical setting), participant characteristics (sample size, age, and sex), airway context, intervention and comparator details, bougie type, stylet details, and laryngoscopy method. Airway context included anticipated or predefined difficult airway criteria when reported, and laryngoscopy modality was categorized as direct laryngoscopy, non-hyperangulated videolaryngoscopy, or hyperangulated videolaryngoscopy where applicable. For dichotomous outcomes, event and non-event counts were extracted for each treatment group. For continuous outcomes, means and standard deviations were extracted when available.

For studies reporting continuous outcomes as median and interquartile range, the mean and standard deviation were estimated using the method described by Wan et al.[7] Specifically, when the median, first quartile (Q1), and third quartile (Q3) were available, the mean was approximated as (Q1 + median + Q3) / 3, and the standard deviation was approximated as (Q3 − Q1) / 1.35. These converted estimates were used only for quantitative synthesis and were considered in sensitivity interpretation.

For outcomes reported using multiple categories of attempts, data were harmonized by dichotomizing the outcome as more than one attempt versus one attempt. When first-attempt success was not explicitly labelled but could be derived from reported attempt categories, the corresponding one-attempt success count

doi:10.24843/8hqnbs41

was extracted. For example, first-attempt success in Thevar Manoharan et al. was derived from the reported distribution of intubation attempts.

For multi-arm trials involving more than one bougie arm and one stylet arm, relevant bougie arms were combined into a single bougie-first group to avoid selective arm inclusion and double-counting of the shared stylet comparator. In Kumar et al., the preloaded bougie and standard bougie groups were combined into one bougie-first group for the main analysis, while the stylet-guided group was retained as the comparator. For continuous outcomes from combined bougie arms, pooled means and standard deviations were calculated using standard formulas based on group sample size, mean, and standard deviation.

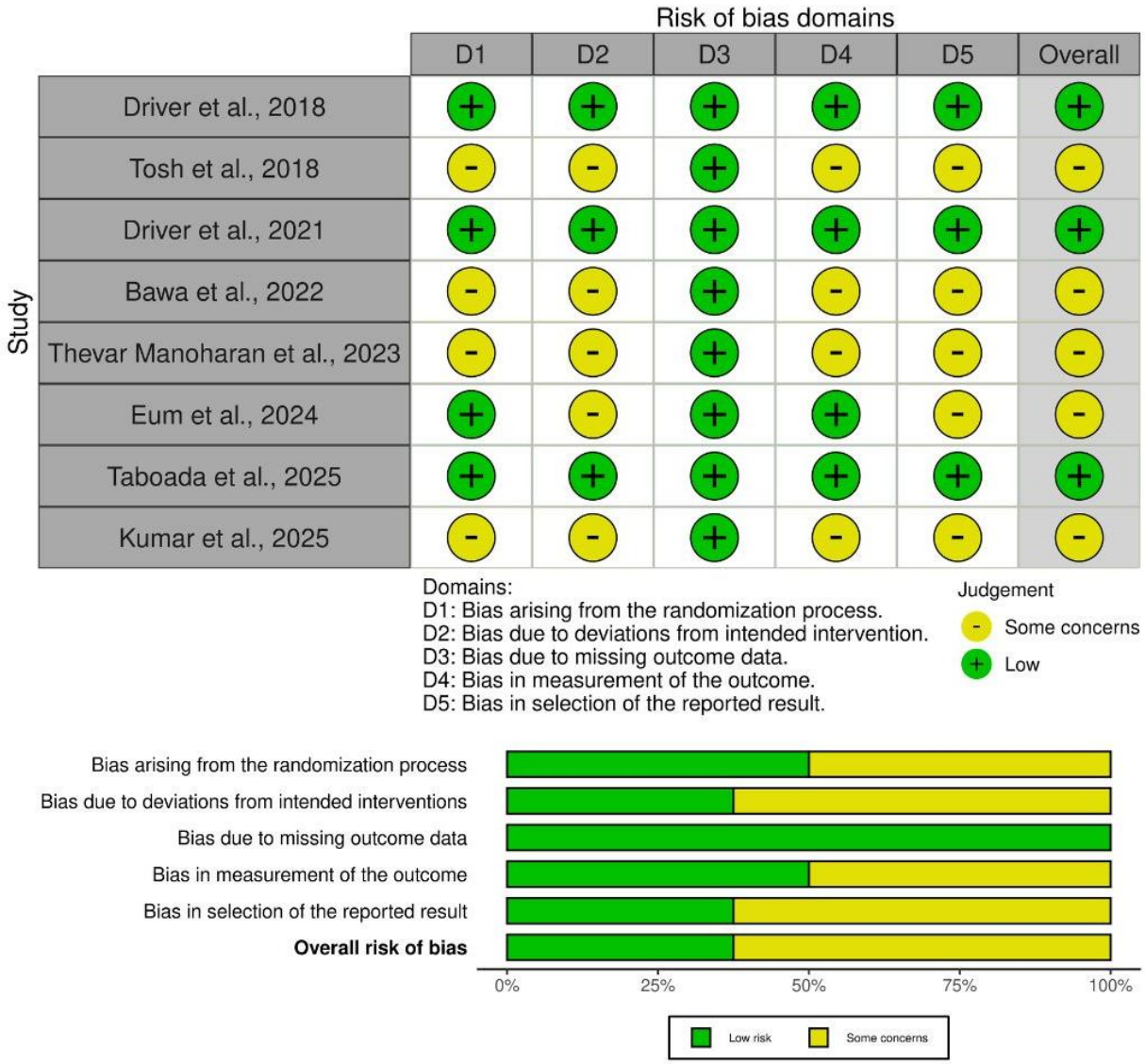

Figure 1. Outcome-level risk of bias assessment of the included studies using the Cochrane Risk of Bias 2 (RoB 2.0) tool, with primary emphasis on first-attempt intubation success and additional consideration of key secondary outcomes.

Definitions of intubation time were extracted as reported by each study, including the start and end points used for timing. Because intubation time was not fully harmonized across trials, with some studies measuring time from induction and others measuring time from laryngoscope insertion or device insertion to successful intubation, this outcome was analyzed as an exploratory secondary procedural outcome and interpreted cautiously. Residual methodological heterogeneity in timing definitions was addressed in the interpretation of findings.

Hypoxemia-related outcomes were extracted when reported. Because definitions and measurement windows varied across trials, including study-defined hypoxemia, desaturation, oxygen saturation <90%, and severe hypoxemia <80%, these outcomes were not pooled quantitatively. Instead, they were summarized narratively as clinically important airway-related safety outcomes.

Risk of Bias Assessment

Risk of bias was assessed using the Cochrane Risk of Bias 2 (RoB 2.0) tool by two independent reviewers. Assessment was performed at the outcome level, with primary emphasis on first-attempt intubation success and additional consideration of key secondary outcomes, including intubation time and airway-related complications. The following domains were evaluated: bias arising from the randomization process, bias due to deviations from intended interventions, bias due to missing outcome data, bias in measurement of the outcome, and bias in selection of the reported result. Each domain was judged as low risk, some concerns, or high risk, and an overall judgment was assigned according to RoB 2 guidance. Disagreements were resolved by consensus.

Synthesis of Results

Meta-analysis was conducted when at least two studies reported an outcome with sufficiently comparable definitions. Dichotomous outcomes were pooled as odds ratios (ORs) with 95% confidence intervals (CIs). To improve clinical interpretability, crude event rates were also reported for the primary outcome alongside the pooled OR. Risk ratios or absolute risk differences were considered descriptively where appropriate, but ORs were retained as the primary pooled effect measure for consistency across dichotomous outcomes. Continuous outcomes were pooled as mean differences (MDs) with 95% CIs when measured in the same unit. Random-effects models were used because clinical and methodological heterogeneity was anticipated across settings, devices, airway contexts, and operator factors. Analyses were performed in Stata (StataCorp, College Station, TX, USA) using a random-effects model with restricted maximum likelihood (REML) estimation for between-study variance (τ^2). Statistical heterogeneity was assessed using Cochran's Q and the I^2 statistic, with τ^2 reported where applicable. An I^2 value ≥50% was considered indicative of substantial heterogeneity.

For rare binary outcomes, studies with zero events in one arm were retained using a continuity correction of 0.5. Studies with zero events in both arms, if present, were not included in odds-ratio pooling but were considered in narrative interpretation. Because rare-event analyses may be sensitive to sparse data and model assumptions, pooled estimates for complications were interpreted cautiously alongside absolute event counts.

Although more than one attempt is conceptually related to first-attempt success, it was retained as a secondary procedural outcome because repeated laryngoscopy attempts represent a clinically relevant escalation endpoint and were reported as attempt categories in several trials. For postoperative sore throat, when multiple postoperative time points were reported, the earliest routinely reported postoperative assessment was extracted for quantitative synthesis.

To further explore clinical and methodological heterogeneity, exploratory subgroup assessment was planned according to clinical setting (ED/ICU vs operating room), laryngoscopy modality (direct or non-hyperangulated laryngoscopy vs hyperangulated videolaryngoscopy), airway difficulty profile (anticipated or predefined difficult airway vs general or unselected population), and bougie type (standard bougie, preloaded bougie, or flexible-tip bougie). Because the number of included studies was limited and the distribution across subgroup categories was uneven, formal subgroup-specific pooled estimates were not generated. These assessments were therefore interpreted qualitatively and considered hypothesis-generating.

For the primary outcome, robustness and heterogeneity were further explored using leave-one-out influence analysis and visual diagnostics, including Galbraith and L'Abbé plots. Potential small-study effects were assessed visually using funnel plots for the primary outcome and interpreted cautiously because fewer than ten studies were included. No formal certainty-of-evidence assessment using GRADE was performed; therefore, findings were described in terms of imprecision, heterogeneity, and limited evidence rather than formal certainty ratings. A two-sided p value <0.05 was considered statistically significant.

Results

Literature Search Result

A total of 1,158 records were identified through database searching (PubMed, n = 412; Scopus, n = 356; Web of Science, n = 296; Cochrane CENTRAL, n = 94). After removal of 318 duplicates, 840 unique records were screened by title and abstract, of which 771 were excluded. Sixty-nine reports were sought for full-text retrieval; three reports could not be retrieved, leaving 66 reports assessed for eligibility. Of these, 58 were excluded for the following reasons: non-randomized design (n = 21), no direct bougie versus stylet comparison (n = 14), ineligible population (pediatric/simulation/animal; n = 9), outcomes not extractable (n = 8), and duplicate or overlapping data (n = 6). Ultimately, eight randomized controlled trials met the inclusion criteria and were included in the qualitative synthesis and quantitative meta-analysis (Figure 2).

Study Characteristics

Across eight randomized controlled trials, a total of 2,578 participants were included to compare bougie-first versus stylet-first tracheal intubation. The included studies were published between 2018 and 2025 and were conducted across diverse clinical settings, including the emergency department, mixed emergency department/intensive care unit environments, intensive care units, and operating rooms. Overall, the included trials were multinational, involving studies from the United States, India, South Korea, and Spain. Sample sizes ranged from small single-center studies to large pragmatic trials. Mean participant age was broadly

comparable between treatment arms within individual trials, with mean ages spanning approximately the late 30s to late 60s across studies. Outcomes reported across trials commonly captured procedural performance, including first-attempt intubation success, number of attempts, and intubation time, as well as safety endpoints such as hypoxemia, esophageal intubation, pulmonary aspiration, postoperative sore throat, dysphagia, and hoarseness (Table 1).

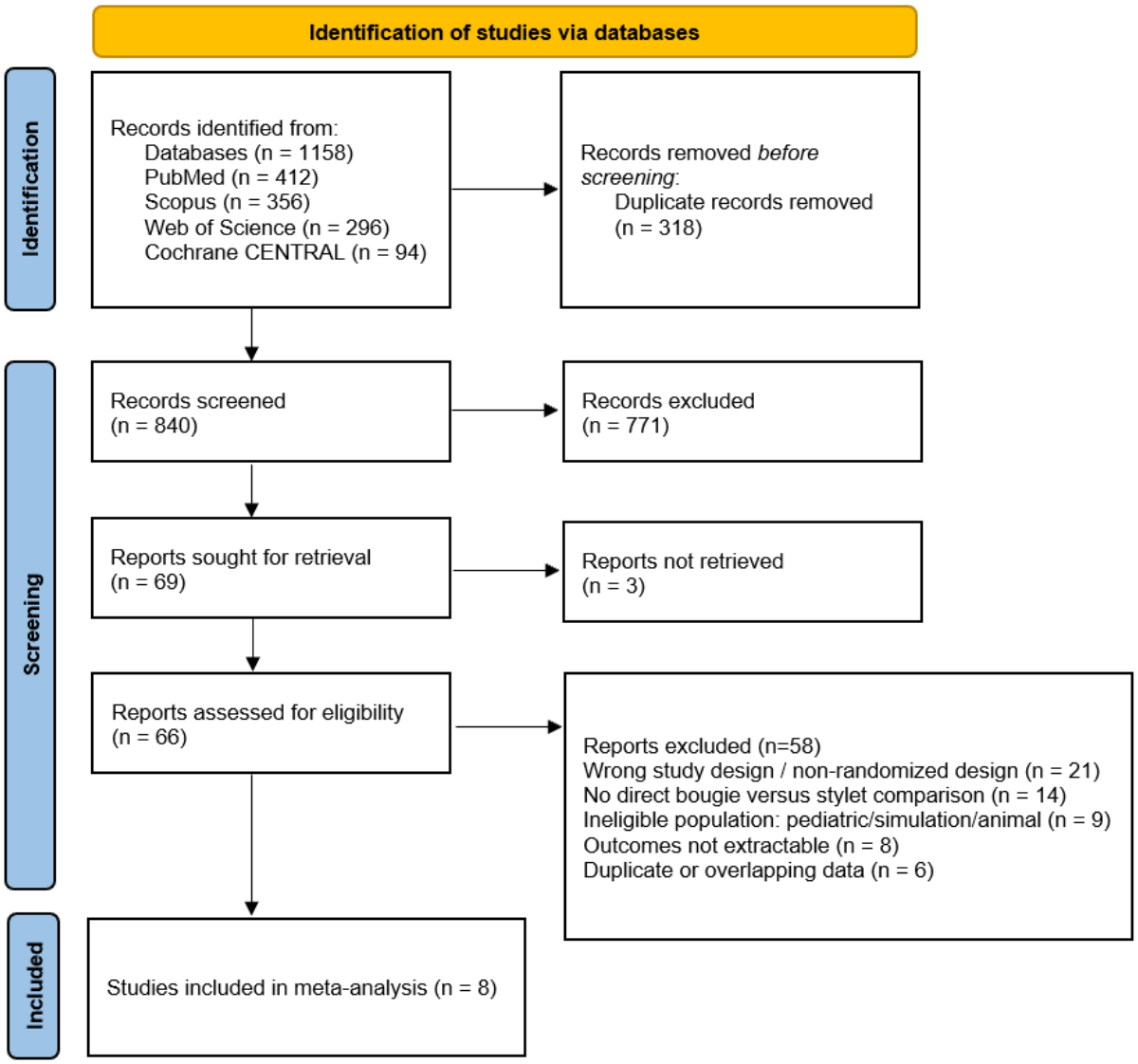

Figure 2. PRISMA Flow Diagram Showing the Results of The Database Search

For Kumar et al., which included two bougie arms and one stylet arm, the preloaded bougie and standard bougie groups were combined into a single bougie-first group for the meta-analysis. For Thevar Manoharan et al., first-attempt intubation success was derived from the reported distribution of intubation attempts.

doi:10.24843/8hqnbs41

Table 1. Characteristics of included randomized controlled trials comparing bougie-first versus stylet-first tracheal intubation.

No	Study	Country	Type of Study	Sample Size		Mean Age (SD)		Outcomes
				Bougie	Stylet	Bougie	Stylet	
1	Driver et al., 2018 [3]	United States	Single-center randomized clinical trial (ED)	381	376	46 (18)	46 (18)	First-attempt intubation success; first-attempt duration; and hypoxemia.
2	Tosh et al.,2018 [8]	India	Randomized controlled trial (OR, RSI)	35	35	40.1 (14.4)	42.2 (14.8)	Ease/difficulty of intubation; loss of airway; hemodynamic responses; intubation time; and number of attempts.
3	Driver et al.,2021 [4]	United States	Multicenter randomized clinical trial (ED/ICU)	556	546	56.3 (20)	56.3 (17)	First-attempt intubation success; and incidence of severe hypoxemia.
4	Bawa et al.,2022 [9]	India	Randomized controlled trial (OR, RSI)	50	50	37.34 (NR)	41.12 (NR)	Time to intubation; number of attempts; hemodynamic responses; airway trauma; and other complications.
5	Thevar Manoharan et al.,2023 [10]	India	Prospective randomized controlled trial (OR, simulated difficult airway)	24	24	40.33 (13.83)	41.96 (11.34)	Ease/difficulty of intubation; time to intubation; number of attempts; and hemodynamic responses.
6	Eum et al.,2024 [5]	South Korea	Randomized controlled trial (OR, elective, videolaryngoscopy)	83	83	52 (16.1)	53 (15.4)	First-attempt intubation success; second- and third-attempt success; intubation time; and postoperative airway symptoms (sore throat, dysphagia, hoarseness).
7	Taboada et al.,2025 [11]	Spain	Prospective randomized controlled trial (ICU)	70	70	68 (13)	68 (13)	First-attempt intubation success; number of attempts; intubation difficulty; and complications.
8	Kumar et al.,2025 [12]	India	Randomized controlled trial (OR, elective) Three-arm RCT; preloaded and standard bougie arms combined for meta-analysis.	130	65	37.91 (13.11)	34.63 (13.82)	Time to successful intubation; number of attempts; need for adjunct airway maneuvers; hemodynamic responses; and incidence/severity of postoperative sore throat (POST).

Primary Outcome – First-Attempt Intubation Success

Eight randomized trials contributed data to the primary analysis of first-attempt intubation success (Figure 3a). Individual trial effects were highly variable, with some trials favoring bougie-first and others favoring stylet-first. The pooled random-effects analysis showed no significant difference between bougie-first and stylet-first techniques for first-attempt intubation success (OR 0.99, 95% CI 0.37–2.65; p = 0.980). Statistical heterogeneity was substantial (I^2 = 89.05%; Q = 63.94; p < 0.001), indicating considerable between-study variability.

The funnel plot for the primary outcome (Figure 3b) was interpreted cautiously because fewer than ten studies were included. Visual inspection suggested variability around the pooled estimate, but the small number of studies precluded reliable assessment of publication bias or small-study effects. Leave-one-out sensitivity analysis (Figure 3c) did not identify a single study that fully explained the heterogeneity or materially changed the overall non-significant conclusion. In absolute terms, first-attempt intubation success occurred in 1,139 of 1,329 patients in the bougie-first group and 1,062 of 1,249 patients in the stylet-first group, corresponding to crude event rates of 85.7% and 85.0%, respectively.

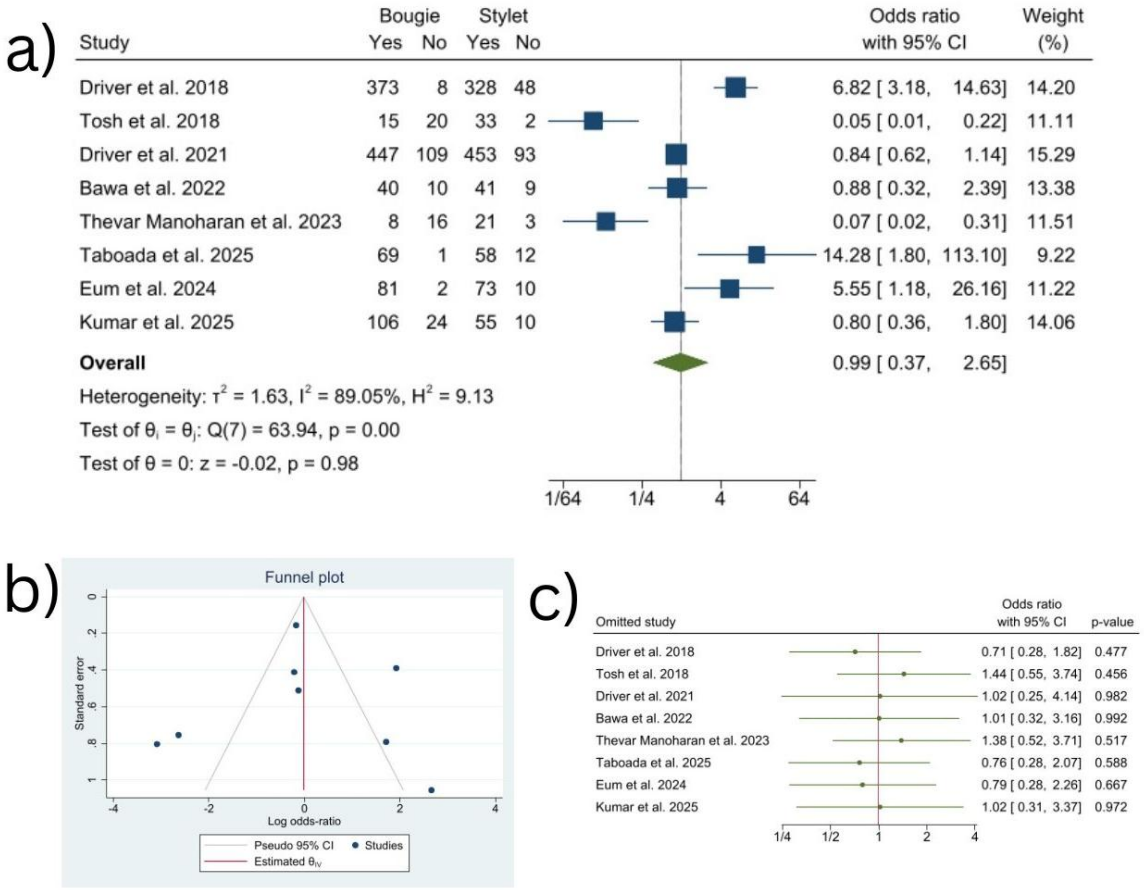

Figure 3. First-attempt intubation success comparing bougie-first versus stylet-first techniques: (a) random-effects forest plot (odds ratios); (b) funnel plot for small-study effects; and (c) leave-one-out sensitivity analysis.

Exploratory Heterogeneity Analyses

Exploratory subgroup assessment was conducted qualitatively according to clinical setting, laryngoscopy modality, airway difficulty profile, and bougie type where data were available. Because of the small number of trials and the uneven distribution of studies across subgroup categories, formal subgroup-specific pooled estimates were not generated. The observed variability suggested that between-study heterogeneity was likely multifactorial and context-dependent, while leave-one-out analysis did not identify any single study as the main driver of heterogeneity.

Secondary Outcomes - Procedural

Five randomized trials reported the need for more than one intubation attempt (Figure 4a). The pooled analysis showed no significant difference between bougie-first and stylet-first techniques in the likelihood of requiring more than one attempt (OR 0.91, 95% CI 0.21–3.91; p = 0.900). Between-study heterogeneity was substantial (I^2 = 84.61%; Q = 25.99; p < 0.001), suggesting that trial-level effects varied considerably across clinical settings, airway difficulty profiles, and procedural approaches.

Five trials contributed data to the analysis of intubation time (Figure 4b). Bougie-first was associated with a longer time to successful intubation compared with stylet-first (MD 21.84 seconds, 95% CI 5.55–38.14; p = 0.010). However, heterogeneity was very high (I^2 = 97.37%; Q = 151.91; p < 0.001). Because timing definitions differed across trials, including differences in whether timing started from induction, laryngoscope insertion, or device insertion, this finding was interpreted as an exploratory procedural result rather than a fully harmonized endpoint.

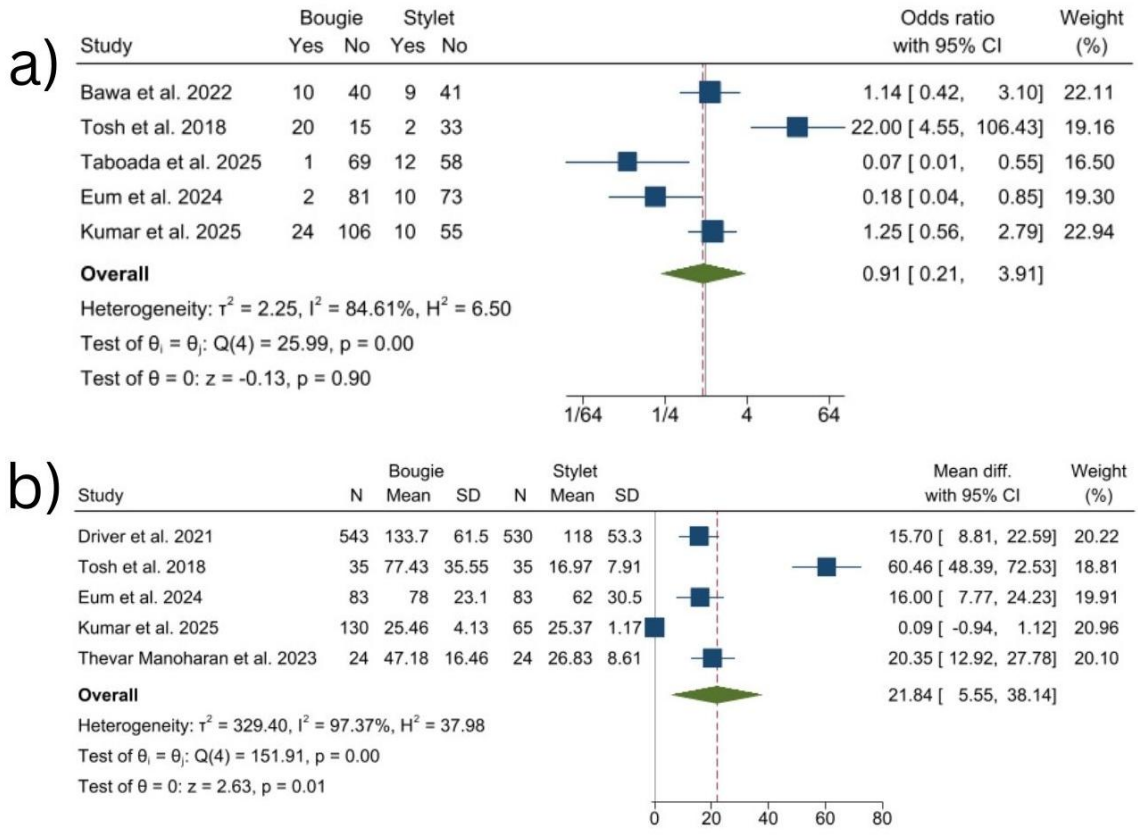

Figure 4. Secondary procedural outcomes comparing bougie-first versus stylet-first techniques: (a) more than one intubation attempt and (b) intubation time.

Secondary Outcomes - Complications

Four randomized trials reported esophageal intubation as an adverse event (Figure 5a). The pooled analysis showed no significant difference between bougie-first and stylet-first techniques (OR 0.48, 95% CI 0.17–1.40; p = 0.180). Statistical heterogeneity was negligible (I^2 = 0.00%; Q = 1.59; p = 0.660), although the estimate remained imprecise because of the low number of events.

Three trials reported pulmonary aspiration (Figure 5b). There was no significant difference between bougie-first and stylet-first techniques (OR 1.47, 95% CI 0.57–3.75; p = 0.420), with no observed heterogeneity (I^2 = 0.00%; Q = 1.32; p = 0.520). Given the low event rates, this estimate should be interpreted cautiously.

Three operating room–based trials reported postoperative sore throat (Figure 5c). The pooled analysis showed no significant difference between bougie-first and stylet-first techniques (OR 1.10, 95% CI 0.48–2.52; p = 0.830). Heterogeneity was substantial (I^2 = 71.92%; Q = 7.12; p = 0.030), likely reflecting differences in bougie design, postoperative assessment timing, and outcome ascertainment.

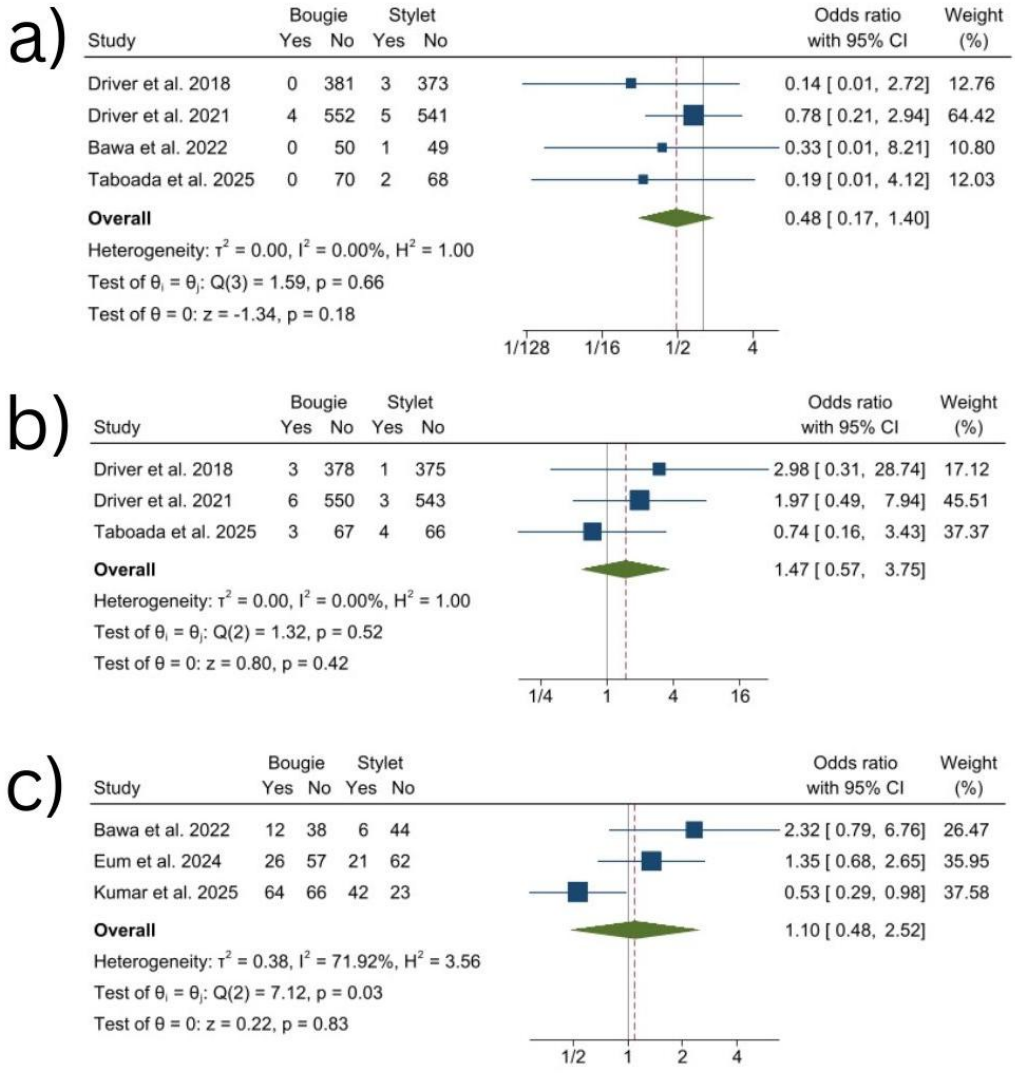

Figure 5. Airway-related complications comparing bougie-first versus stylet-first techniques: (a) esophageal intubation, (b) pulmonary aspiration, and (c) postoperative sore throat.

Discussion

Primary Outcome – First-Attempt Intubation Success

This systematic review and meta-analysis synthesized randomized evidence comparing bougie-first versus stylet-first tracheal intubation in adults. First-attempt intubation success was selected as the primary outcome because it is a clinically meaningful endpoint in airway management, where repeated laryngoscopy attempts are associated with higher rates of peri-intubation adverse events.[1,2] In the pooled analysis, bougie-first did not significantly improve first-attempt intubation success compared with stylet-first intubation. However, the substantial heterogeneity indicates that the pooled estimate should not be interpreted as evidence of a uniform effect across all clinical settings.

The heterogeneity observed in the primary outcome likely reflects clinically meaningful differences among included trials. The included studies varied by clinical setting, airway difficulty profile, laryngoscopy modality, bougie design, and operator workflow. This is illustrated by the contrast between the BEAM trial, which showed improved first-attempt success with bougie-first intubation in emergency department patients with at least one difficult airway characteristic, and the BOUGIE trial, which did not demonstrate a significant difference among critically ill adults undergoing emergency tracheal intubation.[3,4] More recent trials in hyperangulated videolaryngoscopy and difficult airway settings further suggest that the comparative effect of bougie-first versus stylet-first techniques may depend on the device used and the airway context.[5,11,12] These findings suggest that bougie-first intubation should be viewed as a context-dependent strategy rather than a universal default approach. A bougie may be advantageous when the glottic view is limited, the tube trajectory is difficult, or a hyperangulated blade creates a mismatch between glottic visualization and tube passage. Conversely, stylet-first intubation may perform similarly in settings where operators are highly familiar with stylet-guided tube shaping or where laryngoscopy conditions are optimized. This interpretation is consistent with previous meta-analytic evidence showing variable effects of bougie use across clinical contexts. [6,13,14]

Secondary Outcomes - Procedural

The need for more than one intubation attempt did not differ significantly between bougie-first and stylet-first techniques. Although this outcome is closely related to first-attempt success, it remains clinically relevant because repeated attempts represent escalation of airway manipulation and may increase the risk of complications.[2] The absence of a significant difference in this outcome supports the interpretation that neither strategy consistently reduces the need for additional attempts across heterogeneous adult intubation settings.

Bougie-first intubation was associated with a longer intubation time compared with stylet-first intubation. However, this finding should be interpreted cautiously because heterogeneity was very high and timing definitions differed across trials. Some studies measured intubation time from induction, whereas others measured time from laryngoscope insertion, device insertion, or confirmation of successful intubation.[4,5,8,10,12] These differences in timing anchors limit direct comparability

across studies and suggest that intubation time should be interpreted as an exploratory procedural endpoint rather than a fully harmonized outcome.

The clinical significance of longer intubation time is context-dependent. In critically ill patients with limited apnea tolerance, even modest delays may be important. In contrast, in elective operating room settings with adequate preoxygenation and controlled conditions, a short increase in procedural time may be less clinically consequential if intubation remains successful and safe. These findings highlight that both bougie-first and stylet-first techniques require adequate operator training, and institutional airway algorithms should incorporate competency in both adjuncts rather than relying on a single universal strategy.[1]

Secondary Outcomes - Complications

Major airway-related complications were uncommon across included trials. The pooled analyses did not show significant differences between bougie-first and stylet-first techniques for esophageal intubation or pulmonary aspiration. However, because event rates were low, these estimates were imprecise and should be interpreted cautiously. The absence of a statistically significant difference should not be interpreted as definitive equivalence, particularly because the included trials were not primarily powered to detect rare but clinically important airway complications.

Postoperative sore throat also did not differ significantly between techniques in the updated pooled analysis. Nevertheless, heterogeneity was substantial, likely reflecting differences in bougie type, stylet technique, cuff pressure control, postoperative assessment timing, and outcome ascertainment. Postoperative sore throat is clinically relevant for patient comfort, but its interpretation may differ between elective operating room studies and emergency or intensive care intubation settings.[5,9,12]

Hypoxemia was considered an important safety outcome, but it was not pooled quantitatively because definitions varied across trials. Reported thresholds included study-defined hypoxemia, desaturation, oxygen saturation <90%, and severe hypoxemia <80%, with different measurement windows across studies.[3,4,11] Therefore, hypoxemia-related outcomes were summarized narratively rather than combined as a single pooled endpoint.

Overall, the complication findings suggest no clear signal of increased major airway-related harm with either bougie-first or stylet-first intubation, but the evidence remains limited by sparse events, variable definitions, and heterogeneous clinical contexts. Large airway audits and systematic reviews of introducer-associated airway trauma emphasize that airway-related harm is uncommon but clinically important, and that standardized adverse-event reporting is needed to better interpret safety outcomes.[15,16]

Future Directions

Future research should prioritize adequately powered, pragmatic randomized trials with standardized outcome definitions across emergency department, intensive care unit, and operating room settings. Studies should report first-attempt success, number of attempts, intubation time using clearly defined timing anchors, hypoxemia thresholds, and airway-related complications in a consistent manner. Further investigation is also needed to

evaluate effect modification by laryngoscopy modality, bougie design, stylet configuration, operator experience, and airway difficulty. These factors are likely to determine which adjunct provides the greatest benefit in specific clinical scenarios.

Conclusion

Current randomized evidence did not demonstrate a consistent overall difference in first-attempt intubation success between bougie-first and stylet-first tracheal intubation in adults. The likelihood of requiring more than one intubation attempt was also similar between techniques. Bougie-first intubation was associated with longer intubation time, but this finding should be interpreted cautiously because timing definitions varied across trials and heterogeneity was very high. Major airway-related complications, including esophageal intubation and pulmonary aspiration, did not differ significantly between groups, and postoperative sore throat was also not significantly different in the updated analysis. Overall, these findings suggest that bougie-first and stylet-first techniques should be considered context-dependent adjunct strategies rather than one universally superior approach.

Acknowledgement

None.

Funding

None reported.

Conflict of Interest

The author(s) report no conflict of interest.

Data Availability Statement

All data analyzed in this study were extracted from previously published articles. The extracted dataset used for the meta-analysis is available from the corresponding author upon reasonable request.

Author's Contributions

Conceptualisation: O.J.K.J., I.P.F.N. Methodology: O.J.K.J., G.B.S.P.N.O., R.F.N. Investigation: G.B.S.P.N.O., J.F.L., T.F.A., E.S.C. Data Curation: J.F.L., T.F.A. Formal Analysis: O.J.K.J. Writing – original draft: R.F.N. Writing – review & editing: O.J.K.J., I.P.F.N., G.B.S.P.N.O., R.F.N., J.F.L., T.F.A., E.S.C. Supervision: I.P.F.N. All authors have read and approved the final manuscript.

References

1. Apfelbaum JL, Hagberg CA, Connis RT, Abdelmalak BB, Agarkar M, Dutton RP, et al. 2022 American Society of Anesthesiologists Practice Guidelines for Management of the Difficult Airway. Anesthesiology. 2022 Jan 1;136(1):31–81. doi:10.1097/ALN.0000000000004002 PubMed PMID: 34762729.

2. Hasegawa K, Shigemitsu K, Hagiwara Y, Chiba T, Watase H, Brown CA, et al. Association between repeated intubation attempts and adverse events in emergency departments: An analysis of a multicenter prospective observational study. Ann Emerg Med. 2012;60(6). doi:10.1016/j.annemergmed.2012.04.005 PubMed PMID: 22542734.

3. Driver BE, Prekker ME, Klein LR, Reardon RF, Miner JR, Fagerstrom ET, et al. Effect of Use of a Bougie vs Endotracheal Tube and Stylet on First-Attempt Intubation Success Among Patients With Difficult Airways Undergoing Emergency Intubation: A Randomized Clinical Trial. JAMA. 2018 Jun 5;319(21):2179–89. doi:10.1001/jama.2018.6496 PubMed PMID: 29800096.

4. Driver BE, Semler MW, Self WH, Ginde AA, Trent SA, Gandotra S, et al. Effect of Use of a Bougie vs Endotracheal Tube With Stylet on Successful Intubation on the First Attempt Among Critically Ill Patients Undergoing Tracheal Intubation: A Randomized Clinical Trial. JAMA. 2021 Dec 28;326(24):2488–97. doi:10.1001/jama.2021.22002 PubMed PMID: 34879143.

5. Eum D, Ji YJ, Kim HJ. Comparison of the success rate of tracheal intubation between stylet and bougie with

a hyperangulated videolaryngoscope: a randomised controlled trial. Anaesthesia. 2024 Jun 1;79(6):603–10. doi:10.1111/anae.16202 PubMed PMID: 38114306.

6. von Hellmann R, Fuhr N, Ward A, Maia I, Gerberi D, Pedrollo D, Bellolio F, et al. Effect of Bougie Use on First-Attempt Success in Tracheal Intubations: A Systematic Review and Meta-Analysis. Ann Emerg Med. 2024 Feb 1;83(2):132–44. doi:10.1016/j.annemergmed.2023.08.484 PubMed PMID: 37725023.

7. Wan X, Wang W, Liu J, Tong T. Estimating the sample mean and standard deviation from the sample size, median, range and/or interquartile range. BMC Medical Research Methodology 2014 14:1. 2014 Dec 19;14(1):135-. doi:10.1186/1471-2288-14-135 PubMed PMID: 25524443.

8. Tosh P, Rajan S, Kumar L. Ease of Intubation with C-MAC Videolaryngoscope: Use of 60° Angled Styletted Endotracheal Tube versus Intubation over Bougie. Anesth Essays Res. 2018;12(1):194. doi:10.4103/aer.aer_121_17 PubMed PMID: 29628581.

9. Bawa C, Raina J, Dureja M, Singh A, Yadav N, Kumar A. Intubation Performance with Stylet and Preloaded Bougie for Rapid Sequence Intubation in Patients Undergoing General Anaesthesia: A Randomised Clinical Trial. JOURNAL OF CLINICAL AND DIAGNOSTIC RESEARCH. 2022. doi:10.7860/jcdr/2022/55146.16586

10. Manoharan NST, Varghese N, Bhat RRK. Comparison between stylet and bougie with the C-MAC D-blade in cervical simulated immobility. A prospective randomized controlled trial. Colombian Journal of Anesthesiology. 2023;51(2). doi:10.5554/22562087.e1061

11. Taboada M, Cariñena A, Estany-Gestal A, de Miguel M, Iraburu R, Alonso S, et al. Flexible-tip bougie vs. stylet for tracheal intubation with a hyperangulated videolaryngoscope in critical care: a randomised controlled trial. Anaesthesia. 2025 Jul 1;80(7):790–8. doi:10.1111/anae.16574 PubMed PMID: 40159760.

12. Kumar D, Rajkumar S, Johny P, Vaithiyalingam E. Comparison of the Ease of Endotracheal Intubation between Preloaded Bougie, Standard Bougie, and Stylet-Guided Techniques in Difficult Airway Patients Undergoing Elective Surgery: A Randomized Clinical Trial. Bali Journal of Anesthesiology. 2025 Jul 1;9(3):165–71. doi:10.4103/bjoa.bjoa_161_25

13. Wilson SJ, Hendin A, Thiruganasambandamoorthy V. Effect of bougie use on first-attempt success in tracheal intubations: a systematic review and meta-analysis. Canadian Journal of Emergency Medicine 2024 26:11. 2024 Nov 6;26(11):781–3. doi:10.1007/s43678-024-00805-1 PubMed PMID: 39503985.

14. Sheu YJ, Yu SW, Huang TW, Liu FL, Lin YK, Tam KW. Comparison of the efficacy of a bougie and stylet in patients with endotracheal intubation: A meta-analysis of randomized controlled trials. Journal of Trauma and Acute Care Surgery. 2019 May 1;86(5):902–8. doi:10.1097/TA.0000000000002216 PubMed PMID: 30741881.

15. Cook TM, Woodall N, Harper J, Benger J. Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Part 2: intensive care and emergency departments. Br J Anaesth. 2011;106(5):632–42. doi:10.1093/bja/aer059 PubMed PMID: 21447489.

16. Boulton AJ, Smith E, Yasin A, Moreton J, Mendonca C. Tracheal tube introducer-associated airway trauma: a systematic review. Anaesthesia. 2024 Oct 1;79(10):1091–101. doi:10.1111/anae.16379 PubMed PMID: 39073144.