Original Article

Comparison of Macintosh, McCoy, and Glidescope video laryngoscope for intubation in morbidly obese patients: Randomized controlled trial

ABSTRACT

Objectives: The aim of the study was to compare time to intubation and glottic visualization between Macintosh, McCoy, and Glidescope video laryngoscope (GVL) in morbidly obese patients.

Methodology: Forty-five American Society of Anesthesiologists I–III morbidly obese patients were randomized into three groups of 15 each and time to intubation, Cormack–Lehane grading, and Intubation Difficulty Score (IDS) were compared.

Results: GVL took more time to intubate (TTI) compared to Macintosh and McCoy laryngoscope ($P = 0.0001$). Overall IDS were similar between the groups.

Conclusion: To conclude, GVL takes longer TTI with no added advantage in IDS and hemodynamic response to intubation in morbidly obese patients. McCoy is only as effective as Macintosh and hence Macintosh laryngoscope should be laryngoscope of choice due to its widespread availability and familiarity.

Key words: Glidescope video laryngoscope; Macintosh laryngoscope; morbid obesity

Introduction

Morbidly obese patients usually have difficult mask ventilation and difficult laryngoscopy and intubation. The visual alignment of the oral, pharyngeal, and the laryngeal axes are challenging due to the large tongue, restricted mouth opening, excessive soft-tissue folds in the mouth and the pharynx, short thick neck, thick submental fat pad, presence of a double chin, large breasts, and presternal and posterior cervical fat deposits.[1,2] However, actual incidence and degree of difficulties are not clearly documented.[3,4]

The conventional Macintosh laryngoscope is preferred by many even in morbidly obese patients due to its familiarity and ease of use. The McCoy laryngoscope with the hinged tip has been shown to provide improved view of the glottis in patients with and without difficult airway[5,6] and less hemodynamic response to intubation compared to Macintosh laryngoscope.[7] With the advent of Glidescope video laryngoscope (GVL), this new device was compared with Macintosh laryngoscope in obese and nonobese

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individuals and shown to provide either similar or longer time to intubate (TTI),[8-11] but better glottis visualization.[10,12]

In a morbidly obese patient, obtaining a good glottis view and time taken to intubate both are of utmost importance, given their poor functional residual capacity and shorter desaturation times. The best laryngoscope to achieve this goal is not yet known. We, therefore, planned to compare Macintosh, McCoy, and GVL in morbidly obese patients to find out the ideal laryngoscope which takes shorter TTI and also provides good glottis visualization.

Methodology

Study design

This was a single-blinded, prospective, comparative randomized controlled trial.

Study setting

This study was conducted in the Department of Anaesthesiology, Pain Medicine and Critical Care, All India Institute of Medical Sciences, New Delhi after the Institutional Ethics Committee approval and registration in the Clinical Trial Registry of India (CTRI/2016/02/006662).

Sample size calculation

As per the available literature of mean intubation times with all the three devices in obese patients (Glidescope 59 ± 22 s,[3] Macintosh laryngoscope 93 ± 24 s,[3] and McCoy laryngoscope 23.3 ± 15.1 s[13]) with $\alpha = 5\%$ and power = 90%, we needed to enroll 39 cases. Accounting for 10% dropouts, we needed 43 cases.

Study population

Forty-five American Society of Anesthesiologists (ASA) grade I–III patients of age group 18–60 years, with a body mass index of ≥35 kg/m^2 scheduled for elective bariatric surgery were enrolled into the study and informed written consent was obtained from each patient. ASA IV–V patients, patients undergoing emergency surgery, patients with respiratory, oral and pharyngeal pathology, craniofacial abnormalities, restricted neck movement or known cervical spine disease, restricted mouth opening <1.5 cm, bucked teeth, macroglossia, and patients scheduled for oral surgery were excluded from the study.

Randomization and blinding

Included patients were randomized into three study groups according to computer-generated random number table (www.randomizer.org) into Macintosh (n = 15), McCoy (n = 15), and GVL (n = 15). The allocation concealment was done by sealed envelope technique. Intraoperative outcome assessor could not be blinded, but postoperative outcome assessor was blinded to the group allocation.

Study protocol

Thorough preoperative assessment was done including search for significant comorbidities, history of snoring and diagnosis of obstructive sleep apnea. All airway parameters were documented including body mass index and neck circumference at the level of thyroid cartilage.

In the operating room, the study device was kept ready and alternative rescue devices (laryngeal mask airway and fiberoptic bronchoscopy) were kept as standby according to the choice of the senior anesthesiologist. Endotracheal tubes (ETTs) size 7.0–7.5 mmID for women and 8.0–8.5 mmID for men were kept ready. All patients were positioned on the ramp position to achieve horizontal alignment between the external auditory meatus and the sternal notch.[14]

Patients were preoxygenated with 100% oxygen at 10 L/min and continuous positive airway pressure 10 cmH_2O by facemask for 3 min. Anesthesia was induced with fentanyl (2 μg/kg) and propofol (2 mg/kg) calculated according to lean body weight. After ensuring adequate mask ventilation, succinylcholine (1.5 mg/kg total body weight)[15,16] was used to facilitate tracheal intubation. A 12 fr peripheral venous catheter was placed in the nasopharynx insufflating O_2 at 2 L/min for apneic oxygenation. The device allocated for the patient was used for laryngoscopy. The laryngoscopist (primary investigator) was a trainee with experience of >25 successful intubations with each of the study devices. All intubations were performed by the same person.

The primary outcome was time to intubate – (T) defined as the time taken from the time when the blade of the laryngoscope crosses the incisors to the first upstroke of the capnograph. This variable itself was divided into two – the time from insertion of blade till cuff inflation (T1) and the time from cuff inflation to the first upstroke of the capnograph (T2).

Intubation Difficulty Score (IDS) – A sum of seven different components was noted and the hemodynamic variables were also recorded at baseline, after induction, after intubation, (0 min) and then every 2 min for the next 10 min. An independent observer (with a stopwatch) recorded the “TTI.” Successful tracheal intubation is that which occurred within first two attempts by principal investigator. Each attempt has being described as introduction of tip of laryngoscope beyond incisors. At the event of two failed intubations by principal investigator, it was considered a "failure" and taken over by a senior anesthesiologist, first with the same device and if still not successful, with an alternate device as per his/her discretion.

Tracheal intubation was confirmed by auscultation of the chest and appearance of the capnograph waveform on the monitor. Any significant airway event (desaturation to <90%, airway trauma defined as blood on the laryngoscopy blade, laryngospasm or bronchospasm, bradycardia, and hypotension) were also noted.

The Cormack–Lehane (CL) grade and the IDS were noted by the laryngoscopist. The laryngoscopy view was graded according to the CL scale as follows,

- Grade 1: Vocal cords completely visible
- Grade 2a: Only posterior part of the glottis visible, Grade 2b; Only arytenoids are visible
- Grade 3: Only epiglottis visible
- Grade 4: Epiglottis not visible.

Each patient was assessed and given an IDS developed by Adnet *et al*. on the basis of 7 variables associated with difficult intubation.[17] They are:

- N_1 – number of attempts
- N_2 – number of additional operators
- N_3 – number of alternative intubation techniques used
- N_4 – CL grading of laryngoscopy (Grade1, $N_4 = 0$, Grade 2, $N_4 = 1$, Grade 3, $N_4 = 2$, Grade 4, $N_4 = 3$)
- N_5 – lifting force during laryngoscopy ($N_5 = 0$ if inconsiderable and $N_5 = 1$ if considerable)
- N_6 – need to apply external laryngeal pressure to improve glottic view ($N_6 = 0$ if no external laryngeal pressure or only the Sellick maneuver was applied and $N_6 = 1$ if external laryngeal pressure was used)
- N_7 – position of vocal cords ($N_7 = 0$ if abducted or not visible and $N_7 = 1$ if adducted)

The IDS score is the sum of N_1 through N_7.

- Score of = 0 intubation under ideal conditions.
- Score of = 1–5 slight difficulty.
- Score of >5 moderate to major difficulty.

Postoperatively patients were asked about the presence of sore throat and hoarseness of voice.

Statistical analysis

Continuous data are represented as mean ± standard deviation and categorical data in frequencies (%). The data were analyzed using SPSS 21.0 (IBM Corporation, USA). Categorical data were compared by applying Chi-square test or Fischer exact test. For quantitative change in hemodynamic variable over a period, repeated measure analysis followed by *post hoc* comparison was done separately for each group. $P < 0.05$ was considered statistically significant.

Results

The demographic parameters (quantitative) were analyzed using one-way ANOVAs test and *post hoc* comparison done using Bonferroni method. Demographic parameters were comparable [Table 1].

The time taken to intubate (T) was 31.81 ± 8.57 s, 35.27 ± 8.29 s, and 53.6 ± 19.27 s in Groups Macintosh, McCoy, and GVL, respectively. There was a significant difference between the three groups ($P = 0.0001$). There was a significant difference between the three groups in T1 values and T2 values as well.

Post hoc comparison using Bonferroni method showed no difference in T, T1, and T2 between Group Macintosh versus McCoy, whereas all three time parameters were significantly different between Group McCoy versus GVL and Group Macintosh versus GVL [Table 2].

Each of the patients was assessed for intubation difficulties using the IDS score [Table 3]. The number of patients intubated in the first attempt was 86.7% patients in group Macintosh, 80% in group McCoy, and 73.33% in group GVL (N1 = 0). All patients were intubated in the first or second attempt in groups Macintosh and McCoy; however, in group GVL 6.67% (1 patient out of 15) was intubated in the third attempt. In this patient, two attempts were made by the principal investigator and the third by the senior anesthesiologist present with GVL itself. No additional operator (N2) was required in any of the cases in group Macintosh or group McCoy. No alternate techniques were used in any of the three groups (N3 = 0). Sixty percentage of the patients in the Macintosh group had a CL grading (N4) of 133.33% in McCoy and 66.67% in GVL group had the same. Only one patient (6.67%) in group McCoy however had a CL view of 3 (N4 = 2).The lifting force required (N5) was more than adequate in 3 out of 15 (20%) in the Macintosh and McCoy groups and in 4 (26.6%) patients GVL group. About 60%, 80%, and 73.33% patients in Macintosh, McCoy, and GVL group respectively did not require any external laryngeal maneuver (N6) to optimize laryngoscopy. Vocal cords were abducted (N7) in all patients in the first two groups, whereas in the Glidescope group, 2 out of 15 patients required cricoid pressure. The final IDS score of 0 was obtained in 53.33% in group Macintosh, 26.67% in group McCoy, and 20% in GVL. Only one patient in group McCoy had an IDS of 5 and one patient in GVL had an IDS score of 6. The IDS scores failed to elicit any statistical difference between the three groups (Fisher's exact = 0.308).

Table 1: Demographic parameters

	Group Macintosh	Group McCoy	Group GVL	*P*
Age (years)	40.6±11.6	48.93±9.33	42.06±13.25	0.1201
Sex (%)				
Male	3 (20)	3 (20)	3 (20)	Fisher's exact=1.000
Female	12 (80)	12 (80)	12 (80)	
ASA (%)				
1	5 (33)	4 (26)	3 (20)	Fisher's exact=0.753
2	9 (60)	10 (66)	12 (80)	
3	1 (6.67)	1 (6.67)	0	
Weight (kg)	116.8±18.76	110.06±21.95	117.16±0.86	0.5715
Height (cm)	151.17±42.25	150.76±42.08	158.52±9.65	0.7913
BMI (kg/m^2)	44.67±6.64	43.11±9.04	46.91±6.92	0.3964

$P<0.05$ is considered statistically significant. BMI: Body mass index; ASA: American Society of Anesthesiologists; GVL: Glidescope video laryngoscope

Table 2: Comparison of time to intubate using the different laryngoscopes

Time to intubate (s)	Mean±SD			*P*	*Post hoc* analysis		
	Group Macintosh	Group McCoy	Group GVL		1 versus 2	2 versus 3	1 versus 3
TTI	31.81±8.57	35.27±8.29	53.6±19.27	0.0001*	1.000	0.001*	0.000*
T1	22.29±8.08	25.29±6.27	37.26±16.34	0.0015*	1.000	0.016*	0.002*
T2	10.20±3.4	10.20±3.4	16.86±6.13	0.0002*	1.000	0.001*	0.001*

*$P<0.05$ is considered statistically significant. TTI: Time to intubate; GVL: Glidescope video laryngoscope; SD: Standard deviation

The baseline SpO_2 values were comparable ($P > 0.05$) in all 3 and the saturation at 0, 2, 4, 6, 8, and 10 min after intubations showed no significant difference between the three groups ($P = 0.5445$). The same was the results with blood pressure and heart rates. None of the patients in any group complained of any hoarseness or sore throat in the postoperative period.

Discussion

We found that time taken for intubation was longer with GVL as compared to both Macintosh and McCoy laryngoscopes, whereas there was no significant difference between the TTI using Macintosh versus McCoy. Our findings are similar to other studies conducted in morbidly obese patients by Andersen *et al*. (mean TTI: GVL 48 s vs. Macintosh 32 s; $P = 0.0001$)[18] and Vasileiou *et al*. (mean TTI: GVL 52 s vs. Macintosh 29 s; $P = 0.0001$).[8] However, in normal weight adult patients, time taken to intubate was comparable (GVL 46 s vs. Macintosh 30 s).[9] Majority of the studies comparing GVL with Macintosh laryngoscope recorded either increased or comparable TTI in adult patients.[8-11] However, GVL was still considered to be the advanced airway of choice because even though it took longer to intubate, it provided better laryngoscopic views and intubating conditions. Furthermore, the increased time did not lead to any clinically significant desaturation or airway events.

To erase any discrepancy that might have crept in due to delays in attaching the circuit to the tube and time delay in ventilating the patient, we split our timers to record T1 and T2 and found that T1 remained longer with GVL compared to other two groups. However, the CL grade was comparable between the three groups. All patients in Macintosh group and GVL group had CL grade either 1 or 2, and only one patient in McCoy group had CL grade 3. This suggests that although GVL provides good CL grade in obese patients, it takes longer time to achieve that view. This could be due to technical adjustments required to be done with GVL blade to get the proper CL grade view or difficulty in negotiating/advancing the ETT even with proper view of glottis. The number of advancements made with the ETT toward the direction of the glottis was compared, and it was found that 13/15, 12/15, and 11/15 patients were intubated in the first advancement itself in three groups. The remaining 2 patients in group Macintosh and 3 patients in group McCoy were intubated in the second attempt. However, in GVL group, one patient was intubated in the second advancement, while two were intubated in the third and 1 in the fourth advancement. These findings are in agreement with Sun *et al*.[9] who also experienced more number of attempts with even CL 1 and 2 when the GVL was used. This difficulty in negotiation of the tube into the glottis even after a favorable view has been obtained was probably due to difficulty in hand–eye coordination while looking into the camera and simultaneously negotiating the tube in, and likely to resolve with increasing experience with the device. However, the laryngoscopist in our study had already intubated more than 25 patients with GVL which we considered as adequate experience. Whether this time T1 can be shortened with increasing experience of GVL use remains

Table 3: Comparison of intubation difficulty score

	Group Macintosh, number of patients (%)	Group McCoy, number of patients (%)	Group GVL, number of patients (%)	???
N1				
0	13 (86.67)	12 (80)	11 (73.33)	Fisher's exact=0.475
1	2 (13.33)	3 (20)	1 (6.67)	
2	0	0	2 (13.33)	
3	0	0	1 (6.67)	
N2				
0	15 (100)	15 (100)	14 (93.33)	Fisher's exact=1.000
1	0	0	1 (6.67)	
N3				
0	15 (100)	15 (100)	15 (100)	
N4				
0	9 (60)	5 (33.33)	10 (66.67)	Fisher's exact=0.248
1	6 (40)	9 (60)	5 (33.33)	
2	0	1 (6.67)	0	
N5				
0	12 (80)	12 (80)	11 (73.33)	Fisher's exact=1.000
1	3 (20)	3 (20)	4 (26.67)	
N6				
0	9 (60)	12 (80)	11 (73.33)	Fisher's exact=0.601
1	6 (40)	3 (20)	4 (26.67)	
N7				
0	15 (100)	15 (100)	13 (86.67)	Fisher's exact=0.318
1	0	0.00 (100)	2 (13.33)	
IDS				
0	8 (53.33)	4 (26.67)	3 (20)	Fisher's exact=0.308
1	2 (13.33)	6 (40)	7 (46.67)	
2	2 (13.33)	3 (20)	2 (13.33)	
3	3 (20)	1 (6.67)	1 (6.67)	
4	0	0	1 (6.67)	
5	0	1 (6.67)	0	
6	0	0	1 (6.67)	

$P<0.05$ is considered statistically significant. IDS: Intubation Difficulty Score; GVL: Glidescope video laryngoscope

to be answered. It is worth mentioning here that all patients in all the three groups were positioned in ramp and the end point of positioning was to get the external auditory meatus and the sternal angle at the same level.

The lifting force and the external laryngeal pressure required for each of the devices and cord position as judged by the operator were comparable among the three groups. Overall IDS scores were comparable between the groups. In contrast to our findings, lower IDS scores were reported by other authors like Andersen *et al*.[18] (mean IDS score: GVL 1 [0–4] and Macintosh 2 [0–7]; $P = 0.01$) and Vasileiou *et al*.[8] and Ke and Xu.[10] Requirement of lesser force at laryngoscopy using GVL was the reason for lower IDS scores with GVL. In our study, more familiarity with Macintosh laryngoscope, requirement of additional operator in one patient and adducted vocal cords in a couple of patients in GVL group might have negated any superiority of GVL and resulted in comparable IDS scores.

Lim *et al*. compared GVL and Macintosh in simulated easy and difficult airway. TTI was longer with GVL compared to Macintosh laryngoscope (19.0 [9.7] s vs. 12.7 [5.9] s; $P = 0.006$) in simulated easy laryngoscopy scenarios. There was no difference in the number of successful intubations and ease of intubation. In the simulated difficult laryngoscopy scenarios, it took less TTI using the GVL when compared to the Macintosh (23.5 [12.7] s vs. 70.5 [101.2] s; $P = 0.001$). There was no difference in success rate and ease of intubation. Anesthesiologists found it easier to intubate using the Glidescope in the difficult airway situation ($P < 0.0001$).[19] This finding was in agreement with the systematic review and meta-analysis including 17 trials and 1998 patients comparing GVL versus Macintosh laryngoscope. No significant difference was seen regarding successful first attempt or time to intubation by experts. The pooled relative risk of Grade 1 laryngoscopy (≥ Grade 2) for the Glidescope was 2 (95% confidence interval [CI] 1.5–2.5). The pooled relative risk for Grade 1 laryngoscopy (≥ Grade 2) was 1.5 (95% CI: 1.2–1.9) for nondifficult intubations, and for difficult intubations, it was 3.5 (95% CI: 2.3–5.5). In the two studies which examined nonexperts, successful first-attempt intubation (relative risk 1.8, 95% CI: 1.4–2.4) and time to intubation were improved using the Glidescope. Hence, compared to direct laryngoscopies, Glidescope was associated with better glottis visualization, especially in potential or simulated difficult airways.[20] Cook and Tuckey in their study comparing Macintosh and McCoy had concluded that in difficulty laryngoscopy scenarios McCoy laryngoscope may be useful.[5] Similarly, Uchida *et al*., in patients with limited neck extension showed that McCoy improved laryngeal views significantly.[6] However, our study showed that there was no significant difference with regard to CL grades and IDS between Macintosh, McCoy, and Glidescope in morbidly obese patients.

There was no significant difference in hemodynamic response to laryngoscopy among the three groups. Although few previous studies showed less hemodynamic response with McCoy compared to Macintosh[21,22] as it exerts less lifting pressure, in the current study, there was no substantial advantage in obese patients. Hemodynamic response to GVL and Macintosh was comparable in most of the studies.[11,23,24]

Our study had a small sample size of 45 patients as the study was powered for primary outcome only – "TTI." Thus, it is insufficiently powered for assessing the secondary outcomes such as IDS and hemodynamic changes at intubation. Hence, further studies with larger sample size are required to achieve reliable results with respect to secondary outcomes. Moreover, we did not calculate and compare the El-Ganzouri Risk Index (EGRI) in different groups. This has been found to be effective predictor of difficult intubation using GVL in previous studies.[25]

Conclusion

GVL takes longer TTI with no added advantage in IDS and hemodynamic response to intubation in morbidly obese patients. McCoy is only as effective as Macintosh, and hence, Macintosh laryngoscope should be laryngoscope of choice due to its widespread availability and familiarity.

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Conflicts of interest
There are no conflicts of interest.

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