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Original research article

Visibility of the glottis during the induction of general anesthesia in patients with obstructive sleep apnea syndrome: retrospective comparative study of video and direct laryngoscopy

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Abbreviations
ASA – American Society of Anesthesiologists
BMI – body mass index
DL – direct laryngoscopy
ENT – ear, nose and throat
OSAS – obstructive sleep apnea syndrome
VL – videolaryngoscopy

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Abstract

Background and purpose: *Patients with obstructive sleep apnea syndrome (OSAS) may present as an anesthetic challenge during the induction of general anesthesia for possible difficult airway management. The aim of this study was to share our experiences with airway management in OSAS patients during general anesthesia using video laryngoscopy (VL) and direct laryngoscopy (DL), hypothesizing that VL provides superior glottic visibility compared to DL.*

Materials and methods: *We conducted a retrospective comparative study including two groups of adult patients with polysomnographically diagnosed OSAS who underwent uvulopalatopharyngoplasty and/or septoplasty under general anesthesia at the Sveti Duh University Hospital in Zagreb, Croatia. The DL group consisted of patients from January 2009 to August 2013, while the VL group included patients from January 2020 to December 2024. A questionnaire was completed for each patient, recording general, preoperative, intraoperative, and postoperative data relevant for airway management.*

Results: *In the VL group (n=91), the distribution of glottic visibility according to the Cormack-Lehane classification from 1 (best view) to 4 (worst view) was as follows: 62 (68.1%) (score 1), 23 (25.3%) (score 2), 6 (6.6%) (score 3), and 0 (0%) (score 4). In the DL group (n=91), glottic visibility according to the Cormack-Lehane classification from 1 to 4 was as follows: 14 (15.4%) (score 1), 51 (56%) (score 2), 25 (27.5%) (score 3), and 1 (1.1%) (score 4). (p <0.001).*

Conclusions: *In our study, VL provided better glottic visibility in adult patients with obstructive sleep apnea compared to DL.*

INTRODUCTION

Anesthesiologists often encounter patients with obstructive sleep apnea syndrome (OSAS), who may represent significant airway challenges during anesthesia. According to one systematic review and meta-analysis OSAS had a three to four-fold higher risk of difficult intubation or mask ventilation or both, when compared to non-sleep apnea patients *(1).* The Postoperative Vascular Complications in Unrecognized Obstructive Sleep Apnea (POSA) trial revealed further evidence for association of moderate and severe OSAS with difficult intubation and increasing neck circumfer-

ence with difficult mask ventilation *(2).* For these reasons, the guidelines for preoperative assessment and preparation warn anesthesiologists to consider the risks of airway management in OSAS patients *(3,4).*

Videolaryngoscopy, as opposed to traditional direct laryngoscopy, has emerged in anesthetic clinical practice aiming to improve quality and safety of airway management, particularly tracheal intubation. The last Cochrane review states that videolaryngoscopy likely provides a safer risk profile compared to direct laryngoscopy for all adults undergoing tracheal intubation *(5),* but still not concluding details about the selected group of populations, such as OSAS patients.

The purpose of this study was to present our experiences in the anesthetic management of the airway in patients with OSAS during the induction of general anesthesia by comparing two airway techniques, the newer one, videolaryngoscopy, and the traditional one, direct laryngoscopy. The hypothesis was that videolaryngoscopy would improve glottic visibility in patients with OSAS during the induction of general anesthesia compared to direct laryngoscopy.

MATERIALS AND METHODS

Patients and methods

After deciding to perform this retrospective analysis, we claimed for the ethical approval from the local Ethics Committee (No. 03-1174, February 20, 2025). In fact, this study was an extension of the study, which had already been approved of by the same Ethical Committee (No. 01-3995, November 19, 2013), performed at the Department of Anesthesiology, Resuscitation and Intensive Care and the Department of Otorhinolaryngology and Head and Neck Surgery, Sveti Duh University Hospital and published *(6).* That study group included 91 adult patients with OSAS who underwent otorhinolaryngological surgical procedures, specifically uvulopalatopharyngoplasty and/or septoplasty, and were intubated using direct laryngoscopy (DL) The study period for DL was the period from January 2009 to August 2013, when only DL as technique was available *(6).* The new group, referred to as the videolaryngoscopy (VL) group, consisted of similar 91 adult patients with OSAS who underwent similar surgical procedure under general anesthesia, but using videolaryngoscopy (VL) for intubation. The period from which data about the VL was collected was the one when we already had routine experience with videolaryngoscopy (the period January 2020 to December 2024).

Data for both groups were obtained similarly by forming the departmental database from the anesthetic charts and medical documentation. For the DL group, we utilized the existing database. To carry out this extended study, we reviewed records and extracted relevant data *de novo* from the Department of Anesthesiology, Resuscitation and Intensive Care, as well as from the Department of Otorhinolaryngology and Head and Neck Surgery, Sveti Duh University Hospital. The inclusion criteria for the study required that patients underwent uvulopalatopharyngoplasty and/or septoplasty under general anesthesia from January 2020 to December 2024, had to be objectively diagnosed OSAS confirmed by polysomnography, and had to be intubated using videolaryngoscopy. Conversely, the exclusion criteria consisted of patients who underwent surgery in local anesthesia or received local anesthesia with sedation in the presence of an anesthesiologist, and patients with incomplete data in the medical documentation.

We collected and analyzed for both groups the same patients' demographic data: gender (male/female), age (years), American Society of Anesthesiologists (ASA) classification score (I – an otherwise healthy patient; II – a patient with mild systemic disease; III – a patient with severe but compensated systemic disease; IV – a patient with severe and decompensated systemic disease; height (cm), weight (kg), body mass index (BMI, kgm^{-2}). Preoperative data relevant to airway assessment was a modified Mallampati score (ranging from 1 to 4) *(7).* Intraoperative data relevant to airway management were as follows: a Cormack Lehane classification score (ranging from 1 to 4) *(8),* type of laryngoscope (videolaryngoscope or direct laryngoscope), type of laryngoscope blade (Macintosh, McCoy, hyperangulated, C-MAC® D-Blade). For the direct laryngoscopy we used standard metal Macintosh blade laryngoscope or McCoy blade laryngoscope. Available videolaryngoscopes were either reusable C-MAC® D blade with metal blade (Karl Storz, Tuttlingen, Germany) or Infinium ClearVue® (QuadMed, Inc.,Jacksonville, FL, USA) with Macintosh or hyperangulated plastic blades. In addition, we noted the type and size of the tracheal tube, and the type of mechanical ventilation (volume or pressure). Early postoperative data relevant to airway management included any respiratory complications and the discharge location after surgery, whether to the ear, nose and throat (ENT) ward or the surgical intensive care unit.

The primary outcome was airway visibility, particularly the visibility of the glottis (i.e. laryngeal inlet), which we assessed from 1 to 4 according to the Cormack-Lehane classification *(8)* with the following meanings: score 1 means the full glottis visible; score 2 means the epiglottis partially overlaps the glottis; score 3 means only epiglottis visible; score 4 means neither epiglottis, nor glottis visible. Additionally, we evaluated several secondary outcomes: the incidence of difficult airway management defined as difficult ventilation and difficult intubation, including the number of intubation attempts, and the perioperative complications related to airway management (mild laryngospasm, severe laryngospasm, bronchospasm). Difficult intubation and difficult ventilation were defined according to the ASA 2022 guidelines for management of the difficult airway (9).

We used a prepared questionnaire to gather information from medical charts. To ensure anonymity, the ques-

tionnaire did not include patient names. All data were transcribed from the paper questionnaires into an electronic format using an Excel spreadsheet, which served as the database for further statistical analysis.

Statistical methods

Data analysis commenced with descriptive statistics and the presentation of the results tabularly. Categorical data (gender, ASA, BMI category, Mallampati score, Cormack Lehane score, type of laryngoscopy, type of laryngoscopy blade, type of tube, type of mechanical ventilation, respiratory complications, type of postoperative discharge) were expressed in absolute numbers and corresponding percentage. Quantitative data (age, height, weight, BMI) were tested for normality by the Kolmogorov-Smirnov test and the Shapiro- Wilk test. Quan-

Table 1. *Demographic and specific airway management characteristics of all study OSAS patients (N=182)*

Variable (%)	n (%)
Male gender	124 (68.1%)
Agea, years	47.74 ±11.24
ASA I /II /III/ IV	13 (7.1%) / 140 (76.8%) / 29 (15.9%) / 0(–)
ASA ≥ II	169 (92.9%)
ASA ≥ III	29 (15.9%)
Weightb, kg	95.00 [80.75-105.00]
Heightb, cm	176.00 [170.00-182.00]
BMIa, kgm^{-2}	30.41±5.18
BMI 18.5–24.9 kgm^{-2} normal	26 (14.3%)
BMI 25–29.9 kgm^{-2} preobese	63 (34.6%)
BMI 30–34.9 kgm^{-2} obese class I	57 (31.3%)
BMI 35–39.9 kgm^{-2} obese class II	30 (16.5%)
BMI ≥ 40 kgm^{-2} obese class III	6 (3.3%)
BMI ≥ 25 kgm^{-2} overweight	156 (85.7%)
BMI ≥ 30 kgm^{-2} obese class I-III	93 (51.1%)
BMI ≥ 35 kgm^{-2} obese class II-III	36 (19.8%)
BMI ≥ 40 kgm^{-2} obese class III	3 (3.3%)
Mallampati 1/2/3/4	26 (14.3%) / 76 (41.8%) / 70 (43.4%) / 10 (5.5%)
Mallampati ≥ 2	156 (85.7%)
Mallampati ≥ 3	80 (44.0%)
Mallampati ≥ 4	10 (5.5%)
Cormack Lehane 1/2/3/4	76 (41.8%) / 74 (40.7%) / 31 (17.0%) / 1 (0.5%)
Cormack Lehane ≥ 2	106 (58.2%)
Cormack Lehane ≥ 3	32 (17.6%)
Cormack Lehane ≥ 4	1 (0.5%)
Reinforced tube	157 (86.3%)
Tube 6.0 / 6.5 / 7.0 / 7.5 / 8.0 / 8.5	2 (1.1%) / 2 (1.1%) / 24 (13.2%) / 49 (26.9%) / 90 (49.5%) / 15 (8.2%)
Blade: Macintosh / McCoy / hyperangulated / D-blade	93 (51.5%) / 8 (4.4%) / 76 (41.8%) / 5 (7.7%)
Volume controlled ventilation	144 (79.1%)
Difficult manual ventilation	16 (8.8%)
Difficult intubation	10 (5.5%)
Postoperative respiratory complications	8 (4.4%)
Mild laryngospasm	3 (1.6%)
Severe laryngospasm	3 (1.6%)
Bronchospasm	2 (1.1%)

[a] data normally distributed presented as mean ±standard deviation; [b] data not normally distributed presented as median (25^{th} percentile to 75^{th} percentile); ASA – American Society of Anesthesiologists score; BMI – body mass index

Table 2. *The comparison of demographic and specific preoperative airway management data between videolaryngoscopy (VL) and direct laryngoscopy (DL) groups.*

Variable	VL (n=91)	DL (n=91)	p value
Male gender	63 (69.2%)	61 (67.0%)	0.750
Female gender	28 (30.8%)	30 (33.0%)	
Age[a], years	48.77±10.61	46.18±11.76	0.120
ASA I	4 (4.4%)	9 (9.9%)	0.017
ASA II	66 (72.5%)	74 (81.3%)	
ASA III	21(23.1%)	8 (8.8%)	
ASA IV	0 (-)	0 (-)	
ASA ≥ II	87 (95.60%)	82 (90.1%)	0.150
ASA ≥ III	21 (23.1%)	8 (8.8%)	0.008
ASA ≥ IV	0 (0)	0 (-)	-
Weight[b], kg	95 [92-97]	92 [87-98]	0.496
Height[b], cm	178 [175-178]	175 [172-178]	0.345
BMI[a], kgm^{-2}	30.51±4.48	30.31±5.82	0.799
BMI 18.5-24.9 kgm^{-2} normal	5 (5.5%)	21 (23.1%)	0.005
BMI 25-29.9 kgm^{-2} preobese	40 (44.0%)	23 (25.3%)	
BMI 30-34.9 kgm^{-2} obese class I	27 (29.7%)	30 (33.0%)	
BMI 35-39.9 kgm^{-2} obese class II	16 (17.6%)	14 (15.4%)	
BMI ≥ 40 kgm^{-2} obese class III	3 (3.30%)	3 (3.30%)	
BMI ≥ 25 kgm^{-2} overweight	86 (94.5%)	70 (76.9%)	<0.001
BMI ≥ 30 kgm^{-2} obese class I-III	46 (50.5%)	47 (51.6%)	0.882
BMI ≥ 35 kgm^{-2} obese class II-III	19 (20.89%)	17 (18.7%)	0.710
BMI ≥ 40kgm^{-2} obese class III	3 (3.30%)	3 (3.30%)	1.000
Mallampati 1	15 (16.5%)	11 (12.1%)	0.026
Mallampati 2	30 (33.0%)	46 (50.5%)	
Mallampati 3	43 (47.3%)	27 (29.7%)	
Mallampati 4	3 (3.3%)	7 (7.7%)	
Mallampati ≥ 2	76 (83.5%)	80 (87.9%)	0.397
Mallampati ≥ 3	46 (50.5%)	34 (37.4%)	0.073
Mallampati ≥ 4	3 (3.3%)	7 (7.7%)	0.193

[a] data normally distributed presented as mean ±standard deviation; [b] data not normally distributed presented as median (25^{th} percentile to 75^{th} percentile); ASA – American Society of Anesthesiologists score; BMI – body mass index

titative data compatible with normal distribution (age and BMI) were presented as mean and standard deviations, while data incompatible with a normal distribution (height and weight) were presented as medians and interquartile range. The unpaired t-test was used for the comparative analysis of normally distributed quantitative date between the direct laryngoscopy and videolaryngoscopy group. The Mann-Whitney U test was used to compare non-normally distributed quantitative data between the direct laryngoscopy and videolaryngoscopy group. The chi square test was used for the comparative analysis of categorical data. The results were interpreted at the 5% significance level. We used IBM SPSS software for Windows, version 30.0.0.0 (IBM SPSS Inc., Chicago, Il, USA) statistical program.

RESULTS

Table 1 shows demographic and specific airway management characteristics of all OSAS patients (N=182). Table 2 shows a comparison of demographic and specific preoperative airway management data between the study VL(n=91) and DL (n=91) groups. Table 3 shows a comparison of intraoperative and postoperative data relevant

Table 3. *The comparison of specific intraoperative and postoperative airway management data between videolaryngoscopy (VL) and direct laryngoscopy (DL) groups.*

Variable	VL (n=91)	DL (n=91)	p value
Cormack Lehane 1	62 (68.1%)	14 (15.4%)	<0.001
Cormack Lehane 2	23 (25.3%)	51(56.0%)	
Cormack Lehane 3	6 (6.6%)	25 (27.5%)	
Cormack Lehane 4	0 (-)	1 (1.1%)	
Cormack Lehane ≥ 2	29 (31.9%)	77 (84.6%)	<0.001
Cormack Lehane ≥ 3	6 (6.6%)	23 (28.6%)	<0.001
Cormack Lehane ≥ 4	0 (-)	1 (1.10%)	0.316
Reinforced tube	91 (100%)	66 (72.5%)	<0.001
Tube 6.0	0 (-)	2 (2.2%)	<0.001
Tube 6.5	0 (-)	2 (2.2%)	
Tube 7	10 (11.0%)	14 (15.4%)	
Tube 7.5	27 (29.7%)	22 (24.2%)	
Tube 8.0	54 (59.3%)	36 (39.6%)	
Tube 8.5	0 (-)	15 (16.5%)	
Macintosh	10 (11.0%)	83 (91.2%)	<0.001
McCoy	0 (-)	8 (8.8%)	
Hyperangulated	76 (83.5%)	0 (-)	
D-blade	5 (5.5%)	0 (-)	
Pressure controlled ventilation	4 (4.4%)	34 (37.4%)	<0.001
Volume controlled ventilation	87 (95.6%)	57 (62.6%)	
Difficult manual ventilation	0 (-)	16 (17.58%)	<0.001
Difficult intubation	3 (3.3%)	7 (7.7%)	0.193
Postextubation respiratory complications	1 (1.1%)	7 (7.7%)	0.030
No postoperative complications	90 (98.9%)	84 (92.3%)	0.136
Mild laryngospasm	1 (1.1%)	2 (2.2%)	
Severe laryngospasm	0 (-)	3 (3.3%)	
Bronchospasm	0 (-)	2 (2.2%)	

to airway management between the study VL(n=91) and DL (n=91) groups. All patients were postoperatively good enough to be safely discharged from the operation theater directly to the ENT ward.

DISCUSSION

The aim of this study was to present our experience in the airway management of OSAS patients and to test the hypothesis that VL improves visibility of the glottis in OSAS patients. And indeed, the results of our research showed that there is a significant difference in the distribution of the scoring of the Cormack Lehane classification, as a measure of visibility of the glottis in patients with VL compared to DL in favor of VL. Thus, we confirmed our initial hypothesis that visibility of the glottis is better in OSAS patients. This result is not surprising, but it is the first such evidence to our knowledge.

Optimization of glottic visibility enhances chances for successful intubation *(10)*. During last decade VL has emerged as a promising method for airway management in patients with difficult airway with tendency to replace DL, which had been established as the gold standard for intubation for decades *(5)*. VL likely reduces the rates of failed intubation and increases the chances of successful intubation on the first attempt because it enhances glottic visibility *(11)*. Furthermore, VL can decrease the incidence of hypoxia, and hyperangulated VL may reduce the frequency of esophageal intubation in the operation theatre *(5)*. Therefore, it was stated that VL offers a safer risk profile compared to DL for all adult patients requiring intubation *(5)*.

Clinical and polysomnographic diagnoses of OSAS have proven useful predictors of difficult laryngoscopy, with obese patients being more prone to difficult mask ventilation and laryngoscopy *(12,13)*. However, contrary

to the published results in which the incidence of difficult intubation in OSAS patients was 6.7% and difficult mask ventilation was 3.7% *(2),* we found the incidence of difficult mask ventilation higher to difficult intubation (8.8% vs 5.5%). VL cannot affect the manual ventilation, so the significant difference in the difficult mask ventilation, as seen in our study only in DL group, is irrelevant for further discussion.

Previous studies have shown that patients with OSAS undergoing uvulopalatopharyngoplasty have a high risk of difficult laryngoscopy *(14).* Additionally, the rates of difficult intubation in these patients are notable, where a Cormack-Lehane score of ≥3 is a significant indicator of intubation difficulties *(6).* Given these challenges, it would be useful to have more reliable airway devices for better glottic visualization and successful intubation in OSAS patients. So far there has not been specific evidence for the use of VL in OSAS patients. In our study, we found that the visibility of glottis was significantly better, but we did not find a statistically significant difference between VL and DL in the rate of difficult intubation. We think that the possible explanation is in the design and limitations of our study. In addition, our study showed significant differences in tube sizes and type of blades. This is of no relevance for further discussion because types of blades such as D-Blade and hyperregulated are specific for VL, while McCoy is specific for DL.

The limitations of this study are retrospective methodology and analysis in two different time periods that may influence outcomes. Despite the respectable number of overall subjects in our study, the number sufficient for the analysis of difficult intubation or further analysis for VL blade type or related airway complications was not achieved. Namely, the literature depicts that over the decades there has been a decrease in the rates of difficult and failed intubation *(15,16),* not necessarily attributed to the adaptation of technology such as VL, but also to the adaptation and evaluation of the whole concept of difficult airway from the initial *(17)* to the most recent extended version *(18).* It is about how we adopt all recommendations from the guidelines and how we prepare the patients, equipment, team and ourselves for possible difficult airway scenario, and not a single measure or technique we use. As critical events become rarer, what means better quality of care in clinical practice, there is need to involve larger number of participants in the study. For that reason, to get stronger evidence, it is necessary to conduct prospective study with a larger number of subjects or to use administrative databases *(16),* so that the outcomes of difficult intubation and the use of various types of VL blades can also be investigated.

CONCLUSION

Our study showed that adopting VL in airway management for OSAS patients undergoing uvulopalatopharyngoplasty and/or septoplasty in general anesthesia is not just a good idea but has some clinical benefits. VL could be an advantageous practice because it improved visibility of glottis as a prerequisite for successful intubation in this specific clinical scenario. However, additional evidence of VL in OSAS patients is needed to claim general benefits of VL in airway management.

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