

Prospective, randomised, controlled study comparing Videolaryngoscopy versus Direct Laryngoscopy for Double-Lumen Endotracheal Tube Intubation in thoracic surgery

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Abstract

Background:

We investigated the impact of videolaryngoscopy for double-lumen tube (DLT) intubation in thoracic anaesthesia with videolaryngoscopy (GVL) using a thin GlideScope®-Titanium single use blade.

Methods:

A clinical, prospective, randomised, controlled trial was conducted with a total of 70 patients undergoing elective thoracic surgery and need for a DLT intubation. Finally, 65 patients were analysed (DL group [n= 31] vs. GVL group [n=34]). Endpoints were time to intubate, subjective symptoms and objective trauma of the oropharynx and supraglottic space.

Results:

Mean intubation time in GVL group was 178 seconds \pm 279 versus 84 seconds \pm 62 in DL group [p = 0.044]. Videolaryngoscopy resulted in significantly improved visualisation of the larynx compared with Direct Laryngoscopy (DL). Cormack and Lehane (CL) grade of 1 was more frequent in GVL group (97%) than in DL Group (74%) [p = 0.008]. In analysis of the postoperatively completed questionnaires, no significant differences regarding the subjective symptoms could be determined.

Objectifiable endoscopic examinations revealed significant differences in GVL group compared to DL group showing less hypopharyngeal haematoma [p = 0.048], red-blooded vocal cord [p = 0.01], vocal cord haematoma [p = 0.027] and vocal cord haemorrhage [p = 0.03].

Conclusions:

Videolaryngoscopy prolongs DLT intubation duration; on the other hand, it allows a better view of the glottis and reduces postoperative trauma. Due to the better view, there is objectively less intubation trauma. The different objective intubation traumata did not seem to affect subjective symptoms of the patients after a DLT intubation.

Background

Modern thoracic surgery is supported by one-lung ventilation, which can be achieved by intubation with a double-lumen endotracheal tube (DLT) or a standard single-lumen endotracheal tube and an additive bronchial blocking method (1). Compared to a single-lumen endotracheal tube, a DLT has a larger outer diameter, and is longer and more rigid. Therefore, the DLT intubation procedure is more challenging and the incidence of injuries to the pharynx, larynx (particularly to the vocal cords), and trachea during tube placement is higher than during placement of a standard single-lumen endotracheal tube combined with a bronchial blocker (2–4). Videolaryngoscopic intubation with a standard single lumen endotracheal tube using a GlideScope® causes less soft tissue damage compared to conventional MacIntosh laryngoscopy

(5). The advantages of videolaryngoscopy for DLT intubation compared with traditional MacIntosh laryngoscopy (DL) is currently being discussed controversially in terms of differences in intubation times and the associated injuries (6, 7). Moreover, some meta-data with moderate to low quality evidence exist, showing a higher success rate at first attempt, a higher incidence of malpositioned double-lumen tube and a lower incidence of oral, mucosal or dental injuries with videolaryngoscopy for DLT intubation (8). However, the benefit of using videolaryngoscopy for intubation with DLTs is still unclear.

GlideScope® videolaryngoscopy with a 60° hyper-angulated blade was developed in Canada in 2001 by Pacey (9, 10). Videolaryngoscopy itself with high-resolution digital camera often enables a better view of the vocal cord (9–13). There is convincing data for using videolaryngoscopy in difficult airway management and reducing cervical spine movement (11, 14, 15). Current research shows an improvement in intubation conditions and first success rates with slightly longer intubation times through GlideScope® videolaryngoscopy (13). In 2014, the GlideScope®-Titanium video laryngoscope was launched. The GlideScope®-Titanium Single use blades are thinner than the previous blades of the GlideScope®. For GlideScope®-Titanium, single use blades are 3 mm (Size 3) and 2.7 mm (Size 4).

In our study, we investigated the effect of videolaryngoscopy on the DLT intubation and especially the potential benefit of one particular videolaryngoscope (GlideScope® Titanium single use blade), which had a blade that was nearly 3 mm thinner than the currently used GlideScope® videolaryngoscope. A thinner blade design should be useful during the intubation of patients with a small oral cavity or limited mouth opening capacity. Presumably this device offers more space in the pharynx during DLT intubation. In contrast to the previous studies, we tried to increase the quality of our follow-up, detecting subjective symptoms and objectifiable injuries after DLT intubation. Therefore, in addition to a patient questionnaire, we used two consecutive investigator-blinded nasal endoscopic examinations for follow-up. The video files of these endoscopies were evaluated by three independent investigators.

Methods

With approval by the institutional ethics committee of the Philipps-University Marburg (File number 115/16; 14.09.2016) (DRKS00020978, retrospectively registered), and patient written informed consent, 70 adult patients scheduled for elective thoracic surgery requiring general anaesthesia with the need of a double-lumen tube (DLT) intubation and with American Society of Anesthesiologists physical status I–IV were enrolled from 23.02.2017 until 18.09.2017.

The main exclusion criterion was patients aged less than 18 years. In addition, non-fasting patients, pregnant women and patients with gastro-oesophageal reflux disease, which were indicated for rapid-sequence induction, were excluded from the study. Other exclusion criteria were the following: contraindication to a left or right DLT; contraindication to one-lung ventilation; and an abnormal physical status of the Cervical spine (e.g., after C-spine trauma, Bechterew's disease).

Patients were pre-medicated with 3.75–7.5 mg oral midazolam 45 minutes before surgery. On arrival in the operating room (OR), all participants were blinded, randomly assigned to either conventional

laryngoscopy (MacIntosh) or GlideScope® videolaryngoscopy (GlideScope; Verathon Inc., Bothell, WA) by sealed envelope randomisation. In the OR, every patient received pre-oxygenation with 100% oxygen through a mask over 5 minutes. After pre-oxygenation, anaesthesia was induced with 0.3 µg/kg sufentanil and 2 mg/kg 1% propofol, followed by a total intravenous anaesthesia (TIVA) according to the in-house standard operation procedure (SOP) in anaesthesia for thoracic surgery with propofol (4–6 mg/kg bodyweight/h) and remifentanil (15–25 µg/kg bodyweight/h). Muscle relaxation was induced with 0.6 mg/kg rocuronium bromide followed by at least 3 minutes of bag-mask ventilation. The depth of anaesthesia was monitored by measuring derived EEG signals using Bispectral Index monitoring (BIS). The neuromuscular monitoring was performed by a relaxometry Train of Four (TOF). DLT intubation was not performed until there was a sufficient depth of sleep and full relaxation of the patient, which was checked by the full relaxation status (TOF 0/4) and a BIS value below 60. Intubation was performed using a MacIntosh blade (size 3 or 4) in the MacIntosh group or with the GlideScope®-Titanium Single-Use-blade with hyper-angulation (size 3 or 4) in the videolaryngoscopy group. At the start of our study, there was no rigid stylet (GlideRite® Guide) for double-lumen tubes (DLT) available. Therefore, we used DLT with the original inner stylet in both groups. In the GVL group, we used the original rigid stylet GlideRite® for the single-lumen endotracheal tube as a template to shape the inner stylet and to replicate the curve of the GlideScope according to the hyper-angulation videolaryngoscopy-blade with the 60 degree angle. An appropriately sized DLT (Rüsch Bronchopart; Teleflex Medical GmbH, Dublin, Ireland) was chosen for DLT intubation by the experienced physician. All DLT intubations were performed by three experienced senior physicians in the department. All three physicians who took part in this study were specialists who regularly perform thoracic anaesthesia and regularly use the GlideScope® for tracheal intubation. All three of the physicians have routinely performed more than 1000 intubations with a DLT using direct laryngoscopy. In addition, they also had a lot of experience in videolaryngoscopy with GlideScope® (primary videolaryngoscope established as a routine in the department since 2010) for a single-lumen endotracheal tube. Nevertheless, all three physicians had little experience using the GlideScope® for DLT insertion and no exercise with the new GlideScope® Titanium single use blade before the investigation started.

The primary outcome was duration of endobronchial DLT intubation regardless of the number of attempts. The intubation time was defined as: blade passes mouth opening → positive capnography (three visible CO₂ curves at the capnograph). In this context, we also reported the number of intubation attempts, the assessment of difficulty and any complications during DLT intubation in both groups.

The secondary endpoint of this clinical study was the incidence of intubation-related injuries in both groups. Therefore, we performed two consecutive transnasal flexible endoscopic examinations of the oropharynx, of the supraglottic space and of the vocal cords, a follow-up survey by questionnaire and a dental examination to detect dental trauma.

The first endoscopic examination was under general anaesthesia before extubation, while the second endoscopic examination took place 24 h after extubation under local anaesthesia. Both endoscopic examinations were performed by the main investigator.

All endoscopic examinations were anonymised and blinded to the technique as video files and evaluated by three independent investigators (2 anaesthesiologists and 1 ENT specialist, investigator-blinded). Both endoscopic examinations of each patient were compared. The hypopharynx, the vocal cords and the arytenoid cartilage were evaluated on the basis of various criteria. The different criteria were scored from zero to three depending on the degree of the findings (0 = not assessable, 1 = without pathological findings, 2 = minor injuries, 3 = severe injuries). The results were averaged for further analysis.

At the second follow-up examination 24 h after DLT intubation, the patients first completed a questionnaire (Validated H&N35 Quality of Life Questionnaire Head and Neck Module and NRS) to express their subjective symptoms (hoarseness, etc.).

Finally a physician of oral and maxillofacial surgery (investigator blinded) performed a dental examination after DLT intubation in all study patients, examining the patient for lip and dental trauma, such as enamel fractures.

Our sample size calculation was based on a previous study from 2012 (7), which reported a mean (SD) time of 46 (11) s for DLT placement with videolaryngoscopy. Based on these results and factoring in a 20% drop-out rate, we calculated that 35 patients were required in each group to detect a 20% difference in the time taken for DLT intubation. Our sample size was calculated for a data analysis using a non-parametric Mann-Whitney U test. The a priori power analysis was performed with a (p) of 0.80 and a significance level $\alpha = 0.05$.

The values for descriptive statistics were expressed as using means, standard deviations and percentages with the Student's t-test as appropriate. Non-parametric data were analysed using the Mann-Whitney U-test, with $p < 0.05$ being statistically significant (IBM Corp. Released 2016, IBM SPSS Statistics for Windows, Version 24.0, Armonk, NY: IBM Corp.). Data are presented as tables and box-and-whisker diagrams.

Results

After written informed consent, 70 patients were recruited. Out of the 70 patients 65 completed the study and were included in the final analysis (Fig. 1). Four patients in the MacIntosh group and one patient in the GlideScope® group were excluded from the final analysis. In two participants randomised to the conventional MacIntosh group, the conventional DLT intubation failed and the experienced examiner changed the method using videolaryngoscopy. Finally intubation with a single endotracheal tube and a bronchial blocker had to be performed in these two cases because of impossible DLT intubation, with both devices conventionally with DL and with videolaryngoscopy (GVL). Two participants randomised to the conventional MacIntosh group refused postoperative nasal endoscopic examination and one participant in the GlideScope group needed long-term post-operative ventilation on the intensive care unit and was lost to follow-up. All five participants were excluded from the final analyses due to relevant study protocol violation (Fig. 1).

Both groups had no significant differences in bio-metric data and pre-operative airway assessments (Table 1). In almost all cases, a left-sided DLT was used. It was noticeable that all three experienced specialists in thoracic anaesthesia who performed the DLT intubations in the study used smaller blades and tended towards smaller tube sizes in the GVL group. The difference between the two groups was statistically significant [$p < 0.05$] (Table 1).

Table 1
Biometric data and descriptive data of patients enrolled in the study

Parameter	Macintosh (n 31)	GlideScope® (n 34)	Independent Two-Sample t-Test (p-Value)
Gender (male/female) n	25/6	25/9	0,502
Age (years) mean \pm SD	60 \pm 12	63 \pm 15	0,261
Weight (kg) mean \pm SD	85 \pm 16	80 \pm 15	0,202
Height (cm) mean \pm SD	176 \pm 8	172 \pm 9	0,063
Body mass index (kg x m ⁻²) mean \pm SD	27 \pm 5	27 \pm 6	0,847
ASA n (%):	0 (0%)	1 (3%)	0,637
I	10 (32%)	9 (26%)	
II	19 (61%)	24 (71%)	
III	2 (7%)	0 (0%)	
IV			
Mallampati score n (%):	11 (35%)	14 (41%)	0,705
I	16 (52%)	14 (41%)	
II	4 (13%)	6 (18%)	
>II			
Blade size used n (%):	1 (3%)	16 (47%)	< 0,001*
size 3	30 (97%)	18 (53%)	
size 4			
DLT size used n (%):	1 (3%)	1 (3%)	0,036*
35 French	6 (19%)	18 (53%)	
37 French	17 (55%)	10 (29%)	
39 French	7 (23%)	5 (15%)	
41 French			
DLT design used n (%):	31 (100%)	33 (97%)	0,344
left-sided	0 (0%)	1 (3%)	
right-sided			

Overall, the mean (\pm SD) duration of the successful completion of DLT intubation (primary endpoint) was significantly [$p = 0.044$] longer in the GVL group (178 seconds \pm 279) compared to the MacIntosh group (84 seconds \pm 62) (Fig. 2). Despite prolonged DLT intubation duration in the GVL group, there was better visualisation of the larynx with GVL. A CL grade of 1 was with 97% more frequent than in the MacIntosh

Group, with 74%. For the CL grade 1–4, a statistically significant difference in our data could be shown between the groups [$p = 0.008$]. In 32% of the patients in GVL group and 45% in the MacIntosh group, the BURP manoeuvre was necessary to achieve better conditions for endobronchial intubation [$p > 0.05$] (Table 2).

Table 2

DLT intubation data: Assessment of difficulty and complications

Parameter	Macintosh (n 31)	GlideScope® (n 34)	Mann Whitney U-test (p-Value)
Cormack-Lehane score n (%): I° II° III° IV°	23 (74%) 7 (23%) 1 (3%) 0 (0%)	33 (97%) 1 (3%) 0 (0%) 0 (0%)	0,008*
BURP maneuver n (%): yes no	14 (45%) 17 (55%)	11 (32%) 23 (68%)	0,293
first-attempt success n (%): yes no	28 (90%) 3 (10%)	29 (85%) 5 (15%)	0,287
DLT intubation attempts n (%): 1 2 3 > 3	28 (90%) 2 (7%) 1 (3%) 0 (0%)	29 (85%) 2 (6%) 1 (3%) 2 (6%)	0,497
SpO2 < 85% n (%): yes no	2 (6%) 29 (94%)	2 (6%) 32 (94%)	0,925
Bronchospasm n (%): yes no	2 (6%) 29 (94%)	0 (0%) 34 (100%)	0,135
Cardiac arrhythmia n (%): yes no	0 (0%) 31 (100%)	0 (0%) 34 (100%)	1,000
blood on device n (%): yes no	4 (13%) 27 (87%)	3 (9%) 31 (91%)	0,599
Correct DLT position n (%): yes no	24 (77%) 7 (23%)	18 (53%) 16 (47%)	0,041*
Carina trauma n (%): yes no	0 (0%) 31 (100%)	1 (3%) 33 (97%)	0,340
Lip trauma n (%): yes no	0 (0%) 31 (100%)	0 (0%) 34 (100%)	1,000
Dental trauma n (%): yes no	0 (0%) 21 (100%)	0 (%) 26 (100%)	1,000

Parameter	Macintosh (n 31)	GlideScope® (n 34)	Mann Whitney U-test (p-Value)
Enamel fractures n (%):	0 (0%)	0 (%)	1,000
yes	21 (100%)	26 (100%)	
no			

The next focus of the investigation, the first-attempt success, did not differ significantly between the GVL group (85%) and the MacIntosh group (90%) [$p > 0.05$]. There was also no statistically significant difference between both groups in the frequency of intubation attempts [$p > 0.05$]. None of the participants from the MacIntosh group included in the analysis required more than three intubation attempts (Table 2).

At endoscopic control a correct DLT position directly after successful endobronchial intubation was reported in 77% of the MacIntosh group and only 53% of the GVL group. The difference observed between the two groups was statistically significant [$p = 0.041$] (Table 2).

There was no other significant difference in terms of direct complications under DLT intubation between the two groups. All parameters like oxygen saturation ($SpO_2 < 85\%$), bronchospasm and arrhythmias which occurred during DLT intubation did not differ significantly between the GVL and MacIntosh groups. Blood on device after successful endobronchial intubation and carina traumatized endoscopically examined directly after successful endobronchial intubation were similar between the two groups (Table 2). Furthermore, lip and dental trauma, as well as enamel fractures examined by the dental follow-up, were not significantly different in both groups (Table 3).

Table 3

Results of relevant selected parameters from evaluation of the H&N35 Quality of Life Questionnaire Head and Neck Module (H&N Score)

Parameter H&N Score	Macintosh (n 31)	GlideScope® (n 34)	Mann Whitney U-test (p-Value)
Sore throat mean ± SD	16 ± 28	10 ± 19	0,402
Dysphagia mean ± SD	13 ± 27	21 ± 27	0,115
Cough mean ± SD	20 ± 33	22 ± 28	0,532
Hoarseness mean ± SD	21 ± 35	21 ± 26	0,640
Dry mouth mean ± SD	42 ± 46	38 ± 41	0,735
Viscous mucus mean ± SD	25 ± 37	19 ± 32	0,628
Paresthesia mean ± SD	0 ± 0	1 ± 6	0,340
Language problems mean ± SD	8 ± 24	7 ± 16	0,457
Mouth opening problems mean ± SD	0 ± 0	0 ± 0	1,000
Toothache mean ± SD	1 ± 6	0 ± 0	0,295

When analysing the postoperative questionnaires (H&N35 and NRS Score) to record the subjective symptoms after DLT-Intubation, such as sore throat, dysphagia, cough and hoarseness, no significant difference could be detected between the two groups for all items [$p > 0.05$] (Table 4).

Table 4

Results of parameters additionally examined with numerical rating scale (NRS). NRS scores 1–3 correspond to mild, scores of 4–6 to moderate and scores ≥ 7 to severe symptoms. Values are expressed as the number of patients or as the total number in percent.

Parameter NRS Score	Macintosh (n 31)	GlideScope® (n 34)	U-test (p-Value)
Sore throat n (mild/ moderate/ severe) (total in %)	7/2/0 (29%)	6/3/1 (29%)	0,430
Dysphagia n (mild/ moderate/ severe) (total in %)	4/3/0 (23%)	6/3/2 (32%)	0,289
Cough n (mild/ moderate/ severe) (total in %)	9/3/1(42%)	10/3/1 (41%)	0,782
Hoarseness n (mild/ moderate/ severe) (total in %)	7/5/0 (39%)	4/6/1 (32%)	0,477

Table 5

Data of the reported intubation related injuries from two transnasal endoscopic examinations; before and 24 h after DLT extubation. All different criteria were scored from 0 to 3. (0 = not assessable, 1 = without pathological findings, 2 = minor injuries, 3 = severe injuries). Values are expressed as mean and standard deviation.

Parameter	Macintosh pre-extubation	GlideScope® pre-extubation	U-Test (p-Value)	Macintosh 24 h post-extubation	GlideScope® 24 h post-extubation	U-Test (p-Value)
Vocal cord swelling	1,7 ± 0,3	1,6 ± 0,3	0,328	2,3 ± 0,4	2,3 ± 0,4	0,483
Vocal cord redness	1,6 ± 0,4	1,5 ± 0,3	0,804	2,2 ± 0,3	2,0 ± 0,3	0,01*
Vocal cord oedema	1,4 ± 0,3	1,3 ± 0,2	0,064	2,0 ± 0,3	2,0 ± 0,3	0,87
Vocal cord erythema	1,5 ± 0,3	1,4 ± 0,2	0,154	2,0 ± 0,3	1,9 ± 0,3	0,288
Vocal cord hematoma	1,6 ± 0,3	1,5 ± 0,3	0,285	2,4 ± 0,6	2,1 ± 0,5	0,027*
Vocal cord hemorrhage	1,7 ± 0,3	1,6 ± 0,4	0,165	2,3 ± 0,5	2,0 ± 0,4	0,03*
Vocal cord granuloma	1,1 ± 0,2	1,1 ± 0,2	0,561	2,0 ± 0,3	2,03 ± 0,5	0,534
Vocal cord mobility	1	1	1	2,0 ± 0,2	2,1 ± 0,4	0,332
Arytenoid cartilage trauma	1,6 ± 0,4	1,5 ± 0,4	0,158	2,0 ± 0,3	2,0 ± 0,4	0,403
Hypopharynx redness	2,1 ± 0,5	1,9 ± 0,4	0,081	2,4 ± 0,3	2,3 ± 0,3	0,123
Hypopharynx oedema	1,7 ± 0,3	1,7 ± 0,4	0,383	2,1 ± 0,3	2,2 ± 0,4	0,437
Hypopharynx hematoma	2,0 ± 0,4	1,8 ± 0,4	0,048*	2,3 ± 0,3	2,2 ± 0,4	0,271
Hypopharynx hemorrhage	2,2 ± 0,6	2,1 ± 0,5	0,165	2,3 ± 0,4	2,2 ± 0,4	0,762
Subglottic redness	1	1	1	1,8 ± 0,5	1,8 ± 0,6	0,457
Subglottic oedema	1	1	1	1,7 ± 0,4	1,6 ± 0,4	0,687

Parameter	Macintosh pre- extubation	GlideScope® pre- extubation	U-Test (p- Value)	Macintosh 24 h post- extubation	GlideScope® 24 h post- extubation	U-Test (p- Value)
Subglottic hematoma	1	1	1	1,9 ± 0,7	1,9 ± 0,7	0,811
Subglottic hemorrhage	1	1	1	1,8 ± 0,5	1,8 ± 0,6	0,788

In contrast to the subjective symptoms, endoscopic examinations revealed significant differences in the GVL group compared to the DL group in the objectifiable trauma hypopharyngeal haematoma [$p = 0.048$], red-blooded vocal cord [$p = 0.01$], vocal cord haematoma [$p = 0.027$] and vocal cord haemorrhage [$p = 0.03$] (Table. 5).

Discussion

We compared DLT tracheal intubation with videolaryngoscopy with a thin video-blade to the conventional Macintosh laryngoscopy. We found significantly prolonged intubation times and no significant difference in intubation success despite significantly better intubation conditions compared to conventional laryngoscopy. In addition, there was a significantly higher incidence of malpositioned double-lumen tubes in the videolaryngoscopy group. Our complex investigator blinded nasal endoscopic follow-up after DLT intubation showed significant differences in only five of the seventeen objectifiable parameters, e.g. a reduced incidence of vocal cord redness, vocal cord haematomas, vocal cord bleeding and hypopharynx haematoma in the videolaryngoscopic group. The dental follow-up showed no significant differences in DLT intubation-related injuries between the two groups. These results of reported intubation-related injuries from two trans-nasal endoscopic examinations after DLT intubation do not seem to have an impact on patient wellbeing, since none of the subjective symptoms like sore throat, dysphagia, cough and hoarseness differed between the two groups.

Prolonged intubation times for GVL videolaryngoscopy for DLT intubation were shown in previous studies (6, 16, 17). Prolonged intubation times inevitably have a greater risk of hypoxia and could be harmful to patients with pulmonary comorbidities. In a prior study by Russell et al. in 2012, anaesthetists found that GVL was more difficult to use than the Macintosh laryngoscope and ETI took longer. In their study all DLT intubations were performed by less experienced novice anaesthetists (6), whereas in our study, all DLT intubations were performed by three consultants of anaesthesiology well experienced with DLT intubations in thoracic anaesthesia and GlideScope videolaryngoscopy. Nevertheless, we could also show prolonged intubation times with GVL. A limitation of our study was, that prior to present investigation our consultants had little experience using the Titanium single use blade GlideScope for DLT insertion.

In contrast to these findings are the results of a recent meta-analysis in 2018 from Liu et al., with a total of 14 studies showing no difference in intubation time. The meta-analysis included studies with various videolaryngoscopes like Airtraq, McGrath Series 5, McGrath MAC - not all of these provide hyperacute angled devices (8). Considering only the four studies using GlideScope® videolaryngoscopy of that meta-analysis, our results are consistent with three of these four studies (6, 7, 16, 17). Only Hsu et al. were able to show shorter intubation times with Glidescope videolaryngoscopy for DLT intubation.

The first attempt success rate reported here using GVL for DLT intubation was 85%. Our reported failure rate of 15% at the first attempt using GVL is similar to most of the results reported by other groups (6, 18, 19). We were also unable to show a 100% first pass success rate with GVL, like the group of Hsu et al. (7). In the study of Hsu et al., all DLT intubations were performed by two experienced anaesthetists, who had both performed over 300 intubations using DLT with GVL. In addition, the BURP manoeuvre was not required for successful DLT intubations with GVL (7).

The process of advancing the DLT past the vocal cords seems to be the main sticking point for using hyper-angulated videolaryngoscopy (6, 20). Our findings support that DLT tube delivery and advancement into the trachea is the most difficult step in the procedure using videolaryngoscopy with hyper-angulated non-channelled blades for DLT intubations which causes prolonged intubation times for GVL. This assumption is supported by our data. Our experienced anaesthetists needed a BURP manoeuvre in 32% of all DLT intubations with GVL and we reported significantly more malpositions of the DLT (in 47% of cases). Presumably caused by the rotation manoeuvre, which is needed for the advancement into the trachea, there is a higher incidence of main bronchus malposition of the DLT. Caused by the required bending of the DLT-tube for hyper-angulated blades, the tip of the DLT often hits the ceiling when trying to insert the tube into the trachea past the vocal cords. Usually, a BURP manoeuvre is first performed to adjust the trachea, positioning it more posterior and more in line. Second, a rotation manoeuvre could be necessary. Such a rotation manoeuvre was described by Bustamante and Hernandez (21, 22). Rotation manoeuvre more often results in the incorrect position of the DLT. Liu et al. concluded that the use of videolaryngoscopes, especially with a hyper-angulated blade for DLT intubation, complicates the already complicated DLT intubation technique through rotation manoeuvres (8). Our data support the thesis that these sequential rotation manoeuvres are probably the reason why videolaryngoscopy increases the incidence of mispositioning of DLT. We could not confirm our hypothesis that a thinner hyper-angulated blade provides better visibility and in consequence more space for a rotation manoeuvre and therefore a lower incidence of sore throat and hoarseness. Hsu et al. were able to show a lower incidence of sore throat and hoarseness (7). There are controversial results in the literature. Russell et al. were unable to identify any significant differences in their study (6). Due to the controversial results in the current literature and our results, the question remains whether the questionnaires used are sensitive enough to record differences in subjective symptoms.

In regard to the incidence of dental trauma, a study by Lee et al. (2011) comparing DL and VL showed that less force is exerted on the teeth of the upper jaw when using VL (23, 24). This is in accordance with the results of the current study situation (6, 17). Our dental follow up showed no significant differences in

DLT intubation-related injuries. However, our study was not powered to detect that the incidence of dental trauma is different.

Limitations:

This study was randomised, but has some limitations. First, the operators were not blinded to the intubation device used; however, it is difficult to circumvent this problem when evaluating different intubation devices. Nevertheless, the patient and follow-up endoscopic examinations were anonymised and blinded. A second limitation might be that the operators were not equally experienced with both intubation devices. Videolaryngoscopy is used routinely in our department, but not for DLT intubation. Furthermore, the new GlideScope®-Titanium was used for the first time during this study in our hospital.

A further limitation of our study is the small number of patients with a supposed difficult airway (Mallampati 3 and 4, 13% in the DL group vs. 17% in the GVL group) and the low incidence of predicted difficult airways (CL 3 and 4, 3% in the DL group vs. 0% in the GVL group).

In addition, an appropriate rigid stylet for the DLT intubation with the GlideScope, like the GlideRite® Rigid Stylet, which is standardly used for the single lumen tube intubation, was not available at the start of the study (18). Instead, we used the original rigid GlideRite® stylet for the single-lumen endotracheal tube as a template to shape the inner stylet of the DLT. A technique like the one developed and described by Bussier et al. and Bustamante et al. was not mandatory for our anaesthetists (18, 21).

DLT intubation with the GlideScope®-Titanium might be improved if the users are given some additional training and use the adequate rigid stylet for DLT, which keeps its shape and is better adapted to the hyper-angulated blade of the GVL.

There are currently many different videolaryngoscopes with varying designs and quality available on the market. For these reasons, our study results should not be generalised, and further investigation into VL and DLT intubation is needed.

Conclusions

In conclusion, DLT tracheal intubation using GlideScope Titanium videolaryngoscopy with an extra thin blade takes more time while allowing a better laryngeal view and causing less objectified trauma than the MacIntosh laryngoscope. In our study collective, this had no impact on subjective symptoms such as sore throat, dysphagia, cough, and hoarseness after DLT intubation. Additional investigations are recommended to evaluate the effectiveness of videolaryngoscopy for DLT intubation and to improve the experience of using videolaryngoscopy for DLT intubation with the different individual devices.

List Of Abbreviation

BIS Bispectral Index Monitoring

BURP Backwards Upwards Right Pressure

CL Cormack and Lehane

DL Direct Laryngoscopy

DLT Double Lumen Tube

GVL GlideScope Videolaryngoscopy

NRS Numeric Rating Scale

OR Operating room

SD Standard Deviation

TIVA Total intravenous anaesthesia

TOF Train of Four

Declarations

Ethics approval and consent to participate

Ethics approval was granted by the Ethics Committee of Philipps-University Marburg, Baldingerstrasse/Postfach 2360, 35032 Marburg, Germany Az.: 115/16; 14.09.2016.

We conduct our study in compliance with recognized international standards, including the principles of the Declaration of Helsinki.

All experiments and data collection were performed with prior informed consent to participate. Written consent to participate in the study were obtained from each participant.

Consent for publication

Not applicable

Availability of data and material

The data that support the findings of this study are available from the corresponding author. The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

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Authors' contributions

JR, AKS and KM analysed and interpreted the patient data. JR and KM were the major contributors to writing the manuscript. All authors read and approved the final manuscript.

Authors' information

Our study adheres to CONSORT guidelines and we included with submission a completed CONSORT checklist and CONSORT Diagram.

References

1. Meggiolaro KM, Wulf H, Feldmann C, Wiesmann T, Schubert AK, Risse J. [Airway management for lung separation in thoracic surgery: An update]. *Anaesthetist*. 2018;67(8):555-67.
2. Zhong T, Wang W, Chen J, Ran L, Story DA. Sore throat or hoarse voice with bronchial blockers or double-lumen tubes for lung isolation: a randomised, prospective trial. *Anaesth Intensive Care*. 2009;37(3):441-6.
3. Chen A, Lai HY, Lin PC, Chen TY, Shyr MH. GlideScope-assisted double-lumen endobronchial tube placement in a patient with an unanticipated difficult airway. *J Cardiothorac Vasc Anesth*. 2008;22(1):170-2.
4. Liu H, Jahr JS, Sullivan E, Waters PF. Tracheobronchial rupture after double-lumen endotracheal intubation. *J Cardiothorac Vasc Anesth*. 2004;18(2):228-33.
5. Choi GS, Lee EH, Lim CS, Yoon SH. A comparative study on the usefulness of the GlideScope or Macintosh laryngoscope when intubating normal airways. *Korean J Anesthesiol*. 2011;60(5):339-43.
6. Russell T, Slinger P, Roscoe A, McRae K, Van Rensburg A. A randomised controlled trial comparing the GlideScope® and the Macintosh laryngoscope for double-lumen endobronchial intubation. *Anaesthesia*. 2013;68(12):1253-8.
7. Hsu HT, Chou SH, Wu PJ, Tseng KY, Kuo YW, Chou CY, et al. Comparison of the GlideScope® videolaryngoscope and the Macintosh laryngoscope for double-lumen tube intubation. *Anaesthesia*. 2012;67(4):411-5.
8. Liu TT, Li L, Wan L, Zhang CH, Yao WL. Videolaryngoscopy vs. Macintosh laryngoscopy for double-lumen tube intubation in thoracic surgery: a systematic review and meta-analysis. *Anaesthesia*. 2018;73(8):997-1007.
9. Cooper RM. Use of a new videolaryngoscope (GlideScope) in the management of a difficult airway. *Can J Anaesth*. 2003;50(6):611-3.

10. Cooper RM, Pacey JA, Bishop MJ, McCluskey SA. Early clinical experience with a new videolaryngoscope (GlideScope) in 728 patients. *Can J Anaesth.* 2005;52(2):191-8.
11. Agrò F, Barzoi G, Montecchia F. Tracheal intubation using a Macintosh laryngoscope or a GlideScope in 15 patients with cervical spine immobilization. *Br J Anaesth.* 2003;90(5):705-6.
12. Sakles JC, Rodgers R, Keim SM. Optical and video laryngoscopes for emergency airway management. *Intern Emerg Med.* 2008;3(2):139-43.
13. Sun DA, Warriner CB, Parsons DG, Klein R, Umedaly HS, Moulton M. The GlideScope Video Laryngoscope: randomized clinical trial in 200 patients. *Br J Anaesth.* 2005;94(3):381-4.
14. Kill C, Risse J, Wallot P, Seidl P, Steinfeldt T, Wulf H. Videolaryngoscopy with GlideScope reduces cervical spine movement in patients with unsecured cervical spine. *J Emerg Med.* 2013;44(4):750-6.
15. Su YC, Chen CC, Lee YK, Lee JY, Lin KJ. Comparison of video laryngoscopes with direct laryngoscopy for tracheal intubation: a meta-analysis of randomised trials. *Eur J Anaesthesiol.* 2011;28(11):788-95.
16. Yi J HY, Luo A. Comparison of GlideScope video-laryngoscope and Macintosh laryngoscope for double-lumen tube intubation. *Chinese Journal of Anesthesiology* 2013;33:201-4.
17. Bensghir M, Alaoui H, Azendour H, Drissi M, Elwali A, Meziane M, et al. [Faster double-lumen tube intubation with the videolaryngoscope than with a standard laryngoscope]. *Can J Anaesth.* 2010;57(11):980-4.
18. Bussièrès JS, Martel F, Somma J, Morin S, Gagné N. A customised stylet for GlideScope® insertion of double lumen tubes. *Canadian Journal of Anesthesia/Journal Canadien d'Anesthésie.* 2012;59(4):424-5.
19. Lin W, Li H, Liu W, Cao L, Tan H, Zhong Z. A randomised trial comparing the CEL-100 videolaryngoscope(TM) with the Macintosh laryngoscope blade for insertion of double-lumen tubes. *Anaesthesia.* 2012;67(7):771-6.
20. Yao WL, Zhang CH. Macintosh laryngoscopy for double-lumen tube placement - a reply. *Anaesthesia.* 2015;70(10):1206-8.
21. Bustamante S, Parra-Sánchez I, Apostolakis J. Sequential rotation to insert a left double-lumen endotracheal tube using the GlideScope. *Can J Anaesth.* 2010;57(3):282-3.
22. Hernandez AA, Wong DH. Using a Glidescope for intubation with a double lumen endotracheal tube. *Can J Anaesth.* 2005;52(6):658-9.
23. Lee RA, van Zundert AA, Maassen RL, Wieringa PA. Forces applied to the maxillary incisors by video laryngoscopes and the Macintosh laryngoscope. *Acta Anaesthesiol Scand.* 2012;56(2):224-9.
24. Verelst PL, van Zundert AA. Use of the EZ-Blocker for lung separation. *J Clin Anesth.* 2013;25(2):161-2.

Figures

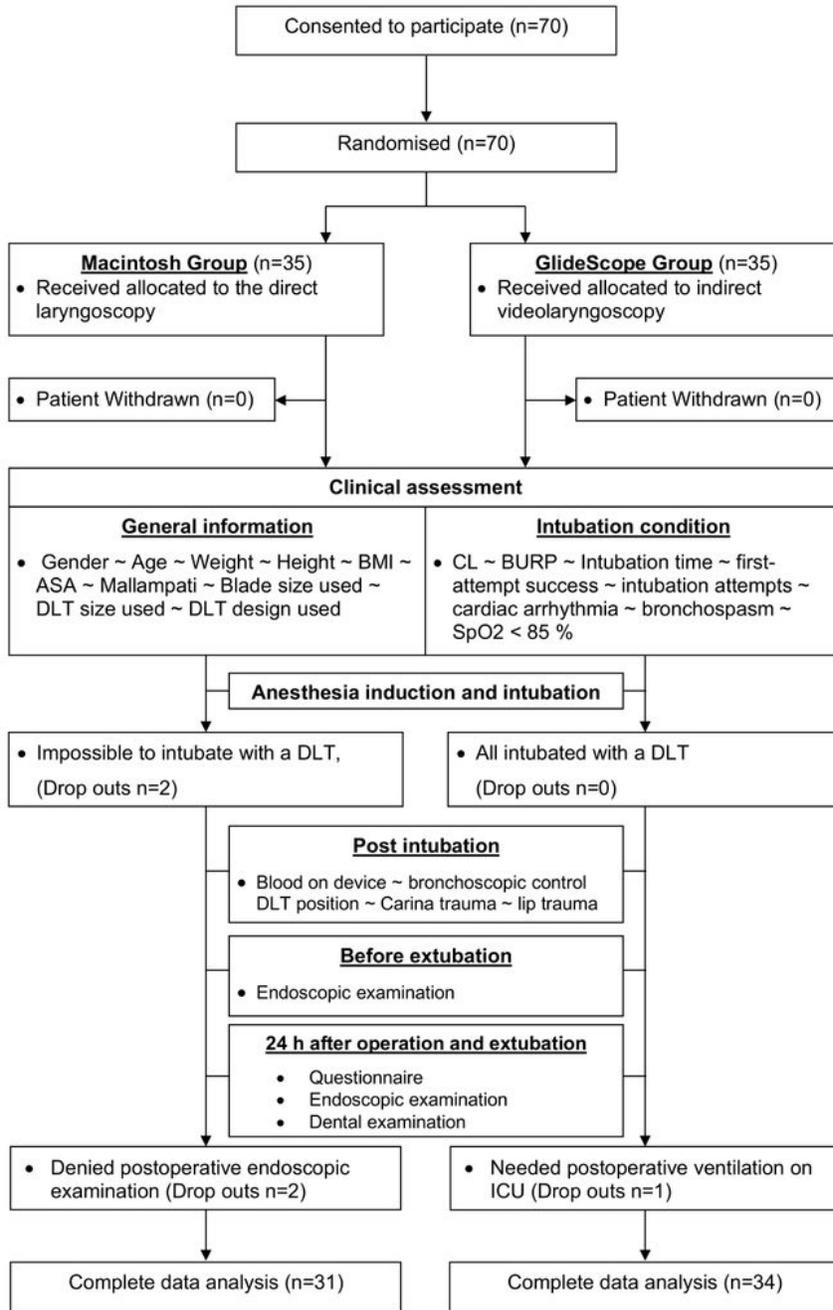


Figure 1

Study Flow Chart Diagram

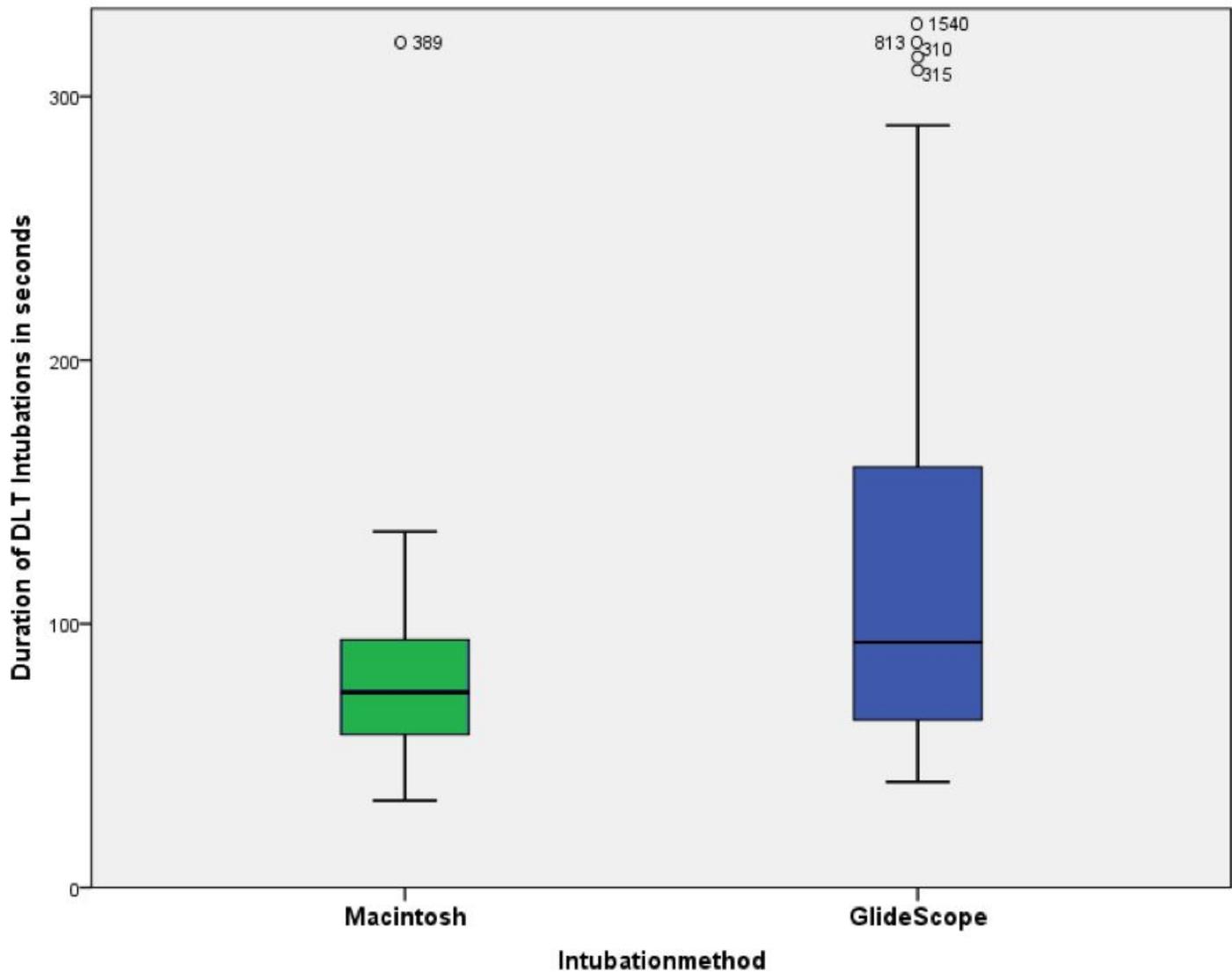


Figure 2

Duration of successful completion of DLT intubation between direct laryngoscopy (DL) and videolaryngoscopy (GVL) Legend: boxplot x-axis: methods Macintosh-DL (green) and GlideScope-VL (blue), y-axis: Duration of successful DLT intubation in seconds

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [CONSORT2010Checklist.doc](#)
- [CONSORT2010FlowDiagram.doc](#)