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META-ANALYSIS

Comparison of the incidence of postoperative sore throat between patients undergoing videolaryngoscope-guided versus Macintosh laryngoscope-guided double-lumen intubation: a systematic review and meta-analysis

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Abstract

Postoperative sore throat is a common complication of tracheal intubation, especially double-lumen tube intubation, after general anesthesia. Several studies have been conducted to compare the incidence of postoperative sore throat among patients undergoing videolaryngoscope-guided double-lumen intubation with that among patients undergoing Macintosh laryngoscope-guided double-lumen intubation. We purported to summarize all the existing evidences to explore the effect of videolaryngoscope and Macintosh laryngoscope on postoperative sore throat in patients with double-lumen intubation. PubMed, Cochrane Library, EMBASE and China National Knowledge Infrastructure databases were searched for all randomized controlled trials published before 01 June 2021 that compared videolaryngoscopy with Macintosh laryngoscopy for prevention of postoperative sore throat among patients undergoing double-lumen intubation. The results showed that, 9 studies involving 695 patients were included in our meta-analysis. There was no significant difference about the incidence of postoperative hoarseness (risk ratio: 0.80; 95% confidence interval: 0.49–1.32; p-value = 0.38; I^2 = 83%), tube malposition (risk ratio: 0.75; 95% confidence interval: 0.07–7.60; p-value = 0.80; I^2 = 71%) and the success rate at the first attempt (risk ratio: 1.03; 95% confidence interval: 0.96–1.10; p-value = 0.42; I^2 = 70%) between the two groups. We found that the videolaryngoscopy provided much lower incidence of oral injury (risk ratio: 0.49; 95% confidence interval: 0.27–0.89; p-value = 0.02; I^2 = 7%) compared with Macintosh laryngoscopy. There was no significant difference in the incidence of postoperative sore throat (risk ratio: 0.74; 95% confidence interval: 0.42–1.32; p-value = 0.31; I^2 = 87%) between the two groups. The sensitivity analysis excluding one study suggested that the incidence of postoperative sore throat was lower in the videolaryngoscopy group (risk ratio: 0.64; 95% confidence interval: 0.46–0.89; p-value = 0.008; I^2 = 19%). The subgroup analysis suggested that the incidence of postoperative sore throat was lower in the videolaryngoscopy group in studies performed by experienced anesthetists (risk ratio: 0.62; 95% confidence interval: 0.45–0.87; p-value = 0.005; I^2 = 5%). The current evidence demonstrates that, experienced anesthetist under the guidance of videolaryngoscope can significantly reduce the risk of postoperative sore throat in patients with double-lumen intubation. Using the videolaryngoscope resulted in a lower incidence of oral injury-related complications. However, there was no advantage in using a videolaryngoscope over Macintosh laryngoscope in the reduction of postoperative hoarseness, tube malposition and the success rate at first attempt.

Keywords

Videolaryngoscope; Macintosh laryngoscope; Tracheal intubation; Double-lumen tube; Postoperative sore throat

1. Introduction

Tracheal intubation is the most commonly used airway management method in general anesthesia. A cuffed tube can

prevent leakage during positive pressure ventilation. Furthermore, it can also protect patients' airways and lungs from aspirating the stomach contents. Laryngoscope-guided intratracheal intubation involves insertion of a hard metal or a plastic laryngoscope into patients' oral cavity and then performing a series of operations, including raising the epiglottis and placing an endotracheal tube (ETT) into patients' trachea between the V-shaped vocal cords. Operations in the patients' oral cavity may cause temporary irritation to the local mucosa of the oropharynx or trachea [1]. The aforementioned injuries could be the main sources of several undesirable complications relating to intubation. Double-lumen tubes are mainly used for thoracic surgery that can achieve one-lung ventilation [2]. A double-lumen intratracheal tube, due to its configuration, is more difficult to be placed into patient's trachea, thus complications relating to double-lumen tube intubation are more common [3].

Postoperative sore throat (POST) is a common complication of tracheal intubation [4], with an estimated incidence of 14.5%–65% [1, 5, 6] which can significantly deteriorate patients' satisfaction level [7] and affect patients' recovery [8, 9]. Moreover, POST can also result in an increased cost of hospitalization for patients. It has been reported by Kalil *et al*. [10] in 2014 that patients with POST stayed longer in postanesthesia care units than those without POST. Therefore, it is an urgent matter to reduce the incidence and the severity of POST.

Compared with the direct laryngoscope, the videolaryngoscope provide greater visualization of patients' epiglottis and glottis. Several clinical trials have been carried out to compare the incidence of POST among patients undergoing videolaryngoscope-guided double-lumen intubation with that among patients undergoing Macintosh laryngoscope-guided double-lumen intubation. However, the results of these studies are inconsistent. For instance, researchers of Hsu *et al*. [11] concluded that patients in the videolaryngoscope group experienced lower incidence of POST than those in the Macintosh laryngoscope group, while some other researchers took the opposite attitudes, such as Bakshi *et al*. [12].

Therefore, we perform a meta-analysis mainly with respect to the incidence of POST and draw a better conclusion which could provide useful enlightenment to the clinical work.

2. Methods and Materials

2.1 Search Strategies

We conducted this systematic review and meta-analysis according to the rules of PRISMA [13]. The PubMed, Cochrane Library, EMBASE and China National Knowledge Infrastructure (CNKI) databases were searched for randomized controlled trials (RCT) published before June 2021 that compared the incidence of postoperative sore throat among patients undergoing videolaryngoscope-guided double-lumen intubation with those undergoing Macintosh laryngoscope-guided double-lumen intubation. We used the key words of double-lumen tube, tracheal intubation, postoperative sore throat, videolaryngoscope and Macintosh laryngoscope.

2.2 Inclusion and Exclusion Criteria

The inclusion criteria were as following: (1) It is an RCT; (2) It has compared the incidence of POST among patients undergoing videolaryngoscope-guided double-lumen intubation with those undergoing Macintosh laryngoscope-guided double-lumen intubation; (3) The full-text and data were available. We then excluded duplicate publications, reviews or meta-analyses, editorials, case reports and animal experiments.

2.3 Data Extraction

Two reviewers independently screened the articles and extracted data from the studies. Any disagreements were resolved by a senior reviewer. The following data were extracted: the first author's name; publication year; sample size; participants' age; type of videolaryngoscope; the anesthetists' level of experience; the incidence of POST, oral injury, postoperative hoarseness, and malposition, as well as the success rate at first attempt. The primary outcome of the meta-analysis was the incidence of POST. The secondary outcomes were the incidences of oral injury, postoperative hoarseness, malposition, as well as the success rate at first attempt.

2.4 Quality assessment and publication bias

We used the Cochrane collaboration tool to complete the risk of bias assessment.

2.5 Statistical analysis

The meta-analysis was conducted using Review Manager Version 5.3 (RevMan, The Cochrane Collaboration 2012, The Nordic Cochrane Centre, Copenhagen, Denmark). Cochran's Q test and Higgins' I^2 statistical test were used to assess the statistical heterogeneity of the pooled results. Data were pooled from all eligible RCTs and the Mantel-Haenszel method was used to calculate the risk ratio (RR) with 95% confidence intervals (CI) for these dichotomous outcomes. A pooled estimate of RR was computed using the DerSimonian and Laird random-effects model. This model provides an appropriate estimate of the average treatment effect when studies are statistically heterogeneous, and it typically yields relatively wide CI resulting in a more conservative statistical claim. We conducted subgroup analyses of the included studies according to the different types of videolaryngoscope and the anesthetists' experience. In addition, by excluding one study at a time, a sensitivity analysis was performed to assess the robustness of the results.

3. Results

3.1 Study inclusion

The literature search identified 198 articles of which 9 articles [11, 12, 14–20] met the inclusion criteria (Fig. 1). The characteristics of the 9 studies involved 695 participants were summarized in Table 1 (Ref. [11, 12, 14–20]). As were shown in the risk of bias graph (Fig. 2) and risk of bias summary (Fig. 3), all studies were rated as high risk for performance bias and detection bias because the performer knew what type

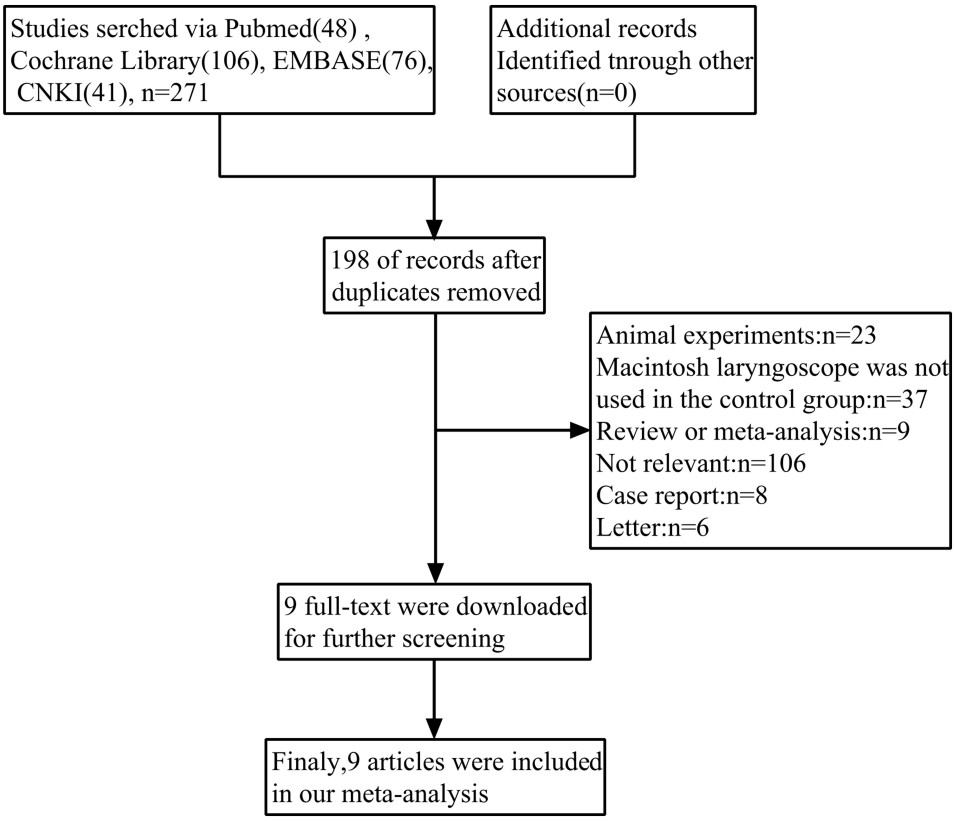

FIGURE 1. The literature screening process.

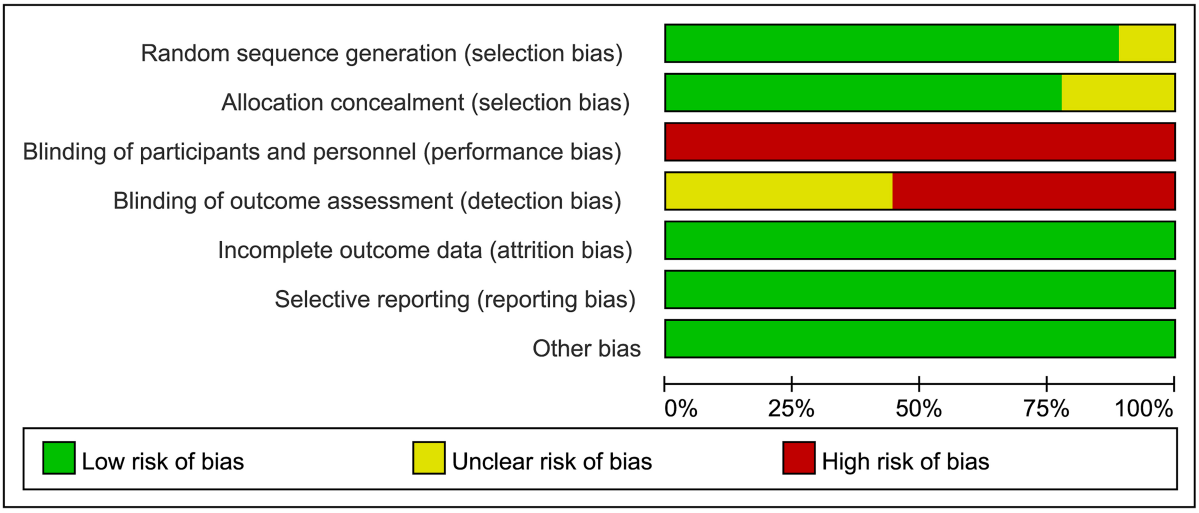

FIGURE 2. Risk of bias assessment graph.

of laryngoscope they had used and it was impossible to blind the assessors for the incidence of success rate and malposition.

3.2 Primary Outcome

After synthesizing the data, the result shows that there was no significant difference about the incidence of POST (RR: 0.74; 95% CI: 0.42–1.32; $p = 0.31$; $I^2 = 87\%$) between the two groups (Fig. 4).

3.3 Subgroup Analysis

Classified by different types of videolaryngoscope: 6 types of videolaryngoscope were adopted in these studies, and we found that none of these videolaryngoscope showed priority over the Macintosh laryngoscope in terms of the incidence of POST (Fig. 5).

The intubations were performed by different anesthetists with different levels of experience. There was no uniform definition of "experienced anesthetists" in the articles. In general, an anesthetist with less than 3 years of experience was defined as "inexperienced" and all others were defined as "experienced".

TABLE 1. Characteristics of the included studies.

Study	Number of participants (Male/Female)	Age (year)	Type of videolaryngoscope	Anesthetists' level of experience
Wasem *et al.* [14]	Videolaryngoscope: 30 (22/8) Macintosh laryngoscope: 30 (12/11)	Videolaryngoscope: 63 ± 10 Macintosh laryngoscope: 55 ± 19	Airtraq laryngoscope	Experienced anesthetists
Hsu *et al.* [11]	Videolaryngoscope: 30 (7/23) Macintosh laryngoscope: 30 (11/19)	Videolaryngoscope: 40.1 ± 18.7 Macintosh laryngoscope: 37.2 ± 15.4	Glidescope	Experienced anesthetists
Russell *et al.* [15]	Videolaryngoscope: 35 (15/20) Macintosh laryngoscope: 35 (18/17)	Videolaryngoscope: 59 ± 12 Macintosh laryngoscope: 62 ± 14	Glidescope	Inexperienced anesthetists
Kido *et al.* [16]	Videolaryngoscope: 25 (15/10) Macintosh laryngoscope: 25 (16/9)	Videolaryngoscope: 66.6 ± 11.3 Macintosh laryngoscope: 67.9 ± 15	McGrath laryngoscope	Inexperienced anesthetists
Lin *et al.* [17]	Videolaryngoscope: 83 (55/28) Macintosh laryngoscope: 82 (52/30)	Videolaryngoscope: 58.2 ± 9.6 Macintosh laryngoscope: 57.6 ± 9.4	CEL-100 laryngoscope	Experienced anesthetists
Hsu *et al.* [18]	Videolaryngoscope: 30 (20/10) Macintosh laryngoscope: 30 (12/8)	Videolaryngoscope: 40 ± 15 Macintosh laryngoscope: 47 ± 15	Trachway bronchoscope	Experienced anesthetists
Xu *et al.* [19]	Videolaryngoscope: 30 (14/16) Macintosh laryngoscope: 30 (17/13)	Videolaryngoscope: 50.1 ± 11.1 Macintosh laryngoscope: 46.3 ± 16.1	Shikani laryngoscope	Experienced anesthetists
Yao *et al.* [20]	Videolaryngoscope: 48(33/16) Macintosh laryngoscope: 48 (33/13)	Videolaryngoscope: 47.6 ± 13.8 Macintosh laryngoscope: 47.8 ± 16.3	McGrath laryngoscope	Experienced anesthetists
Bakshi *et al.* [12]	Videolaryngoscope: 37 (25/12) Macintosh laryngoscope: 37 (23/14)	Videolaryngoscope: 46.9 ± 17 Macintosh laryngoscope: 49.8 ± 16	McGrath laryngoscope	Inexperienced anesthetists

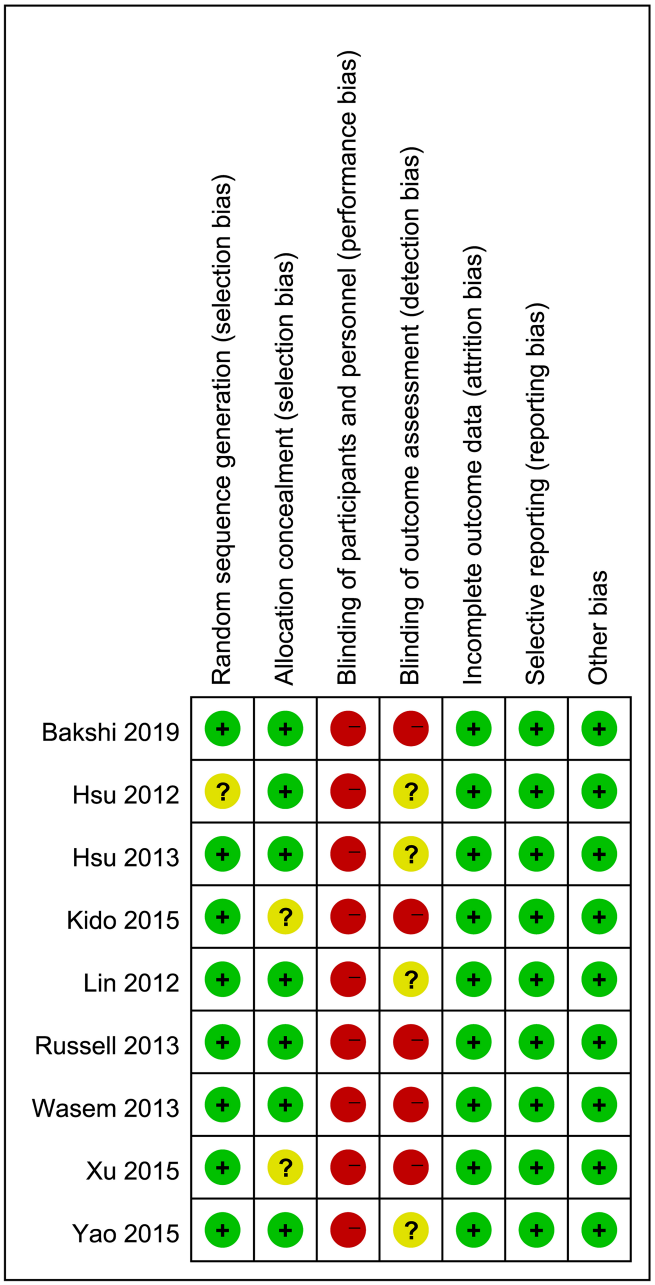

FIGURE 3. Risk of bias assessment summary. Yellow, unclear risk of bias; red, high risk of bias; green, low risk of bias.

The intubation procedure was performed by inexperienced anesthetists in 3 studies, while that in the other 6 studies was done by experienced anesthetists. Obviously, the incidence of POST was lower in the videolaryngoscope group among studies which were performed by experienced anesthetists (RR: 0.62; 95% CI: 0.45–0.87; $p = 0.005$; $I^2 = 5\%$), while there was no significant difference about the incidence of POST between the two group among studies performed by inexperienced anesthetists (RR: 0.95; 95% CI: 0.41–2.17; $p = 0.89$; $I^2 = 77\%$) (Fig. 6).

3.4 Secondary Outcomes

We also compared the incidences of postoperative hoarseness (RR: 0.80; 95% CI: 0.49–1.32; $p = 0.38$; $I^2 = 83\%$) (Fig. 7), tube malposition (RR: 0.75; 95% CI: 0.07–7.60; $p = 0.80$; $I^2 = 71\%$) (Fig. 8) and as well as the success rate at the first attempt (RR: 1.03; 95% CI: 0.96–1.10; $p = 0.42$; $I^2 = 70\%$) (Fig. 9) between the two groups, as were shown in those figures, no significant difference was detected with respect to those aforementioned outcomes. Otherwise, we found that the videolaryngoscope provided much lower incidence of oral injury compared with Macintosh laryngoscope (RR: 0.49; 95% CI: 0.27–0.89; $p = 0.02$; $I^2 = 7\%$) (Fig. 10).

3.5 Sensitivity Analysis

We excluded one study each time and then reanalyzed the rest data. There was no significant change detected with the exception of excluding the study by Bakshi *et al.* [12] for the incidence of POST. After excluding that study with a sample size of 74 participants which was performed by a novice anesthetist and reanalyzing the rest data, the incidence of POST was significantly lower in the videolaryngoscope group than that in the Macintosh Laryngoscope group and the heterogeneity was decreased to an acceptable level (RR: 0.64; 95% CI: 0.46–0.89; $p = 0.008$; $I^2 = 19\%$) (Fig. 11). Other outcomes remained similar when we were performing the sensitivity analysis.

4. Discussion

There is no doubt that the videolaryngoscope presents a better view of patient's glottis and epiglottis for the anesthetist when compared with the direct laryngoscope, however, inconsistent outcomes were found in several previous studies under different conditions [21–24].

POST, which is caused by local tissue injury relating to endotracheal intubation, is a vital risk factor affecting the recovery of patients after surgery [25]. The double-lumen tube may cause more damage because it is more difficult to be placed into patients' trachea. We synthesized the data from all the 9 included studies and found that the videolaryngoscope was not superior over the Macintosh laryngoscope in terms of the incidence of POST among patients undergoing double-lumen intubation. However, significant heterogeneity was detected. The sensitivity analysis showed that the source of heterogeneity was from the study of Bakshi *et al.* [12] by excluding which the heterogeneity decreased to an acceptable level and the result changed significantly. The synthesis of the data from the rest 8 study suggested that the videolaryngoscope was better than the Macintosh laryngoscope in terms of the incidence of POST among patients undergoing double-lumen intubation. Interestingly, the results of the subgroup analysis showed that the patients experienced lower incidence of POST if the intubation procedure was performed by the experienced anesthetists who used videolaryngoscope. It is very important for the anesthetist to improve the success rate of tracheal intubation at the first attempt to prevent tissue injury from happening [26]. However, a video stylet and guided videolaryngoscope require specific techniques and experience that may not be solely predicted by years of anesthesia experience.

The present study suggests that performers' success rate at their first attempt, the incidence of postoperative hoarseness

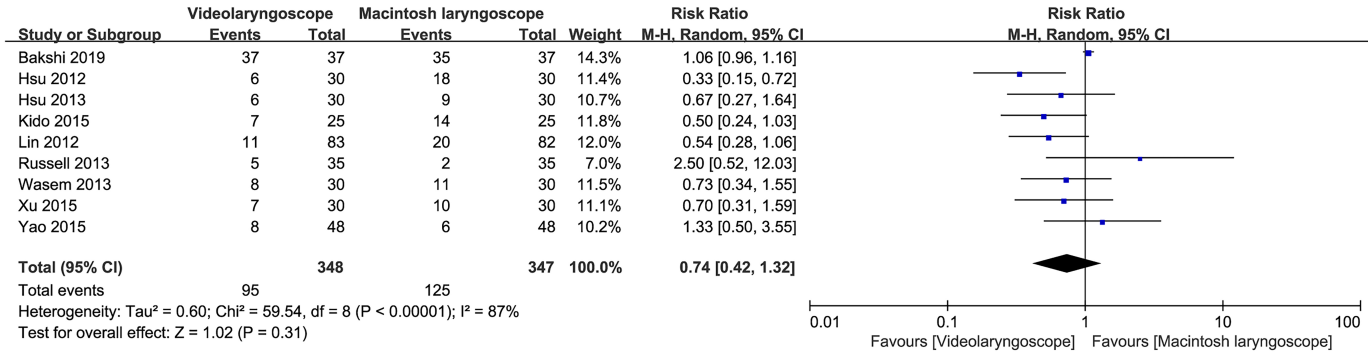

FIGURE 4. Forest plot of videolaryngoscope versus Macintosh laryngoscope for POST.

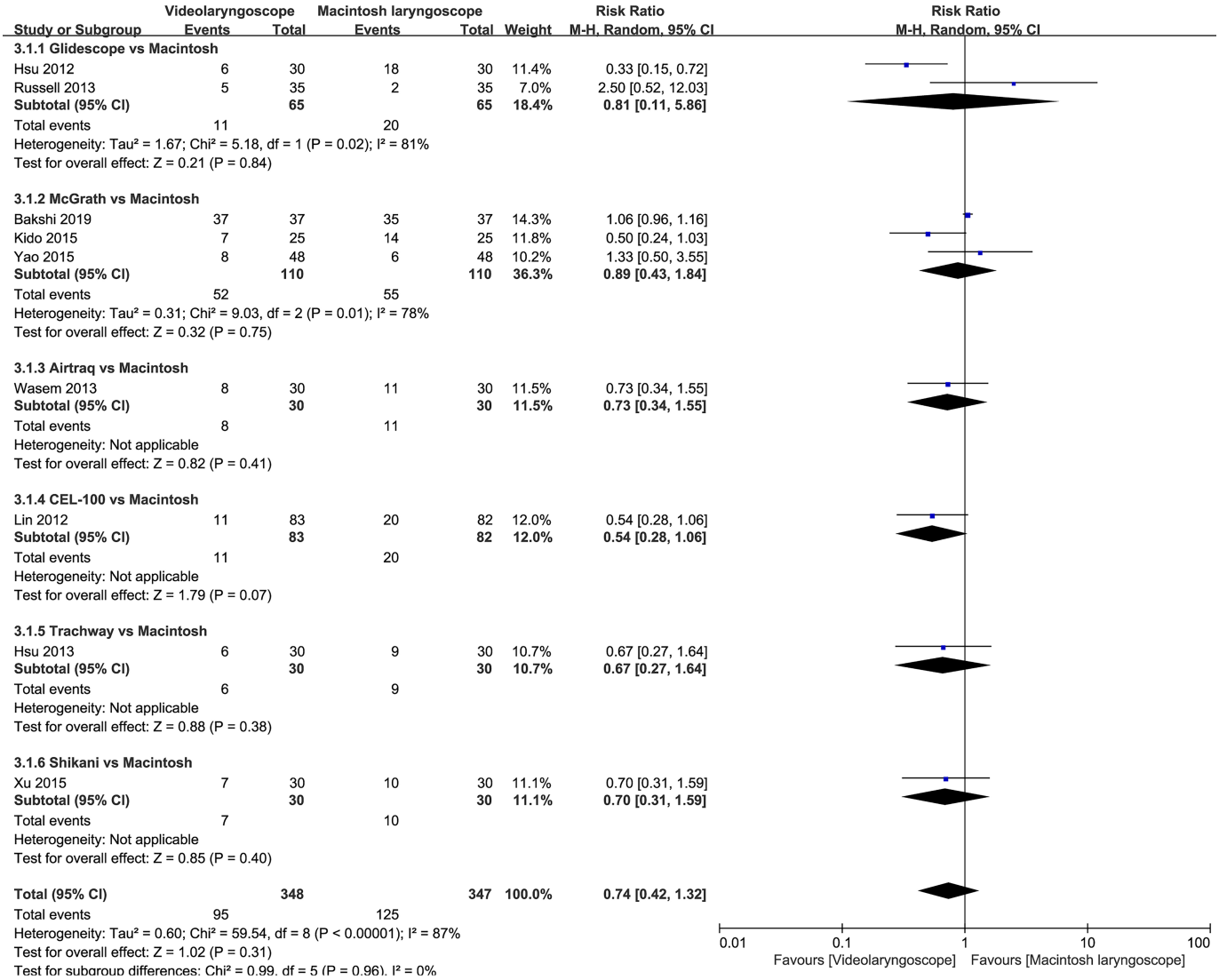

FIGURE 5. Forest plot of subgroup analysis by different types of laryngoscope.

and malposition didn't change with the laryngoscope they used during the intubation procedure. Although the videolaryngoscope could present a clearer view of regional anatomy for the operator, it didn't show superiority over the Macintosh laryngoscope about the aforementioned complications. However, the videolaryngoscope really helped to significantly reduce the incidence of oral injury.

Our research had several limitations. Firstly, the sample size of our study with 9 RCTs was relatively small. However, the search strategies of 4 official databases, clear inclusion and exclusion criteria, as well as strict consideration of studies' quality might have compensated for this limitation. Secondly, 6 different types of laryngoscope were adopted in these included studies, but some just in a pretty limited number of studies, so further studies should be focused on different types of laryngoscope compared with the Macintosh laryngoscope

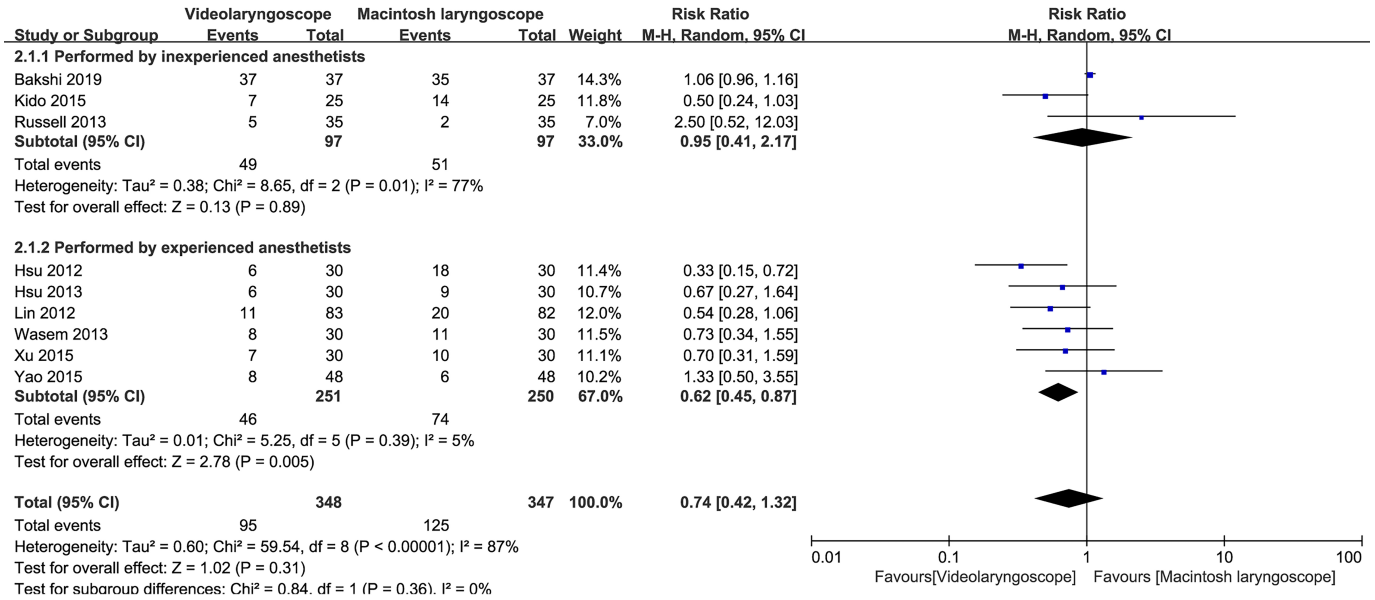

FIGURE 6. Forest plot of subgroup analysis by different anesthetists.

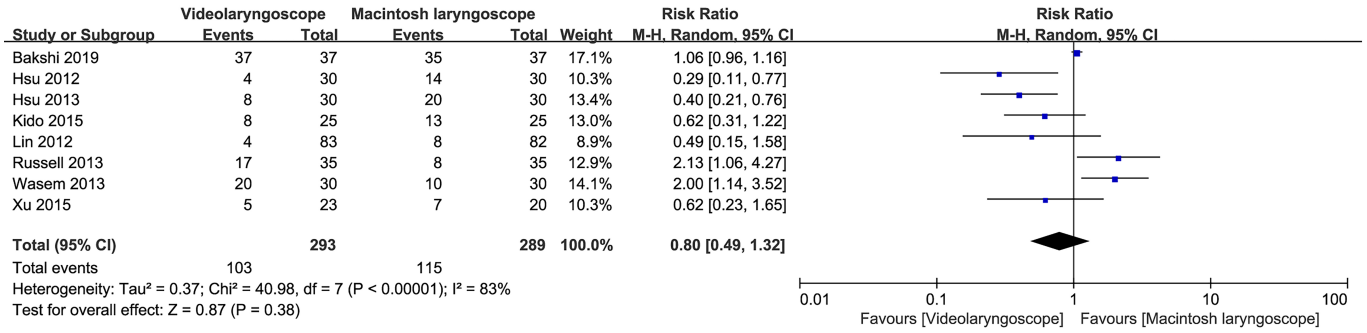

FIGURE 7. Forest plot of videolaryngoscope versus Macintosh laryngoscope for hoarseness.

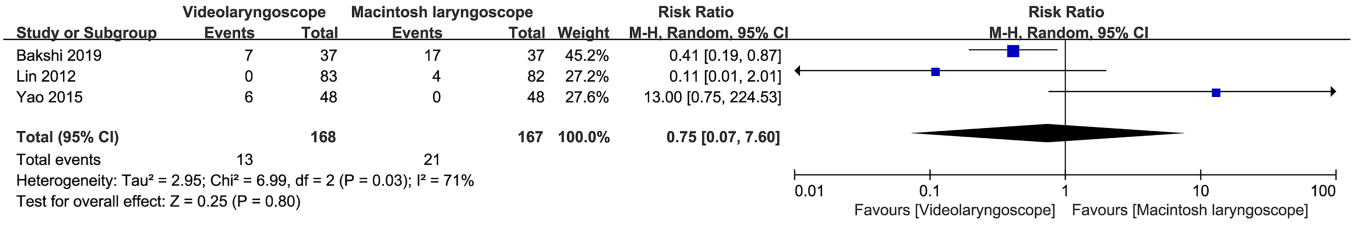

FIGURE 8. Forest plot of videolaryngoscope versus Macintosh laryngoscope for tube malposition.

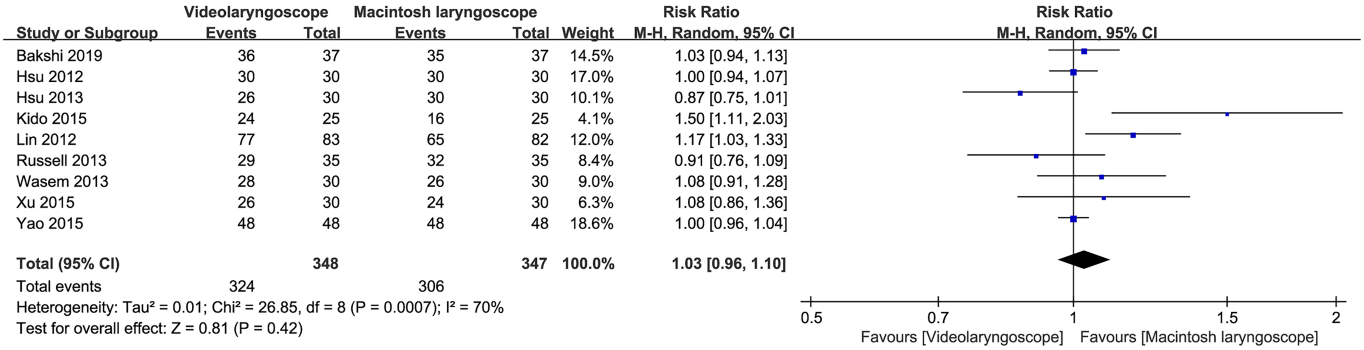

FIGURE 9. Forest plot of videolaryngoscope versus Macintosh laryngoscope for success rate of intubation.

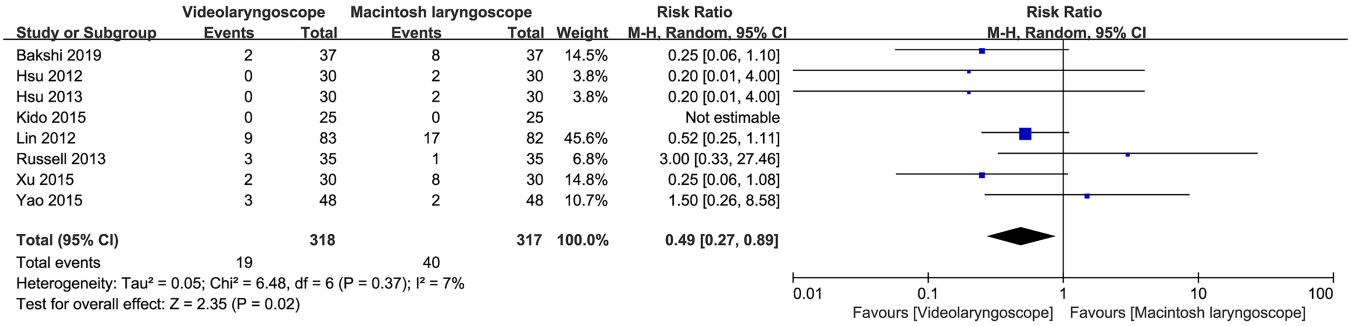

FIGURE 10. Forest plot of videolaryngoscope versus Macintosh laryngoscope for oral injury.

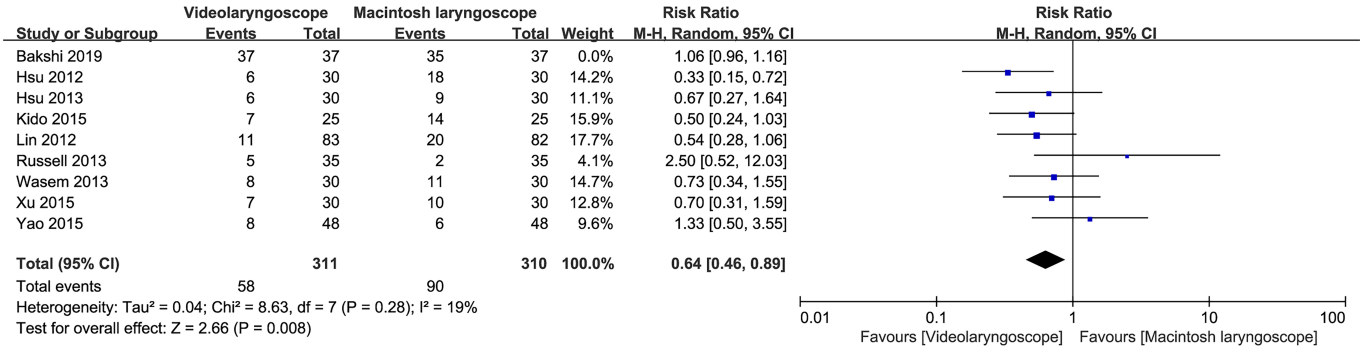

FIGURE 11. Forest plot of sensitivity analysis by excluding high risk studies.

for the incidence of POST in patients undergoing double-lumen tube intubation.

5. Conclusion

The results of this meta-analysis have demonstrated that experienced anesthetist under the guidance of a videolaryngoscope can significantly reduce the risk of POST in patients with double-lumen tube intubation. Therefore, it is necessary to improve the experience of the anesthetist to better complete the double-lumen intubation. Those using the videolaryngoscope experienced a lower incidence of oral injury-related complications. However, there was no advantage over the Macintosh laryngoscope in the reduction of postoperative hoarseness, tube malposition and the success rate at first attempt. More high-quality, large-sample and multi-center RCTs are needed to further evaluate the effect of videolaryngoscope in patients with double-lumen intubation.

AUTHOR CONTRIBUTIONS

WZ and YY designed the study. YY and YL performed data extraction and statistical analyses. WZ, YL and YY drafted and revised the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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