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Standard versus Rotation Technique for Insertion of Supraglottic Airway Devices: Systematic Review and Meta-Analysis

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Purpose: Supraglottic airway devices have been widely utilized as an alternative to tracheal intubation in various clinical situations. The rotation technique has been proposed to improve the insertion success rate of supraglottic airways. However, the clinical efficacy of this technique remains uncertain as previous results have been inconsistent, depending on the variable evaluated.

Materials and Methods: We systematically searched PubMed, Embase, and the Cochrane Central Register of Controlled Trials in April 2015 for randomized controlled trials that compared the rotation and standard techniques for inserting supraglottic airways.

Results: Thirteen randomized controlled trials (1505 patients, 753 with the rotation technique) were included. The success rate at the first attempt was significantly higher with the rotation technique than with the standard technique [relative risk (RR): 1.13; 95% confidence interval (CI): 1.05 to 1.23; p=0.002]. The rotation technique provided significantly higher overall success rates (RR: 1.06; 95% CI: 1.04 to 1.09; p<0.001). Device insertion was completed faster with the rotation technique (mean difference: -4.6 seconds; 95% CI: -7.37 to -1.74; p=0.002). The incidence of blood staining on the removed device (RR: 0.36; 95% CI: 0.27 to 0.47; p<0.001) was significantly lower with the rotation technique.

Conclusion: The rotation technique provided higher first-attempt and overall success rates, faster insertion, and a lower incidence of blood on the removed device, reflecting less mucosal trauma. Thus, it may be considered as an alternative to the standard technique when predicting or encountering difficulty in inserting supraglottic airways.

Key Words: Airway management, complications, laryngeal masks, supraglottic airways

INTRODUCTION

Since the laryngeal mask airway (LMA) Classic first became available, supraglottic airways have been widely utilized for airway management in various clinical situations.[1,2] Compared to tracheal intubation, supraglottic airways may be inserted adequately with relatively less education and training, and healthcare providers unskilled in tracheal intubation have thus recently attempted to insert supraglottic airways for urgent airway care.[3,4]

Insertion of supraglottic airways using the standard technique based on Brain's recommendation is not always successful. Previous studies have reported success rates of 67–93% for the first attempt at inserting supraglottic airways.[5-7] In addition, a degree of skill is required to place supraglottic airways correctly, and suboptimal positioning of the device can give rise to such problems as air leakage or airway obstruction.[8] Given the popularity of supraglottic airways among operators with a wide range of experience, alternative methods are required to improve the likelihood of successful insertion and obtain optimal positioning.[9]

Various techniques have been described to ensure a high successful insertion rate.[2,10,11] Among the alternative methods, the rotation technique derived from the back-to-front insertion technique of the Guedel airway and consists of inserting the

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device with a 90- or 180-degree rotation and then rotating it to the final position as it enters the hypopharynx. Several randomized controlled trials of various types of supraglottic airways have compared the rotation technique to the standard technique, and their results were inconsistent depending on the type of variable that was evaluated.[5,6,8,12-16]

The purpose of this systematic review and meta-analysis was to confirm the clinical efficacy of the rotation technique compared to the standard technique for inserting supraglottic airways.

MATERIALS AND METHODS

This systematic review and meta-analysis is reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) recommendations.[17] A protocol of our study was not registered.

Our systematic review and meta-analysis included prospective randomized controlled trials (RCTs) (including those with crossover designs) that compared standard and 90- or 180-degree rotation techniques for placing supraglottic airways under general anesthesia in adults or children. The typical patterns of the rotation technique were summarized as follows. In the 90-degree rotation technique, the device was introduced into the mouth and then rotated 90 degrees anticlockwise. The device was advanced into the hypopharynx until resistance was felt and then re-rotated clockwise to the standard orientation. In the 180-degree rotation technique, the device was inserted with its lumen facing backwards. The device was advanced into the hypopharynx until resistance was felt and then rotated anticlockwise through 180 degrees.

Two authors (NSB and MSK) independently searched the PubMed, Embase, and Cochrane Central Register of Controlled Trials databases for eligible trials using the following search terms, with no language restriction: "rotation supraglottic airway," "rotational supraglottic airway," "reverse supraglottic airway," "rotation laryngeal mask," "rotational laryngeal mask," "reverse laryngeal mask," "rotation i-gel," "rotational i-gel," and "reverse i-gel." The searches included all studies published up to April 2015. Both authors independently selected the eligible trials. Disagreements over trial selection were resolved via discussion with another author (JSL). References cited in the final selected articles were also examined to seek potentially eligible trials.

From the selected articles, two authors (JHP and JWJ) independently collected the following data: journal name, first author's name, publication year, study design, patient characteristics and number, descriptions of insertion method, first-attempt and overall success rates of insertion, insertion time, oropharyngeal leak pressure (OLP), fiberoptic view, blood staining on the removed device, and complications such as sore throat. The overall success rate was determined according to the criteria for insertion success, such as the number of insertion attempts or time limitation, presented in each trial. When the outcomes were reported as median and total or interquartile range, the mean was estimated from the formula described by Hozo, et al.[18] using the median and the high and low ends of the range for trials with a sample size of less than 25; the median itself was regarded as the mean value for trials with a sample size of more than 25. The standard deviation was also determined from the formula described by Hozo, et al.[18] using the median and the high and low ends of the range for trials with a sample size of less than 15, calculated as the range/4 for trials with a sample size from 15 to 70 and as the range/6 for trials with a sample size greater than 70. Two authors (JHP and MSK) assessed the quality of the studies using the Cochrane Collaboration's tool for grading the risk of bias in several domains, including selection, performance, detection, attrition, and reporting bias.[19] The bias was rated as "low risk," "high risk," or "unclear risk."

Statistical analysis

Comprehensive Meta-Analysis software (version 2.0; Biostat, Englewood, NJ, USA) was used to perform the meta-analyses. If crossover trials were enrolled in this review, we extracted dichotomous or continuous data, which could conservatively be analyzed as parallel group studies. These outcomes were analyzed with outcomes obtained from parallel group studies on the assumption that there was no possibility of a carry-over effect for the outcomes. All statistical outcomes were presented with 95% confidence intervals (CIs). For dichotomous variables, we calculated the relative risk (RR) at the individual trial level and the pooled RR using the Mantel-Haenszel (M-H) method. For continuous variables, we calculated the mean difference (MD) at the individual trial level and the pooled MD using the inverse variance method or the DerSimonian-Laird (D-L) method in a random-effects model. The chi-squared test and the Q-test were conducted to evaluate heterogeneity. When a p value of less than 0.10 on the chi-squared test or an I^2 value of more than 50% was observed, heterogeneity was regarded as substantial, and the random-effects model was applied. Otherwise, the fixed-effect model was applied. Subgroup analyses were performed based on the rotation angles and ages of the enrolled patients. In pooled analyses with substantial heterogeneity (I^2 more than 50%), sensitivity analyses to assess the effects of individual trials were conducted by removing each trial from the analysis. Visual observations of funnel plots and Egger's linear regression test were performed to assess the possibility of publication bias for outcomes obtained from more than three studies. An asymmetric funnel plot and a p value of less than 0.10 on Egger's test indicated the possible presence of publication bias.

RESULTS

Our electronic database searching and study selection process

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is described in Fig. 1. From the references cited in the 12 articles retrieved from the database searches, we found one additional eligible trial.[9] Therefore, we included and analyzed 13 RCTs (1505 patients, 753 with the rotation technique),[5-10,12-16,20,21] one of which was a crossover trial.[20] Characteristics and outcomes of the included articles are summarized in Table 1. Four types of supraglottic airways were used in the included trials: LMA Classic,[7-9,12,13,16,20] LMA Proseal,[6,10,15,21] SoftSeal,[14] and i-gel.[5] In six trials conducted in pediatric patients, the rotation angles were 90 and 180 degrees in one[6] and five studies,[7,12,13,15,20] respectively. In the remaining seven adult trials, the rotation angles were 90 and 180 degrees in three[5,10,21] and four studies,[8,9,14,16] respectively. In six enrolled trials, jaw relaxation[7,8,12-14,20] or ventilation pattern[7,20] was described as clinical judgment of adequate anesthetic depth for device insertion. The sniffing position,[5,6,10] head extension and neck flexion,[7,8,12,13,20] the head resting on a 3-cm pillow,[21] and the triple airway maneuver including head extension, mouth opening, and jaw thrust[14] were mentioned as the positions for device insertions in the enrolled studies.

In Ghai's 2008 study,[7] a lateral technique using a 45-degree rotation was also compared; however, outcomes from that technique were not included in the current meta-analysis. One study, which was published as correspondence, did not specify the rotation angle in the manuscript,[15] although the angle was determined from the reference cited in the article.[12] The risks of bias are summarized in Fig. 2.

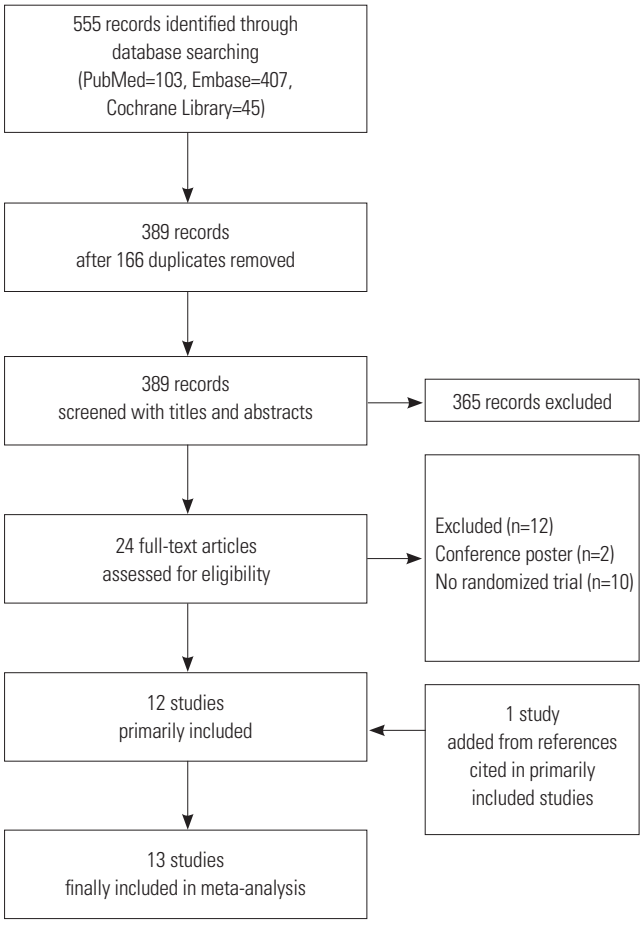

Fig. 1. Flow diagram showing the trial selection process.

Ten studies provided data regarding the insertion success rate at the first attempt.[5-10,12,14,20,21] A pooled analysis from these studies showed that the insertion success rate at the first attempt using the rotation technique was significantly higher than that using the standard technique (RR: 1.13; 95% CI: 1.05 to 1.23; p=0.002; I^2=74%; M-H random). We conducted subgroup analyses for the rotation angles and age (Table 2). Subgroup analyses of four studies using 90-degree rotation[5,6,10,21] and the four studies conducted in children[6,7,12,20] indicated superior results for the rotation technique and reduced heterogeneity. However, we did not know differences between the rotation and standard insertion techniques in the subgroup analysis of the six studies using 180-degree rotation[7-9,12,14,20] and the six studies conducted in adults.[5,8-10,14,21] In the subgroup analysis of the three studies using 90-degree rotation in adult patients[5,10,21] and the three studies using 180-degree rotation in children,[7,12,20] better results with no heterogeneity were shown using the rotation technique. However, a subgroup analysis of the three studies using 180-degree rotation in adult patients[8,9,14] did not demonstrate an improved success rate with the rotation technique. In the sensitivity analyses, removal of Kuvaki's study[14] from the pooled analysis reduced the heterogeneity (RR: 1.18; 95% CI: 1.13 to 1.23; p<0.001; I^2=26%; M-H fixed). All included studies reported overall insertion success rates. The rotation technique provided significantly higher overall success rates (RR: 1.06; 95% CI: 1.04 to 1.09; p<0.001; I^2=10%; M-H fixed). Forest plots of the analyses of insertion success rates are depicted in Fig. 3.

The results of subgroup analyses for the insertion success rate according to the type of supraglottic airway and the use of neuromuscular blocking drugs are summarized in Table 3. In the subgroup analysis for no use of muscle relaxants, we could not confirm a better result for the insertion success rate at the first attempt in the rotation technique. When Kuvaki's study[14] was removed from this subgroup, a significantly better result with reduced heterogeneity was observed for the rotation technique (RR: 1.17; 95% CI: 1.11 to 1.24; p<0.001; I^2=23%; M-H fixed). In a pooled analysis of second-attempt insertions obtained from eight studies,[5-9,12,14,20] a higher insertion success rate for the rotation technique was observed compared to the standard technique (RR: 1.42; 95% CI: 1.08 to 1.86; p=0.011; I^2=0%; M-H fixed). The insertion failure rate in the rotation group was significantly lower than that in the standard group (RR: 0.25; 95% CI: 0.13 to 0.47; p<0.001; I^2=33%; M-H fixed). The mean number of insertion attempts for successful device insertion in the rotation group was significantly lower than that in the standard group (1.17 vs. 1.60; p=0.001).

Insertion time was investigated in 11 studies.[5-10,12,14,15,20,21] In one study,[8] the outcomes were categorized using 30 seconds as the cut-off time, and there were no significant differences between the two techniques. Thus, a pooled analysis was per-

Table 1. Characteristics and Outcomes of Randomized Controlled Trials Included in the Meta-Analysis

Trials	Airway & size	Airway size	Participants	Number of patients per group	Age (yr)	Experience of device provider	Outcomes	Cuff inflation before insertion	Use of NMB
Kim, et al.[5]	i-gel	3, 4	Adults	91 to standard 90 to 90° rotation	65.2 (10.8) 66.6 (9.0)	>300 i-gel insertions	First-attempt and overall success rate of insertion, insertion time, manipulation required, OLP, fiberoptic grade, blood on the removed device, sore throat at the day of surgery and the next day	-	Yes
Kumar, et al.[8]	Classic	3, 4	Adults	50 to standard 50 to 180° rotation	41.68 (14.07) 39.88 (14.24)	>200 LMA insertions in adults	First-attempt and overall success rate of insertion, insertion time, blood on the removed device, laryngospasm, desaturation	No	No
Yun, et al.[6]	Proseal	2, 2.5, 3	Children aged 3 to 9 yrs	63 to standard 63 to 90° rotation	6 (2) 6 (2)	>50 Proseal insertions in children	First-attempt and overall success rate of insertion, insertion time, OLP, blood on the removed device, sore throat and hoarseness on the day of surgery	No	Yes
Ghai, et al.[20]	Classic	1, 1.5, 2, 2.5	Children aged 2.5 months to 10 yrs	78 to standard 78 to 180° rotation (crossover)	4.35 (3.71)	>100 LMA insertions in children	First-attempt and overall success rate of insertion, insertion time, fiberoptic grade, blood on the removed device, maneuvers used to relieve airway obstruction, laryngospasm, desaturation	No in standard group, yes in rotation group	No
Jeon, et al.[21]	Proseal	4, 5	Adults	60 to standard 60 to 90° rotation	50 (13) 48 (11)	>50 insertions by rotation technique and >100 insertions by standard technique	First-attempt and overall success rate of insertion, insertion time, OLP, blood on the removed device, sore throat on the day of surgery	No	Yes
Haghighi, et al.[9]	Classic	4, 5	Adults	50 to standard 50 to 180° rotation	30 (9.4) 32 (7.9)	>100 LMA insertions	First-attempt and overall success rate of insertion, insertion time, leak around the cuff, gastric insufflation, blood on the removed device, laryngospasm, desaturation	No	Sch
Hwang, et al.[10]	Proseal	3	Adults	80 to standard 80 to 90° rotation	44 (12) 42 (10)	>500 insertions by standard technique	First-attempt and overall success rate of insertion, insertion time, manipulation required, blood on the removed device, sore throat on the day of surgery	No	No
Kuvaki, et al.[14]	Softseal	4, 5	Adults	48 to standard 50 to 180° rotation	42.2 (16) 46.7 (18)	>10 yrs of anesthetic experience	First-attempt and overall success rate of insertion, insertion time, fiberoptic grade, blood on the removed device, sore throat on the next day	No	No
Ghai, et al.[7]	Classic	1, 1.5, 2, 2.5	Children aged 6 months to 6 yrs	56 to standard 56 to 180° rotation	4.14 (2.93) 3.29 (2.31)	>100 LMA insertions in children	First-attempt and overall success rate of insertion, insertion time, blood on the removed device, maneuvers used to relieve airway obstruction, laryngospasm, desaturation	No in standard group, yes in rotation group	No

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Table 1. Characteristics and Outcomes of Randomized Controlled Trials Included in the Meta-Analysis (Continued)

Trials	Airway & Size	Airway size	Participants	Number of patients per group	Age (yr)	Experience of device provider	Outcomes	Cuff inflation before insertion	Use of NMB
Watanabe, et al.[15]	Proseal	2	Children using Proseal size 2	40 to standard 40 to 180° rotation	2.93 (1.34) 3.0 (1.13)	Unknown	Overall success rate of insertion, insertion time, blood on the removed device	Unknown	Unknown
Nakayama, et al.[12]	Classic	2	Children aged 10 months to 7 yrs	75 to standard 70 to 180° rotation	3.0 (1.6) 3.0 (1.3)	Insertion experience only by standard technique	First-attempt and overall success rate of insertion, insertion time, blood on the removed device, maneuvers used to relieve airway obstruction, laryngospasm, desaturation	Yes	No
Soh and Ng[13]	Classic	1.5, 2, 2.5, 3	Children aged 1 to 15 yrs	31 to standard 36 to 180° rotation	5.04 5.41	Experienced provider	Overall success rate of insertion, fiberoptic grading, blood on the removed device	No	No
Brimacombe and Berry[16]	Classic	3, 4	Adults	30 to standard 30 to 180° rotation	54 (24) 53 (21)	>500 LMA insertions with experience of both technique	Overall success rate of insertion, fiberoptic grading, blood on the removed device, sore throat and hoarseness on the next day	No	No

NMB, neuromuscular blocking drug; OLP, oropharyngeal leak pressure; LMA, laryngeal mask airway; Sch, succinylcholine; SD, standard deviation.
Values are number and mean (SD).

formed using the results of ten studies reporting insertion time as a continuous variable. When using the rotation technique, device insertion was established more rapidly (MD: -4.6 seconds; 95% CI: -7.37 to -1.74; p=0.002; I^2=95%; D-L random) (Fig. 4). A subgroup analysis of four studies with 90-degree rotation resulted in a greater MD yet similar heterogeneity (MD: -6.49 seconds; 95% CI: -10.97 to -2.01; p=0.005; I^2=84%; D-L random).[5,6,10,21] A subgroup analysis of five adult studies showed similar results (MD: -6.14 seconds; 95% CI: -10.65 to -1.63; p=0.008; I^2=93%; D-L random).[5,9,10,14,21] However, we did not know differences in insertion time during subgroup analyses involving 180-degree rotation[7,9,12,14,15,20] and children.[6,7,12,15,20] In addition, the substantial heterogeneity of the pooled results was not resolved via sensitivity analyses. The incidence of manipulations required for successful insertion was reported in two studies involving 90-degree rotation and adults;[5,10] however, we did not know a decrease in the incidence in the rotation technique (RR: 0.59; 95% CI: 0.34 to 1.05; p=0.074; I^2=54%; M-H random). Blood staining on the airway device at removal was investigated in 12 studies.[5-10,12-15,20,21] One additional study[16] evaluated the presence of blood via fiberoptic visualization, and their results were included in the pooled analysis. The incidence of blood staining using the rotation technique was significantly lower than that observed with the standard technique (RR: 0.36; 95% CI: 0.27 to 0.47; p<0.001; I^2=37%; M-H fixed). Fig. 4 shows the forest plots for the pooled analyses of insertion time and blood staining on the removed airway device. The results of subgroup analyses for insertion time and blood staining on the removed device according to the type of supraglottic airway and the use of neuromuscular blocking drug are summarized in Table 4.

Three studies evaluated OLP,[5,6,21] and we did not know a difference in OLP between the two techniques (MD: 2.0 cmH_2O; 95% CI: -0.55 to 4.54; p=0.125; I^2=73%; IV random). One study[9] assessed the incidence of gastric insufflation and leakage around the cuff, detected by applying 20 cmH_2O pressure instead of OLP measurement, and there were no differences in these variables between the rotation and standard techniques. Five studies graded the fiberoptic view.[5,13,14,16,20] Due to differences in the grading scales among the studies, we analyzed the frequencies of the view in which only vocal cords were visible.[22] The rotation technique produced superior results; however, we did not know a difference between the two techniques (RR: 1.54; 95% CI: 0.87 to 2.75; p=0.140; I^2=82%; M-H random).

Maneuvers used to relieve airway obstruction were reported in three studies involving 180-degree rotation and children,[7,12,20] and the rotation technique significantly reduced the need for these maneuvers (RR: 0.32; 95% CI: 0.14 to 0.72; p=0.006; I^2=0%; M-H fixed). The occurrence of laryngospasm was recorded in two studies involving 180-degree rotation and children;[7,20] its incidence was significantly lower when using the rotation technique (RR: 0.09; 95% CI: 0.01 to 0.69; p=0.021; I^2=0%; M-H fixed). One study reported two desaturation events, both of which occurred with the standard technique.[20]

The incidence of postoperative sore throat on the day of surgery and the next day were assessed in four[5,6,10,21] and three studies,[5,14,16] respectively. We did not know differences in the incidences at both time points (RR: 0.66; 95% CI: 0.37 to 1.19; p=0.163; I^2=66%; M-H random; and RR: 0.80; 95% CI: 0.56 to 1.15; p=0.230; I^2=0%; M-H fixed, respectively). Postoperative hoarseness was reported in one study,[16] in which it was observed only in two patients with the rotation technique.

Egger's test revealed that publication bias was not observed in the following outcomes: success rate of the first attempt (p=0.423); overall insertion success rate (p=0.918); insertion time (p=0.135); fiberoptic views (p=0.261); maneuvers used to relieve airway obstruction (p=0.660); blood staining on the device at removal (p=0.905); and sore throat on the day after surgery (p=0.604). However, the possibility of publication bias was identified for sore throat on the day of surgery (p=0.096).

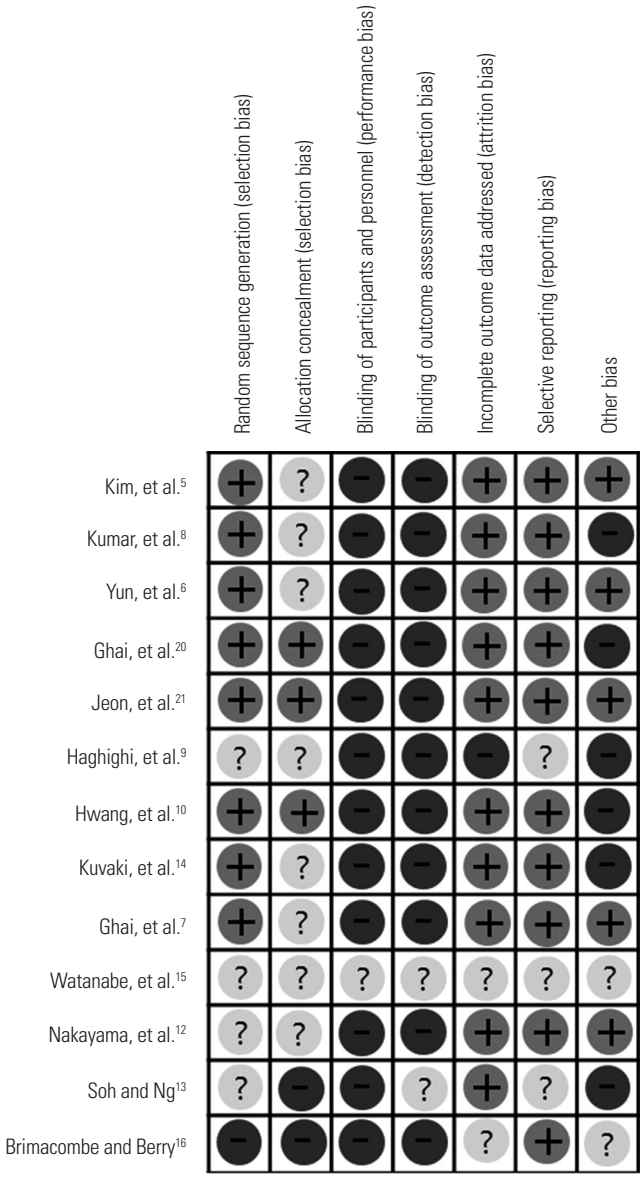

Fig. 2. Investigations of the risk of bias in the included studies (light grey: low risk of bias, ash: uncertain risk of bias, grey: high risk of bias).

DISCUSSION

Our meta-analysis revealed that the rotation technique for inserting supraglottic airways produced a higher success rate of device insertion, a shorter insertion time, and a lower incidence of airway obstruction, laryngospasm, and blood staining on the removed device, compared to the standard technique. However, we could not confirm superior results for OLP, fiberoptic view, or postoperative sore throat.

Insertion success at the first attempt is an essential parameter in the evaluation of supraglottic airways when considering their critical role in maintaining airway patency and oxygenation. During anesthesia induction, multiple attempts at device insertion can lead to prolonged apnea, insufficient depth of anesthesia, and mucosal injury that may result in hypoxia, laryngospasm, or sore throat.[5,7] A higher insertion success rate at the first attempt is particularly necessary in emergency situations in which the oxygen reserve is insufficient.[23] In this regard, the success rates at the first attempt were assessed primarily in this review. In addition, comparisons of the second-attempt success rate and mean insertion attempts for insertion success were also performed to provide more detailed information. Airway management after device insertion failure at the first attempt may be also important under general anesthesia with sufficient monitoring and oxygenation. Given the higher second attempt success rate and the fewer attempts for successful insertion in the rotation technique, the rotation technique could be more effective when device insertion is unsuccessful on the first attempt.

The primary cause of incorrect positioning and insertion failure with supraglottic airways is impaction at the posterior portion of the tongue by posterior displacement or folding of the tongue, as supraglottic airways inserted using the standard technique with a midline path advance over the tongue.[7,10,24] Rotation techniques using a 90- or 180-degree angle may alleviate this obstacle during airway insertion by decreasing resistance between the airway and the tongue.[12] In this meta-analysis, most of the included studies reported higher or comparable success rates during the first attempt at insertion using a rotation technique, and only Kuvaki's study using an adult-sized SoftSeal device reported a significantly lower success rate using a 180-degree rotation technique.[14] Heterogeneity of the pooled analysis for the first attempt success rate (I^2=74%) may be derived from this contrasting result, as a substantial reduction in heterogeneity (I^2=26%) was noted in the sensitivity analysis performed without Kuvaki's study. Structural features of SoftSeal and differences in the insertion process could affect the heterogeneity. SoftSeal differs from the LMA Classic in that it is produced from polyvinyl chloride and has a semi-rigid, wider,

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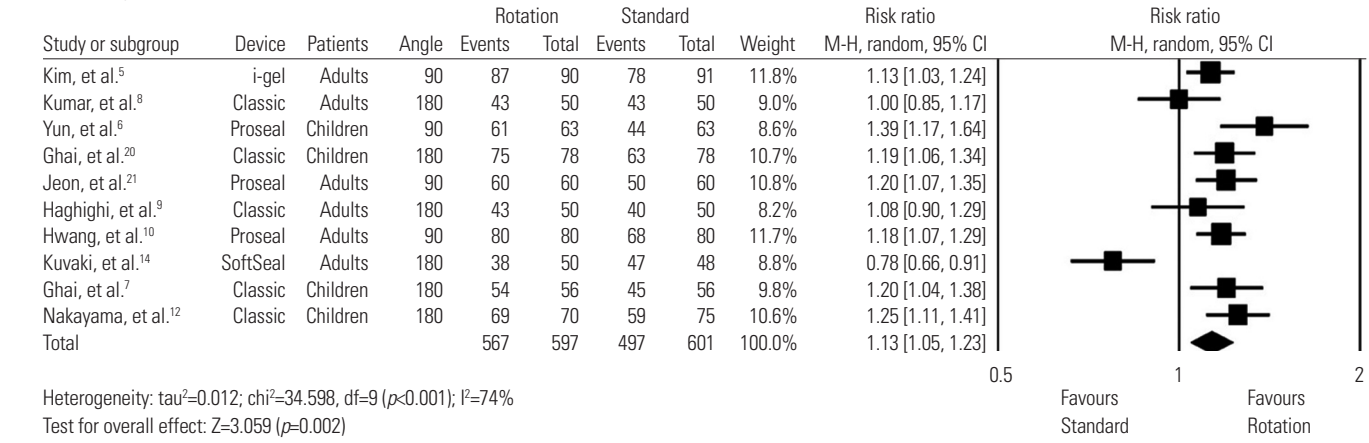
and more curved shaft and a rounder cuff.[14,25] For the included studies involving the LMA Classic or Proseal, the standard insertion technique was conducted using the index finger according to Brain's technique or the manufacturer's instructions. However, Kuvaki, et al.[14] inserted the SoftSeal without intra-oral digital manipulation, using the method proposed by Brima-

Table 2. Subgroup Analyses for Insertion Success Rate at the First Attempt According to the Rotation Angles and Age

Subgroup	Number	Risk ratio	*p* value	I^2 value	Model
90 degrees	4	1.20 (1.14 to 1.27)	<0.001	38%	M-H fixed
180 degrees	6	1.08 (0.94 to 1.23)	0.296	82%	M-H random
Children	4	1.25 (1.17 to 1.34)	<0.001	0%	M-H fixed
Adults	6	1.06 (0.95 to 1.19)	0.323	79%	M-H random
90 degrees in children	1	1.39 (1.17 to 1.64)	<0.001	100%	M-H random
90 degrees in adults	3	1.16 (1.1 to 1.23)	<0.001	0%	M-H fixed
180 degrees in children	3	1.22 (1.13 to 1.31)	<0.001	0%	M-H fixed
180 degrees in adults	3	0.94 (0.77 to 1.14)	0.528	76%	M-H random

M-H, Mantel-Haenszel.



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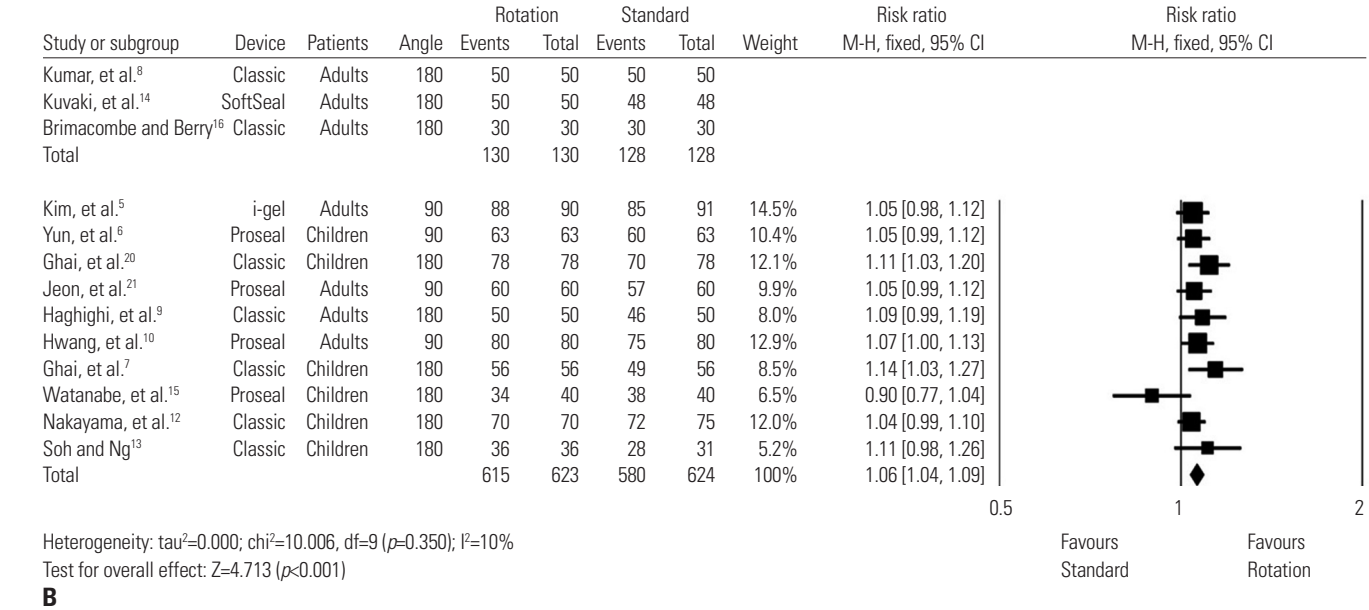

B

Fig. 3. Forest plots of the first attempt (A) and overall (B) insertion success rate comparing the rotation and standard techniques. M-H, Mantel-Haenszel; CI, confidence interval.

combe and Keller[26] involving the triple airway maneuver (head extension, mouth opening, and jaw thrust). The authors stated that the use of this maneuver could facilitate placement of the LMA and thus improve the first-attempt success rate in the standard technique group.[14,27] In addition, they also commented on the point at which the supraglottic airway must be rotated toward its final direction as a factor influencing the insertion success in the rotation group. Device rotation should be attempted after the tip of the supraglottic airway has passed the tongue base or when the operator feels resistance while advancing the device toward the hypopharynx.[14] Hence, the unique results from Kuvaki's study might have been attributed to their insertion method and time of rotation during the insertion process, which may have also accounted for the heterogeneity in the pooled analysis. In addition, no evidence of any difference in the insertion success rate at the first attempt during the subgroup analysis of the three studies using 180-degree rotation in adults could be derived from the conflicting results of Kuvaki's study. From the remaining two studies included in this subgroup,[8,9] the improved success rates were not observed at the individual trial level. Given these results, the clinical efficacy of the 180-degree rotation technique was not proven in this review.

Insertion time for the supraglottic airways is closely associated with the number of insertion attempts, and accordingly, the higher first-attempt success rate may enable a shorter insertion time.[5] In our meta-analysis, the use of the rotation technique reduced the time for insertion significantly, although there was substantial heterogeneity. Wide ranges of MD (-14.00 to 1.87 seconds) at the individual study level deriving from differences in patient characteristics, definition of insertion time, and the type and size of supraglottic airway might have been responsible for the heterogeneity. Interestingly, device insertion in Kuvaki's study was established significantly faster in the rotation group despite its lower first-attempt success rate.[14] The authors suggested that insertion with the rotation technique was very fast if the airway was rotated at the proper time.[14]

Blood staining on the removed supraglottic airway has been investigated as an indicator of pharyngeal mucosal injury, which may promote the development of a postoperative sore throat.[12,28] There might be the criticism that the rotation technique could increase the likelihood of mucosal injury.[5,12,29] All of the included studies reported results regarding blood found on the removed device or observed during fiberoptic visualization, and the rotation technique significantly decreased the incidence of the presence of blood. Smooth advancement of a supraglottic device due to reduced resistance between the airway and the pharyngeal wall could be responsible for less injury to the upper airway tissues. However, the lower incidence of detected blood did not lead to a reduced incidence of sore throat in this meta-analysis. Additional factors such as intracuff pressure, the use of lubrication, and the operator's skill could also be associated with the development of sore throat.[8,14]

Placement of a supraglottic airway into the correct position is important for several functions, such as ensuring adequate ventilation, sealing and protecting the airway, and acting as a conduit for tracheal intubation.[5,30,31] The position of supraglottic airways in relation to the vocal cords has been evaluated by fiberoptic visualization.[5,20,32] Recently, improved fiberoptic views with only the vocal cords visible have been emphasized in order to allow utilization of these devices as conduits for tracheal intubation in difficult intubation situations.[33] Smooth sliding during insertion with minimization of resistance and tongue folding during the rotation technique might help position supraglottic airways correctly.[20] However, significant improvement in the fiberoptic view using the rotation technique was not confirmed in our meta-analysis. Further evaluation regarding the device position after insertion using the rotation technique is warranted, as significantly better results were reported by some of the included studies.[5,20]

Table 3. Subgroup Analyses for the Insertion Success Rate According to Type of Supraglottic Airway and Use of Neuromuscular Blocking Drug

Subgroup	Number	Risk ratio	*p* value	I^2 value	Model
First attempt success rate					
i-gel	1	1.13 (1.03 to 1.24)	0.011	100%	M-H random
Classic	5	1.16 (1.09 to 1.23)	<0.001	34%	M-H fixed
Proseal	3	1.24 (1.15 to 1.33)	<0.001	38%	M-H fixed
Softseal	1	0.78 (0.66 to 0.91)	0.002	100%	M-H random
Use of NMB	4	1.19 (1.11 to 1.27)	<0.001	47%	M-H fixed
No use of NMB	6	1.09 (0.97 to 1.24)	0.157	82%	M-H random
Overall success rate*					
i-gel	1	1.05 (0.98 to 1.12)	0.154	100%	M-H random
Classic	5	1.09 (1.05 to 1.14)	<0.001	6%	M-H fixed
Proseal	4	1.03 (0.99 to 1.07)	0.129	45%	M-H fixed
Use of NMB	4	1.06 (1.02 to 1.09)	0.002	0%	M-H fixed
No use of NMB	5	1.09 (1.05 to 1.13)	<0.001	8%	M-H fixed

NMB, neuromuscular blocking drug; M-H, Mantel-Haenszel.
*Overall insertion success rate between the two insertion methods was identical in the study with SoftSeal.

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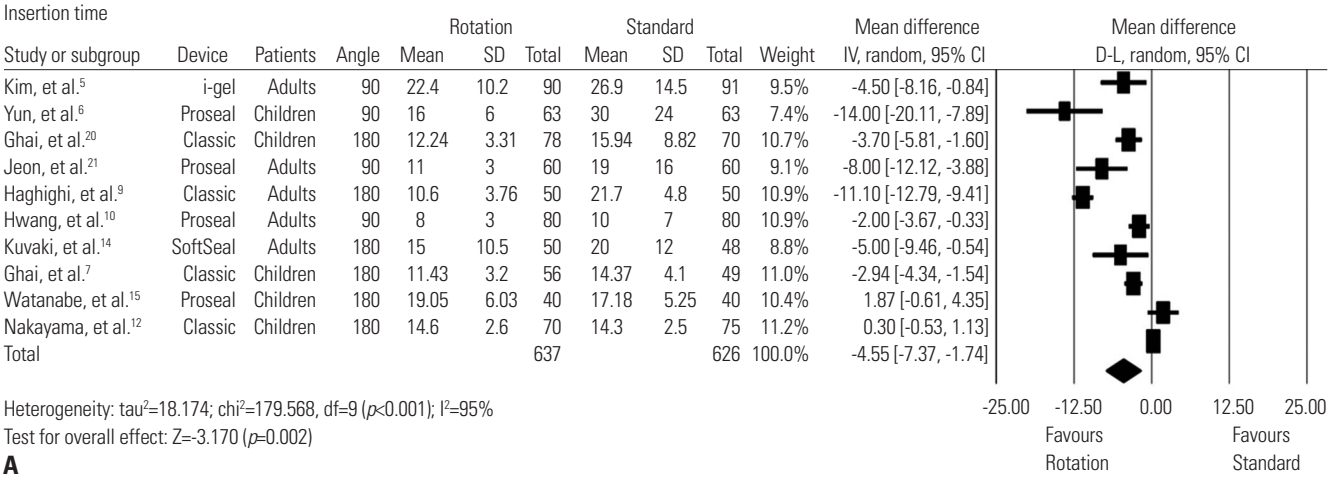

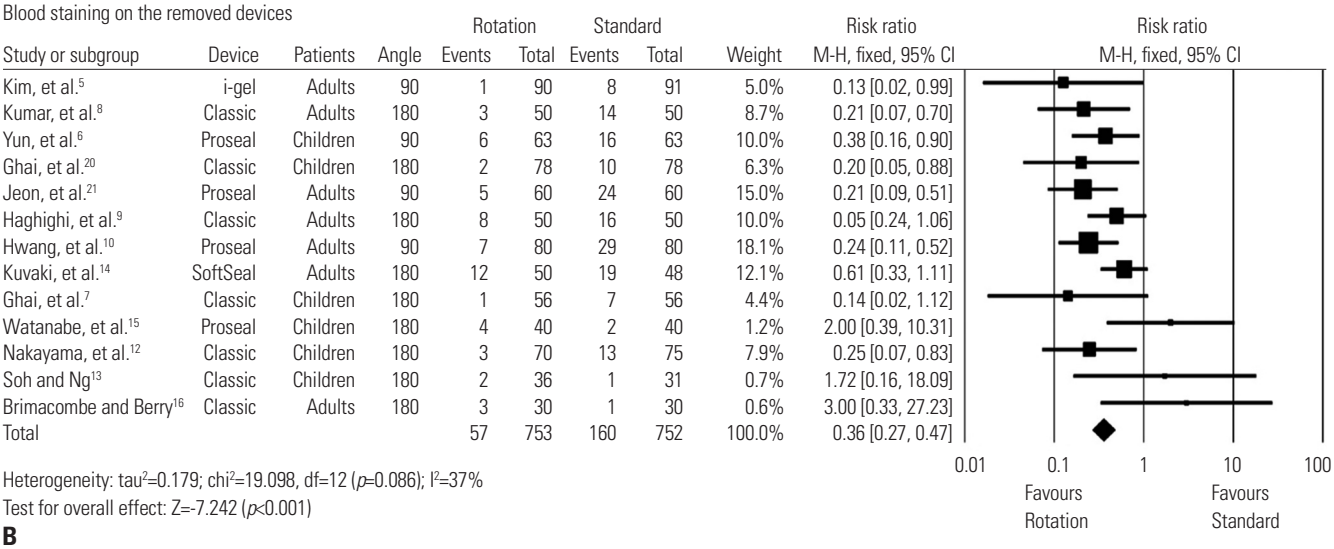

Fig. 4. Forest plots of insertion time (A) and blood staining on the removed devices (B) comparing the rotation and standard techniques. M-H, Mantel-Haenszel; CI, confidence interval.

Table 4. Subgroup Analyses for Insertion Time and Blood Staining on the Removed Devices According to Type of Supraglottic Airway and Use of Neuromuscular Blocking Drug

Subgroup	Number	Mean difference	*p* value	I^2 value	Model
Insertion time					
i-gel	1	-4.50 (-8.16 to -0.84)	0.016	0%	IV fixed
Classic	4	-4.33 (-9.19 to 0.53)	0.08	98%	D-L random
Proseal	4	-4.84 (-9.82 to 0.14)	0.057	91%	D-L random
SoftSeal	1	-5.00 (-9.46 to -0.54)	0.028	0%	IV fixed
Use of NMB	4	-9.16 (-12.85 to -5.48)	<0.001	77%	D-L random
No use of NMB	5	-2.31 (-4.25 to -0.37)	0.02	85%	D-L random
Subgroup	**Number**	**Risk ratio**	***p* value**	**I^2 value**	**Model**
Blood staining on the removed devices					
i-gel	1	0.13 (0.02 to 0.99)	0.049	0%	M-H fixed
Classic	7	0.36 (0.23 to 0.57)	<0.001	29%	M-H fixed
Proseal	4	0.35 (0.17 to 0.71)	0.003	53%	M-H random
SoftSeal	1	0.61 (0.33 to 1.11)	0.105	100%	M-H random
Use of NMB	4	0.31 (0.20 to 0.50)	<0.001	6%	M-H fixed
No use of NMB	8	0.35 (0.24 to 0.50)	<0.001	40%	M-H fixed

NMB, neuromuscular blocking drug; D-L, DerSimonian-Laird; M-H, Mantel-Haenszel.

There are several limitations that should be considered in our systematic review and meta-analysis. First, this systematic review contained the results with substantial heterogeneity. Many factors including type of device, experience of provider, anesthetic depth, use of neuromuscular blocking drugs, and patient age could cause heterogeneous outcomes of pooled analyses. The trials included in this meta-analysis inserted four types of supraglottic airways, and the specific features of each device could have led to the heterogeneous results. The i-gel has a characteristic non-inflatable cuff which is slightly more rigid and bulkier than those of other devices before cuff inflation.[5] However, the results from subgroup analyses of the i-gel were similar to those of the LMA Classic or Proseal. Although the trial inserting SoftSeal provided somewhat different results,[14] the aforementioned issues such as the triple airway maneuver and the timing of rotation during the insertion process should be considered together. Given that devices were inserted by skilled anesthesiologists under general anesthesia, the impact of provider skill and anesthetic depth might have been limited. Subgroup analyses showed that the rotation technique had significantly better results for overall success rate, insertion time, and blood staining on the removed device regardless of the use of muscle relaxant. In the analysis of the subgroup without neuromuscular blocking drugs performed after removal of Kuvaki's study, the significantly better result with reduced heterogeneity for insertion success rate at the first attempt was also confirmed in the rotation technique. Our review included the studies conducted in adults as well as children; thus, differences in airway anatomy depending on patient age could have had an effect on the results when comparing the two methods. Subgroup analyses according to patient age were performed for the insertion success rate at the first attempt and insertion time, considering anatomical differences between children and adults. However, the clinical significance of patient age and anatomical difference was beyond the scope of this study and remains to be proven. Second, the avoidance of performance and detection bias was not possible in our enrolled studies. Blinding of operators and investigators was not possible in situations of airway management.[34] Third, in contrast to parameters such as the insertion success rate and blood staining on the device, the number of studies available for the pooled analyses of OLP, fiberoptic view, and complications was relatively small. These parameters were mainly related to the performance of supraglottic airways. Further evidence is needed to validate the usefulness of the rotation technique with respect to functional perspectives and complications. Fourth, outcomes from one crossover trial were analyzed as parallel group studies on the assumption that there was no carry-over effect. Fifth, we could not confirm detailed causes for insertion failure at each insertion attempt from enrolled studies in this review. However, given that the device was successfully inserted with the rotation technique at the second or third attempt in most cases with insertion failure at the first attempt, it is assumed that the primary cause of insertion failure in this review could also be impaction at the back of the mouth due to tongue folding, as described in previous articles.[24,35] Finally, the number of the articles included in this review was relatively small. In addition, undetected ongoing studies and published papers from the electronic databases may have altered the findings of our meta-analysis.

In conclusion, the rotation technique provided a higher success rate on the first attempt, a higher overall insertion success rate, more rapid insertion, and a lower incidence of blood on the removed device, reflecting less mucosal trauma. It, therefore, may be considered as an alternative to the standard technique when predicting or encountering difficulty with inserting supraglottic airways. However, the clinical efficacy of the 180-degree rotation technique in adult and the superiority of the rotation technique with respect to performance and complications were not confirmed in this meta-analysis, and additional evidence should be accumulated through further research.

REFERENCES

1. Ali A, Canturk S, Turkmen A, Turgut N, Altan A. Comparison of the laryngeal mask airway Supreme and laryngeal mask airway Classic in adults. Eur J Anaesthesiol 2009;26:1010-4.
2. An J, Shin SK, Kim KJ. Laryngeal mask airway insertion in adults: comparison between fully deflated and partially inflated technique. Yonsei Med J 2013;54:747-51.
3. Chen L, Hsiao AL. Randomized trial of endotracheal tube versus laryngeal mask airway in simulated prehospital pediatric arrest. Pediatrics 2008;122:e294-7.
4. Goliasch G, Ruetzler A, Fischer H, Frass M, Sessler DI, Ruetzler K. Evaluation of advanced airway management in absolutely inexperienced hands: a randomized manikin trial. Eur J Emerg Med 2013;20:310-4.
5. Kim HC, Yoo DH, Kim HJ, Jeon YT, Hwang JW, Park HP. A prospective randomised comparison of two insertion methods for i-gel placement in anaesthetised paralysed patients: standard vs. rotational technique. Anaesthesia 2014;69:729-34.
6. Yun MJ, Hwang JW, Park SH, Han SH, Park HP, Kim JH, et al. The 90° rotation technique improves the ease of insertion of the ProSeal™ laryngeal mask airway in children. Can J Anaesth 2011;58:379-83.
7. Ghai B, Makkar JK, Bhardwaj N, Wig J. Laryngeal mask airway insertion in children: comparison between rotational, lateral and standard technique. Paediatr Anaesth 2008;18:308-12.
8. Kumar D, Khan M, Ishaq M. Rotational vs. standard smooth laryngeal mask airway insertion in adults. J Coll Physicians Surg Pak 2012;22:275-9.
9. Haghighi M, Mohammadzadeh A, Naderi B, Seddighinejad A, Movahedi H. Comparing two methods of LMA insertion; classic versus simplified (airway). Middle East J Anaesthesiol 2010;20:509-14.
10. Hwang JW, Park HP, Lim YJ, Do SH, Lee SC, Jeon YT. Comparison of two insertion techniques of ProSeal laryngeal mask airway: standard versus 90-degree rotation. Anesthesiology 2009;110:905-7.
11. Ghai B, Wig J. Comparison of different techniques of laryngeal mask placement in children. Curr Opin Anaesthesiol 2009;22:400-4.
12. Nakayama S, Osaka Y, Yamashita M. The rotational technique with a partially inflated laryngeal mask airway improves the ease of insertion in children. Paediatr Anaesth 2002;12:416-9.

http://dx.doi.org/10.3349/ymj.2016.57.4.987

13. Soh CR, Ng AS. Laryngeal mask airway insertion in paediatric anaesthesia: comparison between the reverse and standard techniques. Anaesth Intensive Care 2001;29:515-9.
14. Kuvaki B, Küçükgüçlü S, Iyilikçi L, Tuncali BE, Cinar O. The Soft Seal disposable laryngeal mask airway in adults: comparison of two insertion techniques without intra-oral manipulation. Anaesthesia 2008;63:1131-4.
15. Watanabe K, Nakayama S, Yamashita M. The rotational technique with ProSeal laryngeal mask airway does not improve the ease of insertion in children. Paediatr Anaesth 2006;16:598-9.
16. Brimacombe J, Berry A. Insertion of the laryngeal mask airway--a prospective study of four techniques. Anaesth Intensive Care 1993; 21:89-92.
17. Moher D, Liberati A, Tetzlaff J, Altman DG; PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med 2009;6:e1000097.
18. Hozo SP, Djulbegovic B, Hozo I. Estimating the mean and variance from the median, range, and the size of a sample. BMC Med Res Methodol 2005;5:13.
19. Higgins JP, Altman DG, Gøtzsche PC, Jüni P, Moher D, Oxman AD, et al. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. BMJ 2011;343:d5928.
20. Ghai B, Ram J, Makkar JK, Wig J. Fiber-optic assessment of LMA position in children: a randomized crossover comparison of two techniques. Paediatr Anaesth 2011;21:1142-7.
21. Jeon YT, Na HS, Park SH, Oh AY, Park HP, Yun MJ, et al. Insertion of the ProSeal laryngeal mask airway is more successful with the 90 degrees rotation technique. Can J Anaesth 2010;57:211-5.
22. Maitra S, Khanna P, Baidya DK. Comparison of laryngeal mask airway Supreme and laryngeal mask airway Pro-Seal for controlled ventilation during general anaesthesia in adult patients: systematic review with meta-analysis. Eur J Anaesthesiol 2014;31:266-73.
23. Ruetzler K, Roessler B, Potura L, Priemayr A, Robak O, Schuster E, et al. Performance and skill retention of intubation by paramedics using seven different airway devices--a manikin study. Resuscitation 2011;82:593-7.
24. Taxak S, Gopinath A. Insertion of the i-gel airway obstructed by the tongue. Anesthesiology 2010;112:500-1.
25. Cook TM, Trümpelmann P, Beringer R, Stedeford J. A randomised comparison of the Portex Softseal laryngeal mask airway with the LMA-Unique during anaesthesia. Anaesthesia 2005;60:1218-25.
26. Brimacombe J, Keller C. Insertion of the LMA-Unique with and without digital intraoral manipulation by inexperienced personnel after manikin-only training. J Emerg Med 2004;26:1-5.
27. Aoyama K, Takenaka I, Sata T, Shigematsu A. The triple airway manoeuvre for insertion of the laryngeal mask airway in paralyzed patients. Can J Anaesth 1995;42:1010-6.
28. Lee JJ. Laryngeal mask and trauma to uvula. Anaesthesia 1989;44: 1014-5.
29. Brain AI. An evaluation of the laryngeal mask airway during routine paediatric anaesthesia. Paediatr Anaesth 1995;5:75.
30. Choi KW, Lee JR, Oh JT, Kim DW, Kim MS. The randomized crossover comparison of airway sealing with the laryngeal mask airway Supreme(™) at three different intracuff pressures in children. Paediatr Anaesth 2014;24:1080-7.
31. Kim MS, Lee JH, Han SW, Im YJ, Kang HJ, Lee JR. A randomized comparison of the i-gel with the self-pressurized air-Q intubating laryngeal airway in children. Paediatr Anaesth 2015;25:405-12.
32. Brimacombe J, Berry A. A proposed fiber-optic scoring system to standardize the assessment of laryngeal mask airway position. Anesth Analg 1993;76:457.
33. Jagannathan N, Sohn L, Ramsey M, Huang A, Sawardekar A, Sequera-Ramos L, et al. A randomized comparison between the i-gel™ and the air-Q™ supraglottic airways when used by anesthesiology trainees as conduits for tracheal intubation in children. Can J Anaesth 2015;62:587-94.
34. Maitra S, Baidya DK, Bhattacharjee S, Khanna P. Evaluation of i-gel(™) airway in children: a meta-analysis. Paediatr Anaesth 2014; 24:1072-9.
35. Brimacombe J, Keller C. The ProSeal laryngeal mask airway: a randomized, crossover study with the standard laryngeal mask airway in paralyzed, anesthetized patients. Anesthesiology 2000; 93:104-9.