Comparative efficacy of different laryngoscopes in obese patients: a systematic review and network meta-analysis

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Abstract

Background: The airway management of obese patients is complex, and intubation is a critical step. Therefore, it is important to choose the optimal laryngoscope. Moreover, the best type of laryngoscopes to use for this population is unclear. The aim of this study was to determine the optimal laryngoscopes for endotracheal intubation in obese patients. Methods: We searched the Cochrane, Medline, EMBASE, EBSCOhost and Web of Science databases for randomized controlled trials comparing video laryngoscopes (VLs) with direct laryngoscopes (DLs) or different brands of VLs in adults with obesity for inclusion in this study. First-attempt success rate, intubation time, glottic view and composite complications were identified in this meta-analysis. Results: A total of 13 trials with 1264 patients were identified. VLs were associated with an increase in the first-attempt success rate (relative risk (RR) 1.11, 95% confidence interval (CI) 1.06-1.16), shorter intubation time (mean difference (MD) -13.19, 95% CI -25.57 to -0.81) and an improved glottic view (RR 1.24, 95% CI 1.17-1.30). No difference was observed in the incidence of composite complications. In the network meta-analysis, all three types of VLs (Macintosh blade VLs, angulated blade VLs and side-channel blade VLs) were associated with an improved glottic view (RR 1.4, 95% credible interval (CrI) 1.2-1.7; RR 1.3, 95% CrI 1.2-1.5; and RR 1.2, 95% CrI 1.1-1.3, respectively). Conclusions: Compared with DLs, VLs generally showed advantages in obese patients requiring endotracheal intubation. Despite the composite complications, there is insufficient evidence to definitively identify the optimal type of laryngoscopes in obese patients. Angulated blade VLs reduce the complications related to intubation compared with side-channel blade VLs and conventional Macintosh DLs. Trial registration: This study was registered with the International Prospective Register of Systematic Reviews (PROSPERO 2017: CRD42017079927. http://www.crd.york.ac.uk/PROSPERO).

Background

Obesity has become a worldwide health concern [1]. An elevated Mallampati score, enlargement of the tongue, a limited mouth opening, reduced cervical mobility and a short thyromental distance are associated with difficult intubation in patients with obesity [2]. In addition to these changes in oral anatomy, patients with obesity have more frequent and rapid oxygen desaturation and increased oxygen consumption and are sensitive to the respiratory depressant effects of anesthetic and analgesic drugs [3,4,5]. *A recent study noted that obesity was associated with an increased risk of difficult intubation and difficult laryngoscopy.*[6] Therefore, *it is essential to rapidly establish a rapid and safe airway among obese patients,* and laryngoscopes play a critical role during endotracheal intubation, *which is the most critical step in establishing an airway* [7]. The use of direct laryngoscopes (DLs) with a Macintosh blade is the most frequent approach and is considered the gold-standard technique due to its effectiveness for endotracheal intubation [3]. Except for DLs, a wide range of different VLs are available for intubation. Some VLs, such as the video-MAC, C-MAC and X-lite VLs, are equipped with blades that resemble the Macintosh blade and enable the device to be used both directly and indirectly [8]. Other VLs, such as the GlideScope and McGrath series 5, have angulated blades that differ from the Macintosh blade [8, 9]. Other common VLs, such as the Pentax AWS and Airtraq VLs, have side-channel blades that can guide the tracheal tube into the glottis [10].

Recently, several RCTs have emphasized the option of laryngoscope use among patients with obesity [3,11]. Rania et al observed that Pentax AWS VLs performed better than Macintosh DLs in terms of intubation success [11]. Yumul et al compared three different brands of VLs with the Macintosh DLs and revealed that McGrath DLs had a lower success rate on the first attempt than the Macintosh DLs [3]. *In 2017, a pairwise meta-analysis [12] concluded that VLs were superior to the DLs for tracheal intubation in obese adults.*

Therefore, whether the use of VLs has advantages in obese patients is controversial and research comparing different types of laryngoscopes is lacking. Consequently, the aim of our study was to perform a pairwise meta-analysis to compare the effects of VLs and DLs on obese patients and a network meta-analysis to evaluate the efficacy of different types of laryngoscope for endotracheal intubation in obese patients.

Methods

Protocol and registration:

This study was registered with the International Prospective Register of Systematic Reviews (PROSPERO 2017: CRD42017079927; http://www.crd.york.ac.uk/PROSPERO).

Eligibility criteria:

We included RCTs that compared VLs with DLs or different brands of VLs for endotracheal intubation in obese adult patients (aged ≥18 years). Trials that enrolled patients with obesity considered a body mass index (BMI) ≥30 kg/m^2 indicative of obesity. The intubations were operated under anesthesia. We excluded reviews, observational studies, retrospective studies, animal studies, case reports, irrelevant studies, duplicate studies, manikin studies and trials in patients aged <18 years and those with normal body weights.

Information sources and study selection:

We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to perform our systematic review (Appendix 1) [13]. We searched the Cochrane Central Register of Controlled Trials (CENTRAL) in the Cochrane Library and the Medline, EMBASE, EBSCOhost and Web of Science databases. *The search date was from the establishment of the databases until November 2017.* We used the following keywords both individually and in combination: “obesity”, “obese”, “laryngoscope”, “direct laryngoscope”, “video laryngoscope”, “endotracheal intubation” (please see Appendix 2 for the search strategy). In addition, we placed no restrictions on either language or year of publication.

Data collection process:

Two authors (ZDZ and GYW) created the search strategy and searched the databases. Three authors (YHL, GYW and ML) independently screened studies based on the title and abstract obtained from the database. Two different groups of authors (ZDZ and GYW for group one; ML and YHL for group two) read the selected full texts, assessed all trials for eligibility and extracted relevant information using a predefined data extraction form. Any disagreements were settled by KJY.

Outcomes:

The primary outcome was the rate of successful intubation on the first attempt, which was defined as the number of successful endotracheal intubations on the first attempt using a certain type of laryngoscope. The secondary outcomes were the intubation time (the interval from the insertion of the device into the oropharynx to the detection of end-tidal carbon dioxide or direct visual confirmation by the anesthetist were referred to as the time to intubation), the glottic view (Cormack-Lehane grades 1 or 2 or modified Cormack-Lehane classification 1 or 2a, which are considered indications of an easy glottic view) and composite complications(including a sore throat, tooth or soft tissue injury, the presence of any blood staining on the blade, and glottic swelling). These four outcomes were applied in both the pairwise and network meta-analyses.

Data items:

In the pairwise meta-analysis, we defined the two groups (the VL and DL groups) according to whether the laryngoscope was or was not equipped with a camera, respectively. In the network meta-analysis, four groups were classified according to the blade forms of the devices and the presence or absence of a camera, as follows: Macintosh blade VLs, angulated blade VLs, side-channel blade VLs and conventional Macintosh DLs.

Assessment of inconsistency:

We used the node-splitting method to assess inconsistencies between direct and indirect sources of evidence. *Inconsistency is evaluated one comparison at a time by separating the direct evidence on that comparison from the network of indirect evidence. The discrepancy between the estimates of relative treatment effects from these two sets of trials indicates the level of inconsistency.*

Risk of bias within individual studies:

The risk of bias of the included trials was independently assessed by two authors independently using the Cochrane risk of bias tool (RoB version 2) [14]. Bias is assessed as a judgment (high, low, or some concern) for individual elements from five domains (*arising from the randomization process, deviations from the intended interventions, missing outcome data, selection of the reported result, and the overall risk of bias*).

Statistical analysis:

The statistical analysis was performed within a Bayesian framework using the GeMTC package in R (version 3.4.1) [15, 16, 17]. *Four chains were fit with 50,000 burn-ins and 50,000 iterations each. Convergence was assessed using model diagnostics, such as trace plots, density plots and the Brooks-Gelman-Rubin statistic. The model fit was determined based on the residual deviation and deviance information criterion (DIC) for each outcome measure.*

Summary measures:

The data synthesis was assumed to be feasible if the clinical and methodological heterogeneity were negligible. We used relative risk (RR) values and 95% confidence intervals (CIs) in pairwise study and 95% credible intervals (CrIs) in network as approximations to measure the rate of successful intubation on the first attempt, the glottic view and the incidence of composite complications in the included obese patients. Mean differences (MDs) and 95% CIs or CrIs were used to express the pooled differences in intubation time.*We performed a sensitivity analysis by assessing the effects of removing individual studies on the pooled RR* [18]. Statistical heterogeneity was assessed with the I^2 statistic using the Higgins-Thompson method as follows: low heterogeneity, 25%; moderate heterogeneity, 50%; and high heterogeneity, 75% [19]. *When heterogeneity was suspected, we initially checked that the original data for each study and the method used to extract the data were correct. If there was no problem, subgroup analyses were conducted to explore the cause of the heterogeneity and the differences between pairwise and network meta-analysis.In addition, a funnel plot (a plot of the treatment effect against the trial precision) and Egger's test were used to evaluate the presence of publication bias.* In the network meta-analyses, model selection was based on the guidelines of Dias et al [20]. The random-effects model was chosen for the analysis. Finally, we ranked the different types of laryngoscopes based on their likelihood of leading to an association using the best results for each outcome.

Quality of evidence assessment

We used the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach[21, 22] to assess the quality of evidence of each outcome both in pairwise work and network. The quality of evidence was based on the presence of the following: limitations in study design, inconsistencies,

indirectness, imprecision of the results, and publication bias. The quality of evidence for the main outcomes was graded very low, low, moderate, or high. *When both direct and indirect comparisons were available, the higher quality ratings were used as the quality rating for the network meta-analysis.*

Results

Study selection:

Of the 666 studies and abstracts identified in the initial search, 477 were unrelated studies, 143 were study duplicates, 6 were non-RCTs and 2 were manikin studies, which were excluded after screening the titles and abstracts. In total, 38 articles were selected for the full-text review. Finally, 11 RCTs [2, 3, 11, 23-30] and 2 abstracts [31, 32] were included in our study (Figure 1 depicts the study selection process).

Study characteristics:

The 13 studies included a total of 1264 patients with obesity [2,3,11,23-32]. The major characteristics of the included trials are summarized in Table 1. The BMIs of the patients were at least 30 kg/m^2. A total of 92% of the endotracheal intubations were performed in the operating theatre under general anesthesia.

Risk of bias within studies:

The operator could not be blinded to the laryngoscopes used in the enrolled RCTs, and therefore, the quality of the evaluation may be at a higher risk. A total of 13 RCTs were identified as having a low to moderate risk of bias according to the Cochrane Collaboration tool. We identified 1 trial with a high risk of bias in sequence generation and 2 trials with a high risk of bias in blinding of the outcome assessors. Postaci et al[31] and Gaszyński et al's[32] studies had an unclear risk of bias. The full risks of bias are summarized in Appendix 3 Figure S1 and Table S1.

Result of pairwise meta-analysis:

A total of 12 trials with 1188 patients with obesity were included in the pairwise meta-analysis, which compared the efficacies of VLs (n=627) versus DLs (n=509) for endotracheal intubation. The results revealed differences in the rate of successful intubation on the first attempt [2,3,11,23-25,27,28,30] (94% vs 86%, RR 1.10, 95% CI 1.04 to 1.16, P<0.0001), the intubation time [2,3,11,23-25,27-32] (38s vs 48s, MD -13.19, 95% CrI -25.57 to -0.81) and the glottic view [2,3,11,24,25,27-29] (97% vs 79%, RR 1.22, 95% CrI 1.14 to 1.31, P<0.0001). The numbers needed to treat to achieve an additional successful intubation and superior glottic view were 11 and 6, respectively. We noted heterogeneity in the rate of successful intubation on the first attempt (I^2=30.8%, moderate), the intubation time (I^2=98.0%, high) and the glottic view (I^2=40.0%, moderate). No significant difference was observed in the incidence of composite complications [2,3,11,23-25,27,28,30] (28.6% vs 20.3%, RR 1.20, 95% CI 0.89 to 1.62, P=0.1495, I^2=2.3%, low) (Figure 2). No evidence of publication bias was observed in the funnel plot (Appendix 3 Figure S2-S5). *The sensitivity analysis showed the stability of the results, which displayed no significant changes except for the outcome "intubation time". When omitting Dhonneu's [29] trial, the pooled MD clearly changed.* However, because this study was well designed and met our inclusion criteria, it was not excluded (Appendix 3 Figure S6). *The whole trial sequential analyses were summarized in Appendix 3 figure S7-S10.*

Result of network meta-analysis:

A network meta-analysis of 12 trials including a total of 1180 patients with obesity was conducted to compare the efficacy of the following four different types of laryngoscopes according to the shapes of the blades: the Macintosh blade VL, the angulated blade VL, the side-channel blade VL and the conventional Macintosh DL. Table 2 shows the network of eligible comparisons. The pooled effect sizes suggest that compared with the conventional Macintosh DLs, the Macintosh blade VLs (RR 1.4, 95% CrI 1.2 to 1.7), the angulated blade VLs (RR 1.4, 95% CrI 1.2 to 1.7) and the side-channel blade VLs (RR 1.2, 95% CrI 1.1 to 1.3) offered an improved glottic view [2,3,14,24-29]. Comparisons of composite complications [2,3,11,23-25,28,32] induced by intubation showed differences between angulated blade VLs versus the side-channel blade VLs and conventional Macintosh DLs (RR 0.51, 95% CrI 0.29 to 0.87; and RR 0.71, 95% CrI 0.52 to 0.98, respectively). The combined results showed no differences in either the rate of successful intubation on the first attempt [2,3,11,23-28,30] or the intubation time [2,11,23-30]. No evidence of publication bias was observed in the funnel plot for the network (Appendix 3 Figure S11-S14). Presentations of the network structure were available in Appendix 3 Figure S15-S18.

For probability ranking, we found that the Macintosh blade VLs had the greatest potential to improve the rate of successful intubation on the first attempt and the glottic view. The probabilities of Macintosh blade VLs holding the top ranking for these two outcomes were 77% and 80%. The conventional Macintosh DLs were estimated to be the fastest laryngoscopy device (with a probability of 72%). The side-channel blade VLs were likely the worst approach with respect to composite complications (with a probability of 81%). The probability rankings for the four outcomes are summarized in Appendix 3 Table S2-S5.

Exploration for inconsistency:

The p values were greater than 0.1 for the inconsistency tests of each outcome. We evaluated the inconsistency of the outcomes using the node-splitting mode and observed no evidence of statistical inconsistencies. (Appendix 3 Figure S19-S22). *The number of included trials was small, and the detected differences may have low power.The results for inconsistency should be interpreted with caution.*

Quality of evidence assessment:

Because the operator could not be blinded to the device, the evaluation may be at a high risk of bias. The quality of evidence was ranked as “moderate” for the effect of the VLs and DLs on the rate of successful intubation on the first attempt and the glottic view. The quality of evidence for composite complications was “low” because the sample size did not reach the optimal information size. For intubation time, the quality of evidence was graded “very low” due to high heterogeneity (Appendix 4). The summary of findings table was summarized in Appendix 5 for network.

Discussion

Summary of evidence:

Our pairwise meta-analysis compared the efficacy between DLs and VLs, and the network meta-analysis compared the efficacy of different laryngoscopes in obese patients.

Previous systematic reviews and meta-analyses often focused on the comparison of laryngoscopes in nonobese patients, and the use of VLs was controversial. In 2017, Hoshijima [12] conducted a meta-analysis including 11 RCTs, which compared the intubation efficacy of DLs and VLs in obese patients between DLs and VLs and concluded that VLs were superior to the DLs with regard to success rate, intubation time and glottic view. Our study included 13 trials, and the pairwise meta-analysis reached the same conclusion. Furthermore, we observed that VLs did not increase the composite complications related to intubation. Obesity-related anatomic airway changes and alterations in respiratory physiology may increase the difficulty of intubation. Therefore, intubation is more likely to require multiple attempts, be more time consuming, and result in more complications in obese patients than in lean patients. VLs could provide an illuminated view of the glottis without requiring alignment of the oral, pharyngeal and laryngeal axes. Therefore, VLs showed more advantages in obese patients.

In addition, Hoshijima et al concluded that the side-channel blade VLs performed better than DLs in subgroup analysis. In our network meta-analysis, the types of VLs were further classified: the Macintosh blade VLs, the angulated blade VLs and the side-channel blade VLs. The pooled results showed that there was no difference among the four types of laryngoscopes with regard to the rate of successful intubation and intubation time. The results were also different from those obtained in our pairwise meta-analysis. Because of the difference in statistical analysis between direct and indirect comparisons, when the number of studies is small, the results may be inconsistent [33]. Head-to-head trials assessing the efficacy of different laryngoscopes in obese patients were limited. The network meta-analysis may rely more heavily on indirect comparisons, while the direct comparisons showed that Macintosh blade VLs had the highest rate of successful intubation on the first attempt. Generally, experienced doctors are able to master the use of the conventional Macintosh laryngoscope, and Macintosh blade VLs can be used as either direct or indirect laryngoscopes [34].The VL with the Macintosh blade has a classical blade shape and radian but can capture the glottic image through a camera device at the tip of the blade [35]. Hence, this type of laryngoscope increases the success of endotracheal intubation. In terms of intubation time, the side-channel VLs showed best performance, because the channel device can quickly guide the tracheal catheter into the glottis.

Regarding the comparison of composite complications in the network, the three types of VLs and the Macintosh DLs showed no significant differences. However, the side-channel blade VLs had the highest likelihood of composite complications, possibly due to the bulky interlock component of this type of VL [9]. In the relatively narrow oral environment of patients with obesity, intense pressure is often required to maneuver the distal tip of the blade beyond the tongue when using the side-channel blade VLs, and an abrupt loss of resistance occurs as the tip of the blade finally passes into the oropharyngeal space. This issue may explain why these types of laryngoscope have the highest incidence of damage to oral tissues. The angulated blade VLs had the lowest likelihood of composite complications because of the design of their blades, which bend at 45° in the McGrath Series 5 and 60° in the GlideScope; these angles are consistent with the physiological curvature of the human oropharynx [36]. When the blade is positioned below the epiglottis, the camera is positioned just in front of the glottis. Therefore, the probability of composite complications is low. It is worth noting that the angulated blade VLs had a high first attempt success rate when there was stylet angulation at 90°. [37]

The interaction of 4 variables may determine the success of endotracheal intubation: the population characteristics, the anesthetist’s skills, the duration of the surgical procedure and the available devices. In addition to different laryngoscopes, operator skill, standardized patient positioning, and the use of bougies or stylets should be considered further [38].

Limitations:

Some limitations of this meta-analysis warrant consideration. First, we defined obesity according to the internationally recognized cut-off BMI value for adults (BMI≥30 kg/m^2). However, patients with morbid obesity (BMI≥35 kg/m^2) were included in some of the enrolled studies, a factor that needs further consideration [39]. In addition, for patients with obesity who require endotracheal intubation, the prevention of complications associated with laryngoscope use is of key step importance [40]. However, in the RCTs included in our study, the definition of complications, which included a sore throat, tooth or soft tissue injury, the presence of any blood staining the blade and glottic swelling, was not unified. The included trials referred to only one or more complications with no consideration of the premorbid status or analgesic regimen. No comprehensive and standard statistics were recorded. Therefore, we counted only the number of patients who experienced the complications listed above. In addition, regarding hypoxia risk, only two RCTs recorded an SpO_2 of<92% during intubation, and only one RCT recorded an SpO_2 of<77%. Thus, we did not include cardiovascular complications in our final list of complications. These results must be interpreted with caution.

Conclusions:

In conclusion, compared with DLs, VLs generally increased the rate of successful endotracheal intubation on the first attempt, reduced intubation time and provided a superior glottic view in patients with obesity, with no increase in the risk of complications. Although there was no significant advantage with regard to either the rate of successful intubation on the first attempt or intubation time, our network results demonstrated that the use of video devices (Macintosh blade VLs, angulated blade VLs and side-channel blade VLs) could improve the visualization of glottis compared with the use of DLs. Compared with side-channel blade VLs and conventional Macintosh VLs, the angulated blade VLs reduced the complications associated with intubation.

List Of Abbreviations

VLs: video laryngoscopes

DLs: direct laryngoscopes

RR: relative risk

CI: confidence interval

BMI: body mass index

MD: mean difference

RCT: randomized control trial

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

All data supporting the conclusions presented in this article are included in this published article.

Competing interests:

The authors declare that they have no competing interests.

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Authors' contributions:

ZDZ and GYW searched five databases. YHL, GYW and ML screened the articles. ZDZ, GYW, ML and YHL were divided into two groups and viewed the full-text and extracted the data from each study, independently. ML and CSW conceived the study and contributed data. Any disagreements were decided by KJY.

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Tables

Table 1: Characteristics of included trials

First author	Country	Patients (n)	Intervention(n)	BMI of each group(kg/m2)	Mallampatii Score(□/□/□/□)(n)	Outcomes	Operators	Surgery and anesthesia information
Abdallah(2011)12	USA	99	Pentax AWS(50) Macintosh size 4 blade(49)	41.2±4.4 42.5±5.9	21/18/7/4 14/21/13/0	Success rate Intubation time Glottic view Complications	Attending anesthesiologists, each of whom had previously used the Pentax AWS 5 to 10 times before the study began	Elective surg general anesthesia
Ander(2017)23	Sweden	80	the Storz C-MAC(40) Macintosh size 3 blade(40)	42.2±5.6 39.9±4.0	8/28/3/0 8/28/3/0	Success rate Intubation time Complications	Anesthetists experienced with both devices	surgery unde general anesthesia; muscle paralyzed rocuronium
Andersen(2011)24	Denmark	100	Glidescope GVL size 4(50) Macintosh size 3 or 4 blade(50)	42±6 41±5	≥□:11 ≥□:16	Success rate Intubation time Glottic view Complications	one of five certified nurse anesthetists or two anesthesiologists all with prior experience from at least 20 GS intubations and with wide experience in anesthetizing patients with obesity	elective baria surgery; mus paralyzed wi succinylchol
Castillo-Monzón (2017)25	Spain	46	Airtraq(23) Macintosh(23)	45.97±3.61 46.87±4.38	1/9/13/0 2/14/7/0	Success rate Intubation time Glottic view Complications	one of the researchers with 19 years of experience in the use of the Macintosh laryngoscope and who had performed 30 tracheal intubations with the Airtraq laryngoscope before starting the research	surgery unde general anesthesia; muscle paralyzed wi rocuronium
Dhonneur(2008)29	France	212	Airqraq(106) Macintosh(106)	43±6 40±7	41/41/21/3 39/44/23/0	Intubation time Glottic view Complications	eight senior anesthesiologists covering the morbid obesity surgery unit became skilled for tracheal intubation with both the LMA CTrach™ and Airtraq™ laryngoscope	elective visc surgery; mus paralyzed wi succinylchol
Gaszyński(2009)32	N/A	68	Airtraq(34) Macintosh(34)	>39 >39	N/A	Intubation time	NA	elective abdominal surgery
Marrel(2007)30	Switzerland	80	X-lite(40) Macintosh(40)	42.8±6.9 43.5±5.4	14/13/10/3 12/15/9/4	Success rate Intubation time	senior anesthesiologist with experience in the use of the videolaryngoscope	bariatric surgery; mus paralyzed wi cisatracuriu
Ndoko(2008)2	France	106	Airtraq(53) Macintosh(53)	44±6 43±5	15/22/10/6 17/20/11/5	Success rate Intubation time Glottic view Complications	All anaesthesiologists performing tracheal intubations were skilled in the use of the AirtraqTM and Macintosh laryngoscopes and frequently anaesthetize for obesity surgery.	gynaecologi and bariatric surgery; mus paralyzed wi succinylchol
Postaci(2015)31	N/A	84	Video-	≥30	N/A	Intubation	NA	NA

			laryngoscope(42) Macintosh(42)	≥30		time		
Putz(2012)26	Belgium	76	Glidescope GVL blade 3(38) Airtraq(38)	33.7±3.9 34.6±5.7	7/7/18/6 3/8/25/2	Success rate Glottic view	two groups intubated by the AirtraqTM, a group by anesthetist, and two others using GlidescopeTM, separated by experimenter.	muscle paralyzed wi rocuronium
Ranieri(2012)27	the New Zealand	132	Airtraq size 3(68) Macintosh 3, 4 or 5 blade(64)	43.5±6.3 42.7±4.4	9/33/22/4 6/32/21/5	Success rate Intubation time Glottic view	The four participating anaesthetists had more than five years of clinical experience with conventional laryngoscopy and had used the Airtraq laryngoscope on manikins and for a minimum of 50 patients.	bariatric surgery; mus paralyzed wi suxamethon and vecuron
Yousef(2012)28	Egypt	60	Glidescope(30) Macintosh(30)	43.2±7.4 43.6±9.5	1/4/18/7 0/3/20/7	Success rate Intubation time Glottic view Complications	All anesthesiologists performing tracheal intubations were trained in manikins in the use of Glidescope laryngoscopes and Macintosh laryngoscopes	Gynecologic and bariatric surgery; paralyzed wi atracurium
Yumul(2016)3	USA	121	Video-MAC(30) Glidescope GVL(30) McGrath Series 5(30) Macintosh(31)	43±8 43±5 41 ± 6 42 ± 5	5/17/7/1 5/13/12/0 4/19/7/0 1/20/10/0	Success rate Intubation time Glottic view Complications	All anesthesiologists performing the tracheal intubations had been previously trained using all three VL devices (with a minimum of 20 intubations with each device).	elective baria surgery; neuromuscu blockade wa used

N/A: not available.

Table 2-1: Relative risks of the effect of interventions for intubation success on the first attempt (blue squares; RR and 95% Crl) and intubation time (pink squares; MD and 95% Crl).

Macintosh blade VLs	6.2(-43. to 53.)	0.94(-41. to 41.)	-15.(-52. to 19.)
1.1 (0.90 to 1.3)	angulated blade VLs	-5.2(-38. to 29.)	-22.(-54. to 11.)
1.1(0.96 to 1.3)	1.1(0.92 to 1.2)	side-channel blade VLs	-16.(-37. to 4.)
1.2(1.0 to 1.4)	1.1(0.98 to 1.3)	1.1(0.96 to 1.2)	conventional Macintosh DLs

VLs: video laryngoscopes; DLs: direct laryngoscopes.

Table 2-2: Relative risks of the effect of interventions for glottic view (yellow squares; RR and 95% Crl) and complications (green squares; RR and 95% Crl).

Macintosh blade VLs	1.0(0.89 to 1.2)	1.1(0.96 to 1.4)	1.4(1.2 to 1.7)
1.5(0.94 to 2.3)	angulated blade VLs	1.1(0.98 to 1.3)	1.3(1.2 to 1.5)
0.75(0.41 to 1.4)	0.51(0.29 to 0.84)	side-channel blade VLs	1.2 (1.1 to 1.3)
1.1(0.69 to 1.6)	0.71(0.52 to 0.98)	1.4(0.91 to 2.2)	conventional Macintosh DLs

VLs: video laryngoscopes; DLs: direct laryngoscopes.

Figures

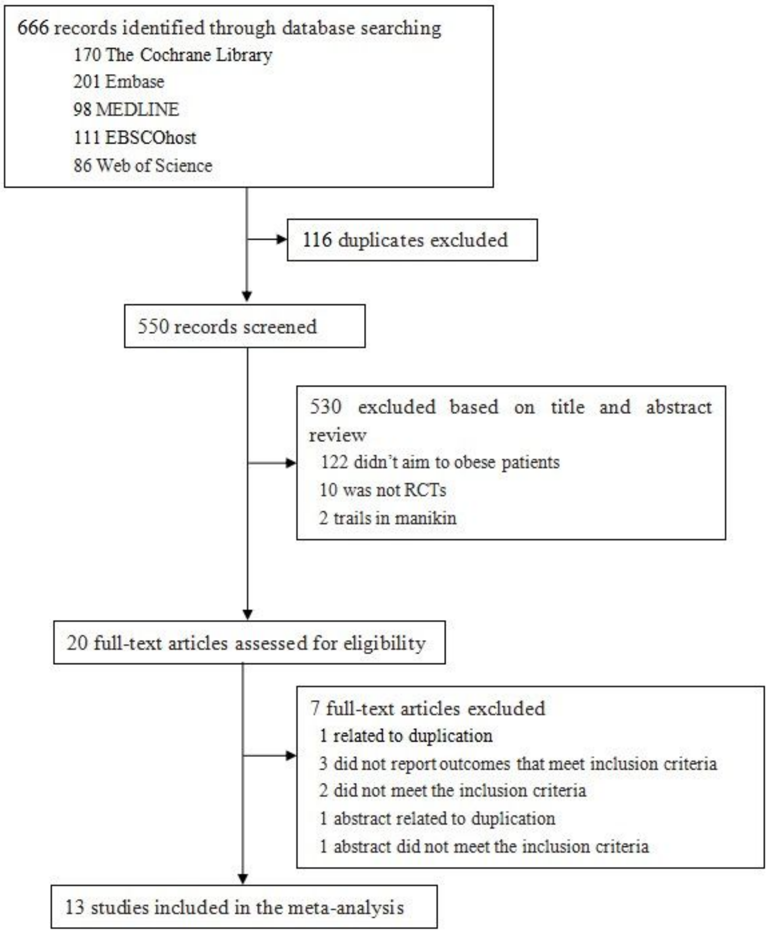

Figure 1

Flow diagram showing search and selection of studies. RCT, randomized controlled trial.

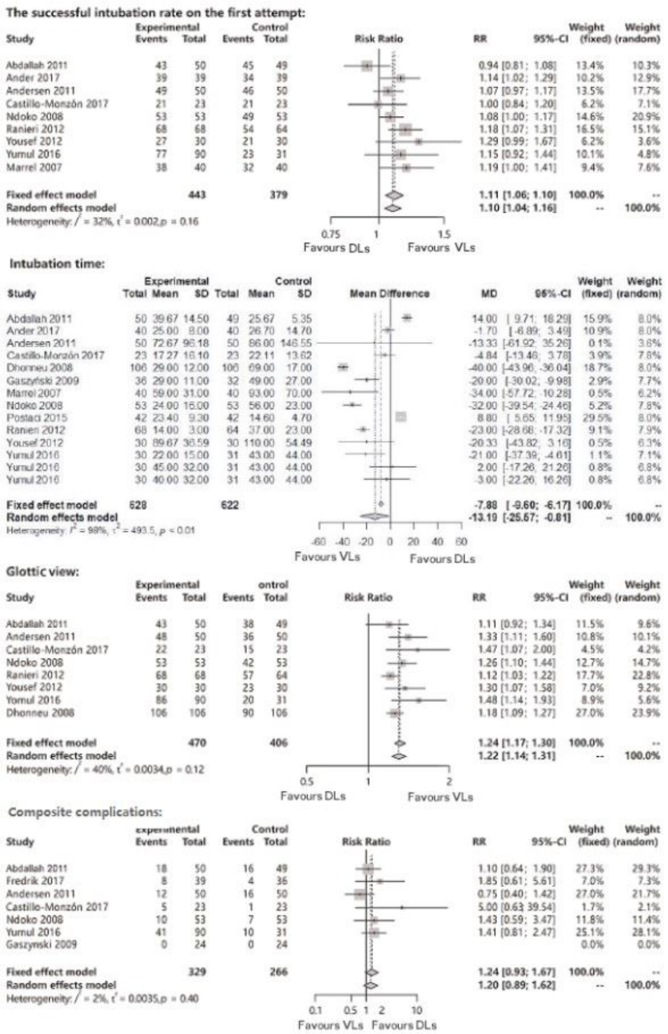

Figure 2

Forest plot of the risk ratio for the successful intubation on the first attempt, glottic view, the intubation time and the incidence of any complications in the pairwise meta-analysis between direct laryngoscopes and video laryngoscopes. The center of each square represents the relative risk for individua trials. The diamonds represent the pooled results. The corresponding horizontal line represents the 95% CI.

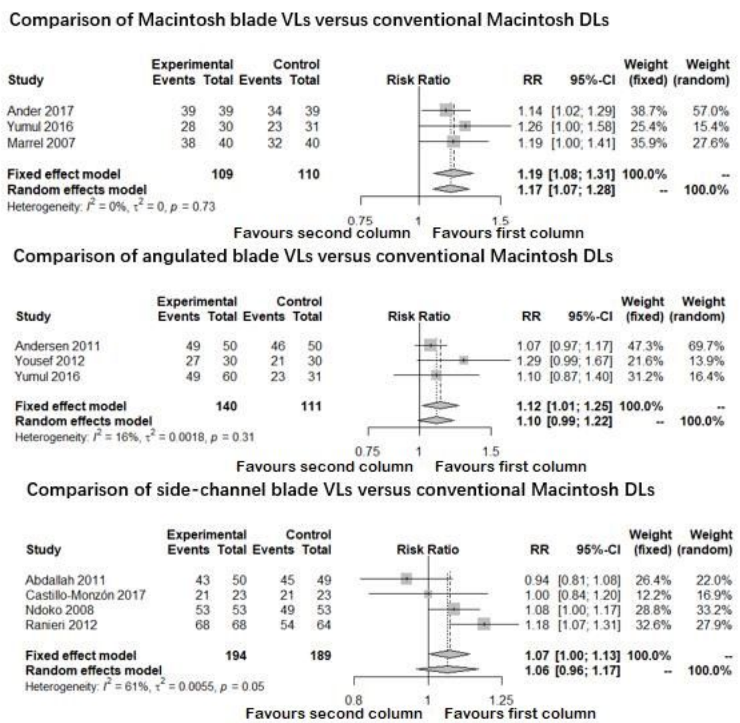

Figure 3

Forest plot of risk ratio for the successful intubation on the first attempt in the subgroup analysis.

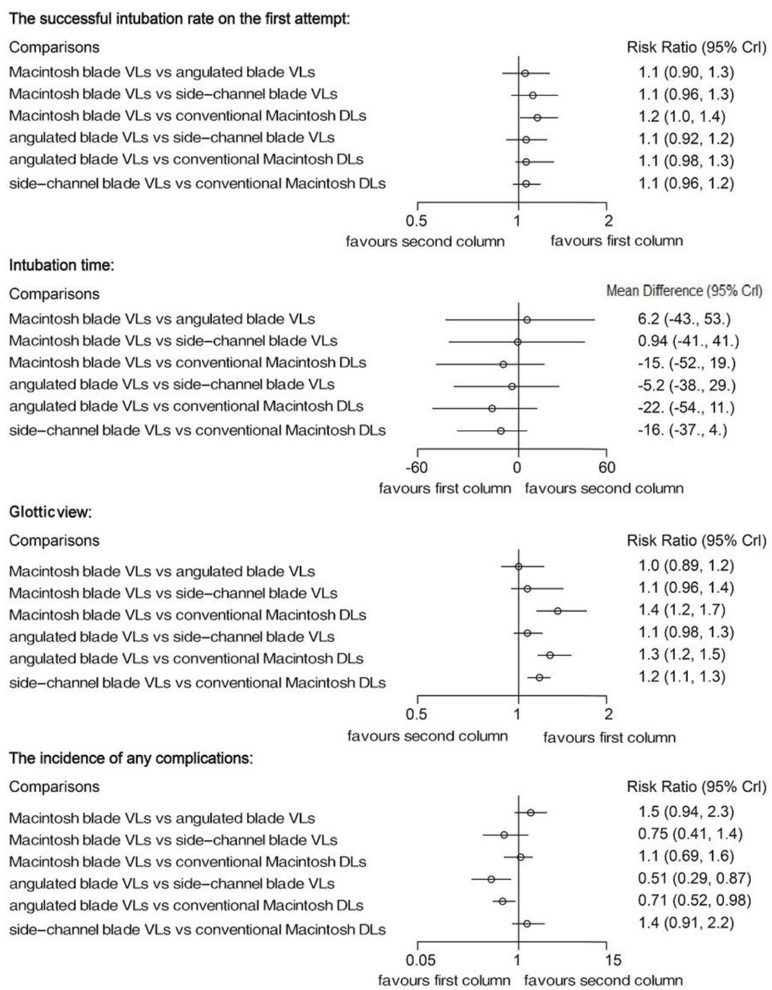

Figure 4

Outcomes of the successful intubation on the first attempt, intubation time, glottic view, the incidence of any complications in the network meta-analysis.

Supplementary Files

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