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Video laryngoscopy vs. direct laryngoscopy for nasotracheal intubation in oromaxillofacial surgery: a systematic review and meta-analysis of randomized controlled trials

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Background: Nasotracheal intubation (NTI) is commonly performed in oromaxillofacial surgeries. We did this meta-analysis to ascertain whether use of video laryngoscopy (VL) provided better NTI characteristics as compared to direct laryngoscopy (DL) in patients undergoing oromaxillofacial surgeries.

Methods: We performed a systematic search to identify randomized controlled trials comparing VL with DL for NTI in adults undergoing elective oromaxillofacial surgery. The primary outcome was time to intubation. Secondary outcomes included the first attempt success, overall success, incidence of nasal bleeding, Cormack and Lehane grade, and maneuvers required.

Results: Of the 456 studies identified following a systematic search, 10 were included. Meta-analysis showed a significantly lower time to tracheal intubation favoring VL (mean difference: −9.04, 95% CI [−12.71, −5.36], P < 0.001; I^2 = 59%). VL was also associated with a greater first attempt success (relative risk [RR]: 1.10, 95% CI [1.04, 1.16], P = 0.001). Maneuvers to facilitate intubation were less with VL (RR: 0.22, 95% CI [0.10, 0.51], P < 0.001). There was no difference in overall intubation success (RR: 1.04, 95% CI [0.98, 1.10], P = 0.17). The incidence of bleeding did not differ between the DL and VL groups (RR: 0.59, 95% CI [0.32, 1.08], P = 0.09).

Conclusions: Evidence as per this meta-analysis suggests VL leads to a shorter time to NTI, a greater first attempt success rate, and reduced need for maneuvers when compared to DL. The present study supports use of VL as a first line device for NTI in oral-maxillofacial surgeries in experienced hands.

Keywords: Intratracheal intubations; Intubation; Laryngoscopes; Meta-analysis; Oral surgical procedures; Orthognathic surgical procedures; Statistics; Systematic review.

Introduction

Oral and maxillofacial surgeries require nasal intubation to secure the airway [1]. According to the 4th National Audit Project, difficult airway situations account for approximately 39% of all events during anesthesia [2]. Direct laryngoscopy (DL) is usually used by positioning the head in a sniffing position to align the oropharyngeal and laryngeal

axes and create a 'line of sight' for glottis visualization and tracheal intubation [3]. Video laryngoscopy (VL) function by transmitting the image from its tip to a monitor or screen attached to its handle or a distant monitor. Thus, tracheal intubation can be performed without the 'line of sight' approach. One may require additional maneuvers, such as optimal external laryngeal pressure, neck rotation, Magill forceps, or the cuff inflation technique to direct the endotracheal tube towards the glottis using a DL. In contrast, VL provides a better laryngeal view without significant distortion of the airway alignment and reduces the need for maneuvers. VL has been shown to improve the success rates of both orotracheal and nasotracheal intubation (NTI) [4–7].

A systematic review concluded that VL resulted in greater success and reduced time for NTI compared to DL [8]. Another systematic review found that VL shortened intubation time and improved the first attempt success rate but did not increase the overall success rate [9]. These systematic reviews included studies with varied surgical populations and did not focus explicitly on the comparative characteristics of VL and DL for NTI in patients undergoing oromaxillofacial surgery.

Therefore, we conducted this systematic review and meta-analysis of randomized controlled trials (RCTs) to study if VL reduces the intubation time, improves the overall and first-attempt success, and reduces the need for maneuvers and occurrence of complications when compared to DL for NTI in adults undergoing oromaxillofacial surgery.

Materials and Methods

We followed the Preferred Reporting Items for Systematic reviews and Meta-Analysis (PRISMA) guidelines to prepare this systematic review and meta-analysis [10]. The study was registered with PROSPERO (https://www.crd.york.ac.uk/PROSPERO, no. CRD42020222444).

Search strategy and initial review

We performed a systematic search of the PubMed and Embase databases for human subject studies published until September 9, 2020. The following free-text terms were used for the search: (nasal intubation OR nasotracheal intubation OR intubation) AND (video laryngoscope OR video laryngoscopy OR Storz DCI OR TruView PCD OR Pentax AWS OR Airway Scope OR Airtraq OR C-MAC OR Glidescope OR McGrath OR King Vision OR laryngoscope OR direct laryngoscope OR Macintosh laryngoscope) AND (buccal surgery OR mouth surgery OR oral surgery OR oral surgical procedures OR maxillofacial OR maxillofacial surgery OR maxillofacial). Review articles and editorials were also screened. References of the selected items were also searched to identify more articles. We included all RCTs that compared VL and DL for NTI in oromaxillofacial surgeries.

Data extraction

Two authors (N.G. and R.S.) assessed the titles and abstracts of all citations to identify all relevant studies. RCTs that compared VL with DL for NTI in adult patients (> 18 years of age) undergoing elective oromaxillofacial surgery were included. Studies in languages other than English, without full text, or conference abstracts were excluded. Studies on manikins, cadavers, and simulation studies, were also excluded along with those on patients with a base of skull fracture, coagulation abnormality, reduced mouth opening (< 3 cm), and midface instability. Any disagreement between the authors was resolved after mutual discussion with the other authors (A.G. and K.M.). The selection process is presented with a PRISMA flow diagram (Fig. 1) [11].

Outcomes

The primary outcome was time to intubation. The secondary outcomes were the first attempt and overall success, need for maneuvers to facilitate NTI, rate of nasal bleeding, and proportion of Cormack and Lehane (CL) classification 1 and 2. The characteristics of various studies included have been summarized in Table 1.

Statistical analysis

The baseline clinical characteristics and outcome measures of the study population were extracted by two authors (N.G. and R.S.). We extracted the sample size, mean, and standard deviation (SD) for continuous data. Data reported as median and interquartile range were transformed into mean and standard deviation with the help of the formula in the Cochrane handbook [12]. We calculated the sample size and the number of events for dichotomous variables and used the relative risk (RR) and 95% CI. Statistical significance was set at $P < 0.05$. We used Review Manager (RevMan)[computer program], version 5.4. The Cochrane Collaboration, 2020 for all analyses. For studies with more than two VL comparisons, the better of the two results was included in our calculation. Any discrepancy in data analysis was resolved by discussion with the other two authors (A.G. and K.M.) until an agreement was reached.

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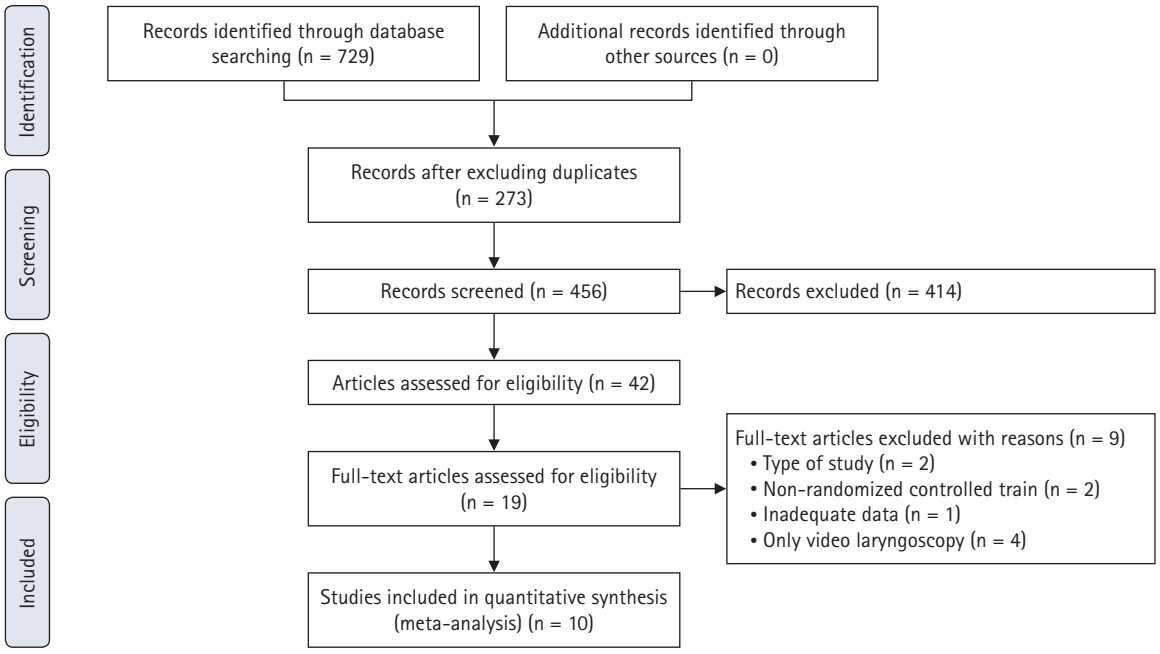

Fig. 1. Flow chart of included and excluded studies.

Assessment of risk of bias

The Risk-of-bias VISualization (Robvis) tool (McGuinness LA, USA) as used to assess the risk of bias for all selected studies by two authors (A.G. and R.S.) [13]. We evaluated the process of randomization, variation from intended intervention, outcome data that were missing, outcome measurement, and selection of reported results. We relied only on the information provided in the articles to assess the risk of bias [13].

Grading of recommendation, assessment, development, and evaluations (GRADE) system criteria were used to evaluate the quality of evidence (high, moderate, low, or very low quality) related to the outcomes based on limitations, inconsistency, imprecision, indirectness, and publication bias, and an evidence table was generated using the GRADE software (Evidence Prime, Inc., McMaster University, Canada) (www.guidelinedevelopment.org) [14] (Table 2).

Heterogeneity among trials was quantified using the Higgins and Thompson I^2 method. Regardless of the I^2 value, we considered a random-effect model. Publication bias was assessed using a funnel plot [15].

Results

In total, 729 articles were identified. We removed 273 duplicates and screened 456 articles for eligibility. Of them, 414 were removed due to a lack of relevance. We discarded case reports, articles on the pediatric population, manikin studies, and non-English language studies from the remaining 42 articles. Of the 19 articles selected for qualitative data synthesis, nine studies were excluded because of the type of study participants [16,17], non-RCT studies [18,19], use of only VL [20–23], and inadequate data [24]. For the systematic review and meta-analysis, a total of 10 studies (n = 597) were included (Fig. 1).

Study characteristics

We included studies with head and neck cancer surgeries [25] and dental or oral maxillofacial surgeries [26–34]. All of them were single-centered, except one, which was performed at three centers [26]. The operator criteria were defined in all studies except in one [32]. The types of video laryngoscopes used included Glidescope (three studies) [26,33,34], C-MAC D-blade (one study) [25], McGrath (four studies) [27–29,31], True View EVO2 (one study) [30], and Pentax Airway scope (two studies) [32,33]. (Table 1)

Risk of bias

The overall risk of bias was low. Only one study showed some concerns [31] (Fig. 2). The quality of evidence assessed using the GRADE system was high (Table 2).

Table 1. Characteristics of the Included Studies

Study	n	Type of Surgery	Devices	Inclusion criteria	Exclusion criteria	Operator experience	Definition of time to intubation
Hazarika 2018 [25]	100	Head and neck cancer	C-MAC & DL	ASA 1–3; 20–70 yr; EGRI 1–7	ASA 4; MO < 2.5; difficult BMV; hyperkalemia; h/o malignant hyperthermia	20 successful nasal or oral intubations C-MAC D-blade	Introduction of scope to mouth till three consecutive $ETCO_2$ readings
Jones 2008 [26]	69	Dental or maxillofacial	GVL & DL	More than equal to 18 yr	Difficult airway; required RSI; C/I for GVL	> 10 successful GVL intubation	End of mask ventilation to detection of $ETCO_2$ of at least 30 mmHg
Sato 2017 [31]	60	Oromaxillofacial	McGrath & DL	ASA 1–2; 20–70 yr	Expected difficulty in intubation; patients with rhino stenosis	Experience > 6 yr by JDSA	Passage of ETT through nasal cavity until chest rise seen
Kwak 2016 [29]	70	Oromaxillofacial with normal airway	McGrath & DL	ASA 1–2; 20–60 yr	Suspected difficult airway; CSI; bleeding tendency; RSI required	Experienced anesthesiologists	Insertion through the nostril to detection of $ETCO_2$
Zhu 2019 [27]	66	Oromaxillofacial	MacGrath & DL	ASA 1–2; 18–60 yr; EGRI 1-7	EGRI > 7; Reflux; OSA; BMI > 40	> 100 NTI with both laryngoscopes	Mouth opening till three consecutive $ETCO_2$ readings
Roh 2019 [28]	80	Dental or maxillofacial	MacGrath & DL	ASA 1–2; 19–60 yr	MMP4; requiring RSI; CSI; bleeding tendencies	> 50 intubations with the study laryngoscopes	Intranasal placement to detection of $ETCO_2$
Puchner 2011 [34]	40	Dental or oromaxillofacial	GVL & DL	ASA 1–2; 18–80 yr	Difficult airway or h/o bleeding	> 10 intubations per laryngoscope	Not specified
Shrestha 2015 [30]	40	Maxillofacial	Truview & DL	ASA 1–2; 18–60 yr	ASA 3,4; morbid obesity; upper airway structural anomalies; C/I for NTI	> 50 intubations with Truview EVO_2 in normal and difficult airways	Insertion between teeth until first capnographic trace
Suzuki 2012 [32]	90	Elective orthodontic	Pentax AWS & DL	ASA 1–2; > 18 yr	h/o CSI; difficult airway; GERD; BMI > 35	Experienced but not defined	Time from the tube passing the incisors until the ETT was traversed
Tseng 2017 [33]	72	Oromaxillofacial	GVL and DL	ASA 1–2; 20–65 yr	MO < 3 cm; CS instability; h/o difficult intubation, chronic suppurative sinusitis, C/I for NTI	Experienced but not defined	Placement of the nasotracheal tube from selected nostril till the removal of the scope

ASA: American Society of Anesthesiologist, AWS: airway scope, BMV: bag mask ventilation, C/I: contraindication, CS: cervical spine, CSI: cervical spine injury, DL: direct laryngoscope, EGRI: El Ganzouri Risk Index, $ETCO_2$: end-tidal carbon dioxide, ETT: endotracheal tube, GERD: gastroesophageal reflux disease, GVL: glidescope video laryngoscope, h/o: history of, JDSA: The Japanese Dental Society of Anesthesiology, MMP: Modified Mallampati Grade, MO: mouth opening, NTI: nasotracheal intubation, OSA: obstructive sleep apnea, RSI: rapid sequence induction.

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Fig. 2. Risk of bias summary. Green: low risk of bias, Yellow: Some concern of bias.

Meta-analysis

Time to intubation

The definition of time to intubation varied from the mouth opening until the detection of $ETCO_2$ [25,27,30], end of mask ventilation until detection of $ETCO_2$ [26], intranasal placement until detection of $ETCO_2$ [28], insertion through nostril until detection of $ETCO_2$ [29], passing through the nasal cavity until chest rise [31], placement of the endotracheal tube [32,33], or as not clear [34]. Pooled analysis showed a significantly shorter time to intubation favoring VL (MD: −9.04, 95% CI [−12.71, −5.36], n = 597, P < 0.001, I^2 = 59%) (Fig. 3). The quality assessment of the GRADE was high.

First attempt success and overall success

First attempt success was reported in all studies except for three [29,32,34]. Pooled analysis demonstrated a significantly high first-attempt success with VL. The first attempt success rate was greater for all video laryngoscopes ([221 out of 233; 94.8%] vs. [197 out of 234; 84.2%]) (RR: 1.10, 95% CI [1.04, 1.16], n = 418, P < 0.001, I^2 = 0; high quality evidence) (Fig. 4). A pooled analysis of overall intubation success rates with the two types of laryngoscopes in all studies except two [28,29] showed no significant difference (RR: 1.04, 95% CI [0.98, 1.10], n = 411, P = 0.17, I^2 = 60%; high-quality evidence) (Supplementary Fig. 1).

Glottic view

All studies, except two, reported CL classification of the glottic view obtained [32,33]. In one study, CL grade was categorized as CL grade 1 and CL grade 2 or higher and was therefore excluded from our analysis [26]. Pooled analysis showed that the VL group showed a higher rate of CL grade 1 or 2 than DL (RR: 1.19, 95% CI [0.98, 1.45], n = 388, P = 0.07, I^2 = 95%; high-quality evidence) (Supplementary Fig. 2) without any statistical significance in the overall effect estimate. The high level of statistical heterogeneity could be explained by the subjective variability associated with its description.

Maneuvers used

Eight studies described maneuvers (cuff inflation technique, rotation of endotracheal tube, Magill forceps use, and external laryngeal pressure) used to guide the endotracheal tube into the glottis. Maneuvers required were significantly higher with DL than with VL (RR: 0.22, 95% CI [0.10, 0.51], n = 212; P < 0.001, I^2 = 83%; high-quality evidence) (Fig. 5). Because of the high level of statistical heterogeneity, no effect estimate was presented for this outcome.

Nasal bleeding

Eight studies mentioned nasal bleeding or epistaxis resulting from nasotracheal intubation. Pooled analysis showed that bleeding was more common with DL than with VL (RR: 0.59, 95%CI [0.32, 1.08], n = 100, P = 0.09; I^2 = 50%; high-quality evidence) (Supplementary Fig. 3), although the difference was not significant.

A funnel plot showed a low risk of publication bias (Fig. 6). The overall risk of bias based on Revman was low (Supplementary Fig. 4).

Discussion

The main conclusion from this meta-analysis of ten studies is that VL is associated with a significantly shorter time to intubate, greater first attempt success, and reduced need of maneuvers to facilitate NTI in patients undergoing oromaxillofacial surgery.

Table 2. Quality of Evidence from GRADE System

Certainty assessment							Summary of findings				
Participants (studies) Follow up	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Overall certainty of evidence	Study event rates (%) With DL	Study event rates (%) With VL	Relative effect (95% CI)	Anticipated absolute effects Risk with direct laryngosocpe	Anticipated absolute effects Risk difference with VL
Total success											
427 (7 RCTs)	not serious	not serious	not serious	not serious	none	⊕⊕⊕⊕ HIGH	199/214 (93.0%)	212/213 (99.5%)	RR 1.04 (0.98, 1.10)	930 per 1,000	37 more per 1,000 (from 19 fewer to 93 more)
Maneuvers											
537 (8 RCTs)	not serious	not serious	not serious	not serious	none	⊕⊕⊕⊕ HIGH	166/269 (61.7%)	46/268 (17.2%)	RR 0.22 (0.10, 0.51)	617 per 1,000	481 fewer per 1,000 (from 555 fewer to 302 fewer)
CL 1 & 2											
436 (7 RCTs)	not serious	not serious	not serious	not serious	none	⊕⊕⊕⊕ HIGH	173/218 (79.4%)	215/218 (98.6%)	RR 1.19 (0.98, 1.45)	794 per 1,000	151 more per 1,000 (from 16 fewer to 357 more)
Bleeding											
537 (8 RCTs)	not serious	not serious	not serious	not serious	none	⊕⊕⊕⊕ HIGH	62/269 (23.0%)	38/268 (14.2%)	RR 0.59 (0.32, 1.08)	230 per 1,000	94 fewer per 1,000 (from 157 fewer to 18 more)
First attempt success rate											
467 (7 RCTs)	not serious	not serious	not serious	not serious	none	⊕⊕⊕⊕ HIGH	197/234 (84.2%)	221/233 (94.8%)	RR 1.10 (1.04, 1.16)	842 per 1,000	84 more per 1,000 (from 34 more to 135 more)
Time to intubation (Scale from: 10 to 200)											
597 (9 RCTs)	not serious	not serious	not serious	not serious	none	⊕⊕⊕⊕ HIGH	299	298	-	The mean TIME TO INTUBATION was 0 SD	MD 9.04 SD lower (12.71 lower to 5.36 lower)

DL: laryngoscopy, RCT: randomized controlled trial, RR: relative risk , SD: standard deviation, VL: video laryngoscopy.

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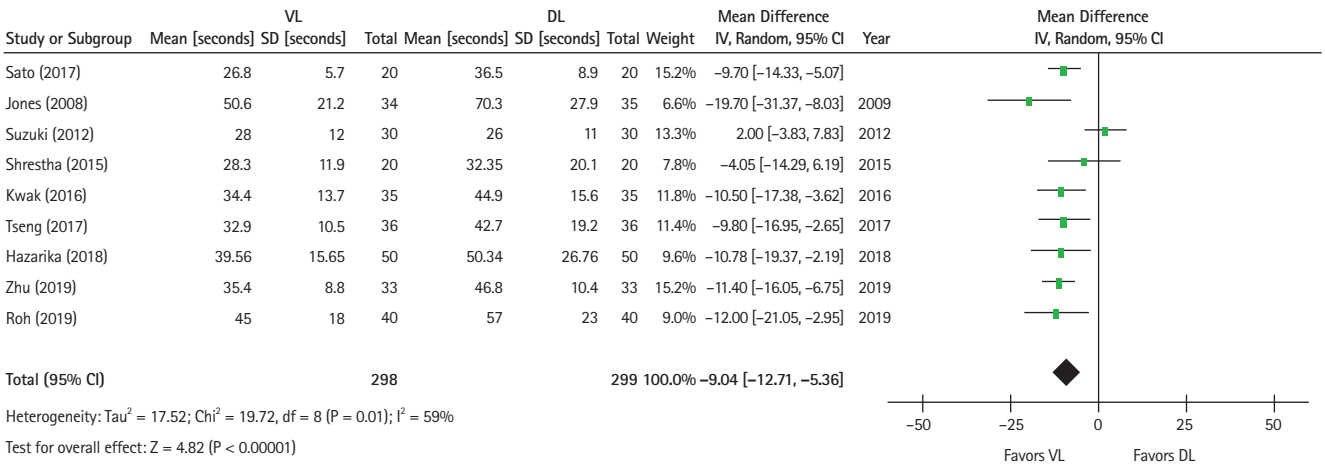

Fig. 3. Forest plot for comparison of time to intubation between video laryngoscopy (VL) and direct laryngoscopy (DL). IV: inverse variance.

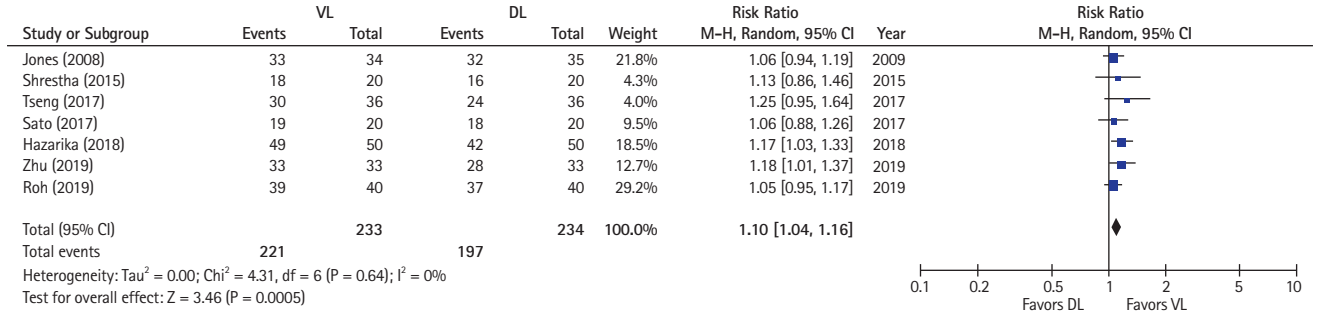

Fig. 4. Forest plot for comparison of first-attempt success rate between video laryngoscopy (VL) and direct laryngoscopy (DL). M-H: Mantel-Haenszel.

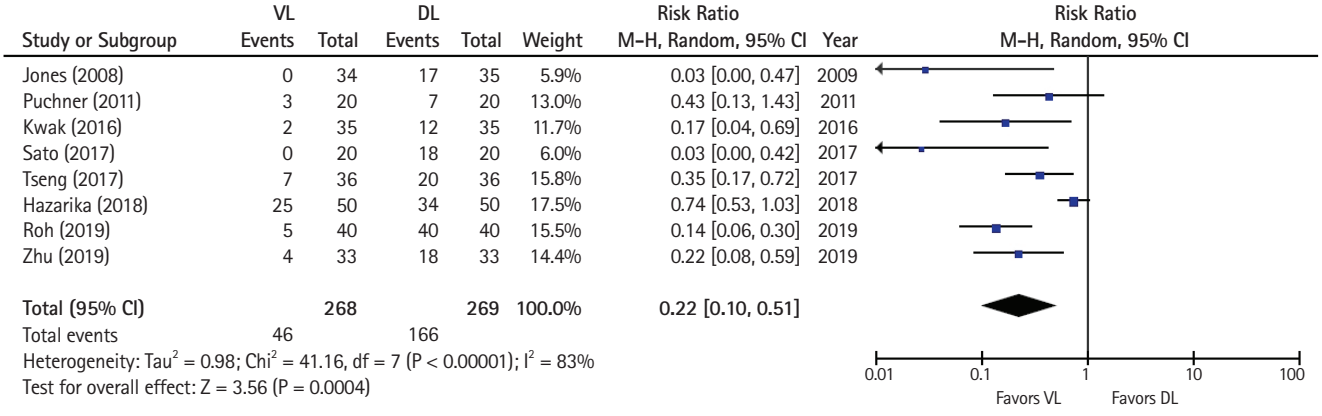

Fig. 5. Forest plot for comparison of maneuvers used between video laryngoscopy (VL) and direct laryngoscopy (DL). M-H: Mantel-Haenszel.

The overall success rate, glottis view in terms of CL grade, and nasal morbidity in terms of bleeding were similar between the two groups.

The finding of a shorter intubation time with VL is opposite to that of findings in previous studies [35,36] but was similar to the findings of Jiang et al. [9]. VL improves laryngeal vision and causes less distortion of the airway structures. Therefore, less tube manipulation is required to navigate the nasally inserted tube into the glottis. This may be responsible for the reduced total time to intubation. In the DL group, the need for maneuvers required to negotiate the tube was also greater, which must have resulted in an increased intubation time. The time to intubation through the

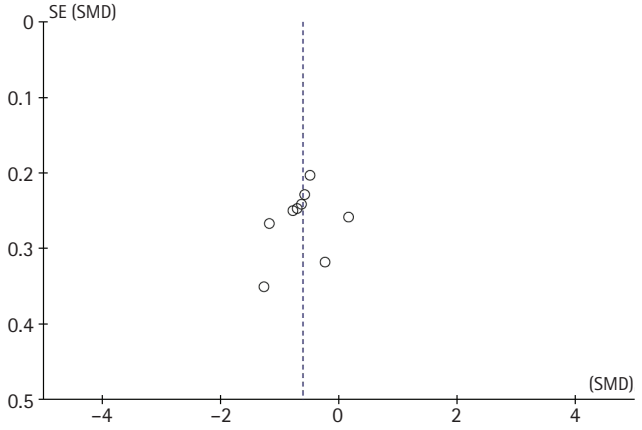

Fig. 6. Funnel plot showing the risk of bias. SMD: standardized mean difference, SE: standard error.

McGrath VL was significantly shorter than that of DL [27–29,31]. However, in the study where Pentax AWS was used, this result was not significant, probably because of a thicker blade that could have led to difficulty in manipulating the endotracheal tube in the oropharynx [32]. A previous meta-analysis comparing Pentax AWS with DL for oral intubation also showed that Pentax AWS resulted in a similar intubation time and intubation success rate despite providing better glottis views [37]. The heterogeneity above 50% can be explained by the different time points used and experience of operators in the various studies calculating the intubation time.

We found that VL increased the first attempt success. This is in agreement with previous studies in which VL improved the first attempt success for both nasotracheal and oral intubation in patients with difficult airways [4,9,36], whereas Donald et al. [35] did not find any significant difference for the same. VL has always been considered when intubation through DL is difficult or fails altogether [24]. Any patient undergoing oromaxillofacial surgery can be considered a potentially difficult airway. Hence, we do not feel that considerations of outcome in other difficult airway cases would be different if the mouth opening is sufficient to allow insertion of a laryngoscope. However, in difficult airway scenarios with restricted mouth opening (less than 2 cm), fiberoptic bronchoscopy remains the method of choice [38].

The overall success rate of NTI was not significantly better with VL despite the better first-attempt success rate. This could be due to the use of alternative techniques and maneuvers in successive attempts with DL. In our study, VL resulted in more CL grade 1 or 2 views than DL. A meta-analysis found that intubation with acutely angled VL blades provided a better view of the glottis as they follow the anatomy of the oral cavity, and the tip of the camera lies in approximation with the glottis opening [36]. A better laryngeal view with minimal force on the anterior airway structures is one of the main reasons for the lesser number of maneuvers required to negotiate the ETT [26]. In addition, a shorter intubation time resulted in lesser device contact with the mucosa. This, in turn, may be responsible for the reduced bleeding with VL.

Our study has a few limitations. The inability to blind anesthesiologists to the devices could lead to an altered performance (Hawthorne effect). The definitions of time to intubation varied in different studies, which may have led to measurement bias. However, such a difference would affect the intubation times with both devices equally. In all the included studies, the experience of operators was specified, except in three [29,32,33] where operators were mentioned to be experienced. A meta-analysis by Donald et al. [35] found that VL by inexperienced operators improved the first attempt success rate and time to intubation, but the same was not seen with experienced operators.

The evidence from this meta-analysis suggests supports the use of a VL over DL for NTI in oral-maxillofacial surgeries. Further robust studies can be planned to ascertain the precise role of VL in NTI with a universal definition of the intubation time and inexperienced users.

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

Author Contributions

Nishkarsh Gupta (Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Software; Supervision; Validation; Visualization; Writing – review & editing)
Anju Gupta (Data curation; Formal analysis; Investigation; Methodology; Supervision; Validation; Writing – review & editing)
Riniki Sarma (Data curation; Formal analysis; Investigation; Methodology; Validation; Writing – original draft; Writing – review & editing)
Atul Batra (Data curation; Formal analysis; Methodology; Supervision; Validation; Writing – review & editing)
Karan Madan (Conceptualization; Formal analysis; Methodology; Supervision; Validation; Visualization; Writing – review & editing)

Supplementary Materials

Supplementary Fig. 1. Forest plot for comparison of overall suc-

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cess rate between video laryngoscopy and direct laryngoscopy. M-H, Mantel-Haenszel.
Supplementary Fig. 2. Forest plot for comparison of glottic view between video laryngoscopy and direct laryngoscopy. M-H, Mantel-Haenszel.
Supplementary Fig. 3. Forest plot for comparison of nasal bleeding between video laryngoscopy and direct laryngoscopy. M-H, Mantel-Haenszel.
Supplementary Fig. 4. Risk of bias.

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