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; I² = 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.

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 (registration number: 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 maxillof). 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.
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].

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).

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).
<table>
<thead>
<tr>
<th>Study</th>
<th>N</th>
<th>Type of Surgery</th>
<th>Devices</th>
<th>Inclusion criteria</th>
<th>Exclusion criteria</th>
<th>Operator experience</th>
<th>Definition of time to intubation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazarika 2018 [25]</td>
<td>100</td>
<td>Head and neck cancer</td>
<td>C-MAC &amp; DL</td>
<td>ASA 1–3; 20–70 yr; EGRI 1–7</td>
<td>ASA 4; MO &lt; 2.5; difficult BMV; hyperkalemia; h/o malignant hyperthermia</td>
<td>20 successful nasal or oral intubations C-MAC D-blade</td>
<td>Introduction of scope to mouth till three consecutive ETCO₂ readings</td>
</tr>
<tr>
<td>Jones 2008 [26]</td>
<td>69</td>
<td>Dental or maxillofacial</td>
<td>GVL &amp; DL</td>
<td>More than equal to 18 yr</td>
<td>ASA 4; MO &lt; 2.5; difficult BMV; hyperkalemia; h/o malignant hyperthermia</td>
<td>&gt; 10 successful GVL intubation</td>
<td>End of mask ventilation to detection of ETCO₂ of at least 30 mmHg</td>
</tr>
<tr>
<td>Sato 2017 [31]</td>
<td>60</td>
<td>Oromaxillofacial</td>
<td>McGrath &amp; DL</td>
<td>ASA 1–2; 20–70 yr</td>
<td>Expected difficulty in intubation; patients with rhino stenosis</td>
<td>Experience &gt; 6 y by JDSA</td>
<td>Passage of ETT through nasal cavity until chest rise seen</td>
</tr>
<tr>
<td>Kwak 2016 [29]</td>
<td>70</td>
<td>Oromaxillofacial with normal airway</td>
<td>McGrath &amp; DL</td>
<td>ASA 1–2; 20–60 yr</td>
<td>Suspected difficult airway; CSI; bleeding tendency; RSI required</td>
<td>Experienced anesthesiologists</td>
<td>Insertion through the nostril to detection of ETCO₂</td>
</tr>
<tr>
<td>Zhu 2019 [27]</td>
<td>66</td>
<td>Oromaxillofacial</td>
<td>MacGrath &amp; DL</td>
<td>ASA 1–2; 18–60 yr</td>
<td>EGR &lt; 7; Reflux; OSA; BMI &gt; 40</td>
<td>&gt; 100 NTI with both laryngoscopes</td>
<td>Mouth opening till three consecutive ETCO₂ readings</td>
</tr>
<tr>
<td>Roh 2019 [28]</td>
<td>80</td>
<td>Dental or maxillofacial</td>
<td>MacGrath &amp; DL</td>
<td>ASA 1–2; 19–60 yr</td>
<td>MMP4; requiring RSI; CSI; bleeding tendencies</td>
<td>&gt; 50 intubations with the study laryngoscopes</td>
<td>Intranasal placement to detection of ETCO₂</td>
</tr>
<tr>
<td>Puchner 2011 [34]</td>
<td>40</td>
<td>Dental or oromaxillofacial</td>
<td>GVL &amp; DL</td>
<td>ASA 1–2; 18–80 yr</td>
<td>Difficult airway or h/o bleeding</td>
<td>&gt; 10 intubations per laryngoscope</td>
<td>Not specified</td>
</tr>
<tr>
<td>Shrestha 2015 [30]</td>
<td>40</td>
<td>Maxillofacial</td>
<td>Truview &amp; DL</td>
<td>ASA 1–2; 18–60 yr</td>
<td>ASA 3.4; morbid obesity; upper airway structural anomalies; C/I for NTI</td>
<td>&gt; 50 intubations with Truview EVO2 in normal and difficult airways</td>
<td>Insertion between teeth until first capnographic trace</td>
</tr>
<tr>
<td>Suzuki 2012 [32]</td>
<td>90</td>
<td>Elective orthodontic</td>
<td>Pentax AWS &amp; DL</td>
<td>ASA 1–2; &gt; 18 yr</td>
<td>h/o CSI; difficult airway; GERD; BMI &gt; 35</td>
<td>Experienced but not defined</td>
<td>Time from the tube passing the incisors until the ETT was traversed</td>
</tr>
<tr>
<td>Tseng 2017 [33]</td>
<td>72</td>
<td>Oromaxillofacial</td>
<td>GVL and DL</td>
<td>ASA 1–2; 20–65 yr</td>
<td>MO &lt; 3 cm; CS instability; h/o difficult intubation, chronic suppurative sinusitis, C/I for NTI</td>
<td>Experienced but not defined</td>
<td>Placement of the nasotracheal tube from selected nostril till the removal of the scope</td>
</tr>
</tbody>
</table>

Meta-analysis

Time to intubation: The definition of time to intubation varied from the mouth opening until the detection of ETCO₂ [25,27,30], end of mask ventilation until detection of ETCO₂ [26], intranasal placement until detection of ETCO₂ [28], insertion through nostril until detection of ETCO₂ [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; I² = 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 higher 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, I² = 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; I² = 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; I² = 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; I² = 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; I² = 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. 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 ma-
## Table 2. Quality of Evidence from GRADE System

<table>
<thead>
<tr>
<th>Participants (studies)</th>
<th>Certainty assessment</th>
<th>Summary of findings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Risk of bias</td>
<td>Inconsistency</td>
</tr>
<tr>
<td>Follow up</td>
<td></td>
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<tr>
<td>Total success</td>
<td></td>
<td></td>
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<tr>
<td>Maneuvers</td>
<td></td>
<td></td>
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<tr>
<td>CL 1 &amp; 2</td>
<td></td>
<td></td>
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<tr>
<td>Bleeding</td>
<td></td>
<td></td>
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<tr>
<td>First attempt success rate</td>
<td></td>
<td></td>
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<tr>
<td>Time to intubation (Scale from: 10 to 200)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.

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 McGrath VL was significantly shorter than that of DL [27–31]. 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 success 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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