Original Article

A randomized control led study comparing CMAC video laryngoscope and Macintosh laryngoscope for insertion of double lumen tube in patients undergoing elective thoracotomy

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Abstract

Background and Aims: Double lumen tube (DLT) insertion for isolation of lung during thoracic surgery is challenging and is associated with considerable airway trauma. The advent of video laryngoscopy has revolutionized the management of difficult airway. Use of video laryngoscopy may reduce the time to intubate for DLTs even in patients with normal airway.

Material and Methods: A total of 87 ASA 1–3 adults, scheduled to undergo elective thoracotomy, requiring a DLT were randomly allocated to videolaryngoscope (CMAC) arm or Macintosh laryngoscope arm. It was on open label study, and only the patient was blinded. The primary objective of this study was to compare the mean time taken for DLT intubation with CMAC (Mac 3) and Macintosh laryngoscope blade and the secondary objectives included the hemodynamic response to intubation, the level of difficulty using the intubation difficulty scale (IDS), and complications associated with intubation. Data was analysed using the statistical software SPSS (version 18.0).

Results: The time taken for intubation was not significantly different (42.8 ± 14.8 s for CMAC and 42.5 ± 11.5 s for Macintosh laryngoscope *P* -0.908). The CMAC video laryngoscope was associated with an improved laryngoscopy grade (Grade I in 81.8% with CMAC and in 46.5% with Macintosh), less pressure applied on the tongue, and less external laryngeal pressure required. Hemodynamic responses to intubation were similar in both groups.

Conclusion: Macintosh blade is as good as CMAC (mac 3) blade to facilitate DLT intubation in adult patients with no anticipated airway difficulty, however CMAC was superior as it offers better laryngoscopic view, needed less force, and fewer external laryngeal manipulations.

Keywords: Anesthesia, CMAC video laryngoscope, double lumen tube, intubation difficulty scale (IDS), Macintosh

Introduction

Thoracic surgery requires the collapse and isolation of the lung and ventilation of the other lung to be operated. Double lumen tube (DLT), the most common method by which lung isolation is achieved, is considered the gold standard for lung isolation.[1] A double lumen tube is longer, more rigid, and has a larger external diameter as compared to a single lumen tube. This difficulty is compounded if it is done by an occasional thoracic anesthetist or if the patient has a difficult airway.[2,3]

Video laryngoscopes are a part of most of the widely accepted airway guidelines such as Difficult Airway Society (DAS)

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and American Society of Anesthesiologists (**ASA**) for endotracheal intubation in case of a difficult airway. Video laryngoscopes have been studied for the ease of intubation of DLT but with varied success. CMAC, a videolaryngoscope introduced by Karl Storz in 2009 is widely used for insertion of endotracheal tubes especially in difficult airway scenarios.[4]

We hypothesized that CMAC video laryngoscope is superior to Macintosh laryngoscope for insertion of DLTs in patients undergoing thoracotomy. The primary objective of this study was to compare the mean time taken for DLT intubation with CMAC (Mac 3) and Macintosh laryngoscope blade.

The secondary objectives were to assess the hemodynamic response to intubation with either scopes, the level of difficulty using the intubation difficulty scale (IDS) and the complications associated with intubation.[5]

Material and Methods

After approval from the Institutional Review Board and obtaining written informed consent, a randomized controlled trial was conducted in 87 patients. They were randomized to CMAC group or Macintosh group. The study was done in thoracic surgery operating rooms of our hospital. All patients were posted for surgeries requiring lung isolation.

Patients between the ages of 18 to 70 years were included in the study. Pregnant patients, patients with anticipated difficult airway – limited neck extension, thyromental distance less than 6.5 cm, height <150 cm, BMI greater than 30, Mallampatti 4, ASA IV patients, and patients at risk of aspiration were not recruited. Patients in whom there was a failure to intubate after three attempts were excluded from the study.

Sample size was calculated using G*Power (Version 3.2.1, Kiel, Germany) to show a minimum difference of about 10 s in the mean intubation time. This is considered clinically important when using CMAC as compared to Macintosh based on previously published studies.[6,7] The calculated sample size was 47 in each group, with 80% power and 5% level of significance.

Anesthetists who had the experience of inserting more than 10 DLTs and who had used both scopes more than 10 times on an intubating mannequin and 5 times in patients were allowed to participate in the study.

Patients who met the eligibility criteria were enrolled by the primary investigator the day before the surgery and patient information sheet was discussed with the patient.

Permuted block randomization of size 2, 4, or 6 was used to generate the random sequence using SAS 9.1.3 software. This computer generated randomization was put in serially numbered opaque sealed envelopes and kept in the operating room. The sealed envelopes were given to the anesthetist just before the induction of anesthesia. During intubation, the method provided in the envelope was administered by the anesthetist.

The study was not blinded as we could not hide the laryngoscope from the study participants, but it was blinded from the patient and the author doing the outcome analysis.

The anesthesia protocol was standardized. All patients received ASA standard monitoring with invasive blood pressure monitoring. The patients were preoxygenated ($ETO2 > 90\%$), anesthesia was induced with propofol (1.5 mg/kg) and fentanyl (2-3 mcg/kg). Additional propofol boluses (maximum upto 3 mg/kg) were titrated till loss of verbal response. After checking for adequacy of mask ventilation, rocuronium (1 mg/kg) was administered. Adequacy of muscle relaxation was ensured by a TOF ratio of zero on ulnar nerve stimulation of adductor pollicis longus using a TOF watch. 35 or 37 F DLT was used for female patients depending on whether their height was less or more than 160 cm. Male patients received 39 or 41 F DLT (Mallinckrodt Medical, Athlone, Ireland) depending on whether their height was less or more than 170 cm. Left main bronchus diameter of >12 mm, 12 mm, 11 mm, and 10 mm were also looked at for selection of 41,39,37, and 35 DLT.[8] After glottic visualization, DLT with stylet curved to match the laryngoscope was introduced with distal concavity facing anteriorly.[1] Once the blue cuff was beyond the vocal cords, the stylet was removed and the tube was rotated 90° counter clockwise and inserted till mild resistance was perceived. If the Cormack & Lehane grade was more than 2, backward, upward and right-sided pressure (BURP) manoeuvre was applied to improve the view.

The time taken for intubation was defined as the time from introduction of the scope till three complete capnographic cycles. The position of the tube was confirmed with a fibre optic bronchoscope. An independent observer, who was familiar with the protocol, measured the time taken for successful intubation using the timer set on Philips MP 70 monitor. The observer also documented the use of external laryngeal manipulations.

We looked at complications like postoperative hoarseness, sore throat, esophageal intubation, blood on the laryngoscope blade, and for any obvious lacerations after intubation. Hemodynamic response (HR, blood pressure. and mean arterial pressure (MAP) to intubation was monitored at zero (baseline), one min, three min, and five min. Postoperatively, an independent observer looked for hoarseness and sore throat. We did not have any changes in methodology or outcome variables after the trial commenced.

We computed mean and standard deviation for normally distributed continuous variables and frequencies and percentages for categorical variables. We used Shapiro Wilk's test to check for normality and then median with inter quartile range was reported for those continuous variables, which were not normally distributed. Student's t-test and ANOVA were used for normally distributed continuous variables. We used Mann Whitney U test to compare between groups for non-normally distributed continuous variables. Chi-square tests were used for categorical variables. We used SPSS version 18 for all analyses. We used $P < 0.05$ as the criterion for statistical significance.

Results

A total of 101 patients were screened, of which 14 patients were excluded from the study as they did not meet the inclusion criteria or did not consent to participate in the study.

Recruitment was done between May 2015 and August 2016. Recruitment was completed when the sample size was attained. Our final sample size was 87, with 44 assigned randomly to the CMAC group and 43 to the Macintosh group. The flow of participants is shown in the Consort diagram [Figure 1].

Both groups were comparable in terms of demographic parameters like age, sex, height, BMI, and airway characteristics [Table 1]. Four consultants and three senior trainees did all the intubations. During lung isolation, left DLTs were preferred due to an increased margin of safety.

The mean time taken to intubate with CMAC laryngoscope was similar to that with Macintosh laryngoscope [Tables 2 and 3]. The hemodyanamic response to intubation with the two scopes at baseline, intubation, and 1, 3 and 5 min after intubation is shown in Figures 2 and 3.

The IDS for the CMAC video laryngoscope (2.6) was significantly less than that, for the Macintosh laryngoscope (4.0) ($P < 0.001$).

None of the subjects in our study developed postoperative hoarseness. One patient in the Macintosh group had mild airway injury during intubation, which was indicated by blood on the blade of the scope. One patient in the CMAC group had a small laceration near the anterior tonsillar pillar. There was no significant difference between two groups when it came to mucosal injuries None of the patients had esophageal intubations, while one patient in the Macintosh group had intubation on the wrong side. The DLT cuff was torn in two patients in the CMAC group.

Discussion

There was no significant difference in time taken for DLT intubation using CMAC and Macintosh blades in our study. The average time taken in our study was comparable to similar studies published by the likes of Hsu *et al*., Russel *et al*.[6,9] Hsu *et al*. in their study comparing Glidescope (videolaryngoscope) and Macintosh laryngoscope had only two anesthetists intubating all cases and both of them had done more than 300 intubations with video laryngoscope. The time taken to intubate was 45.6 ± 10.7 s with Glidescope and 62 ± 29.7 s with Macintosh.[6] As most of the intubations in our study were done by regular thoracic anesthetists, the timings recorded were slightly better in both the groups. Another study done by Russel *et al*. had 30 junior anesthetists intubating with the same two scopes, where Glidescope took significantly longer (32 s for Macintosh vs 70 s for Glidescope).[9]

The subgroup analysis of the consultant's average time and shortest time taken for intubation with CMAC was comparable to Hsu *et al*.(2013). This brings out an important issue about training and the learning curve.[3] We had a heterogeneous group consisting of consultants and trainees performing the intubations rather than one or two experienced anesthetists (Russel *et al*). Thus, our results could be extrapolated to the wider anesthetist pool who

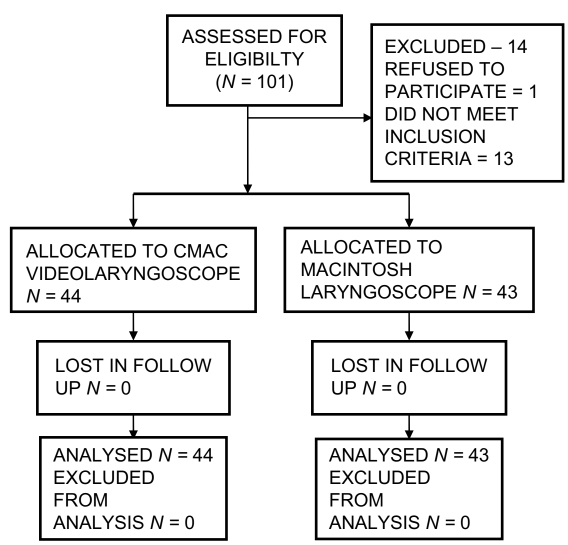

Figure 1: Participant flow [on the basis of guidelines for randomized controlled trails of the CONSORT (consolidated standards of reporting trails) statement]

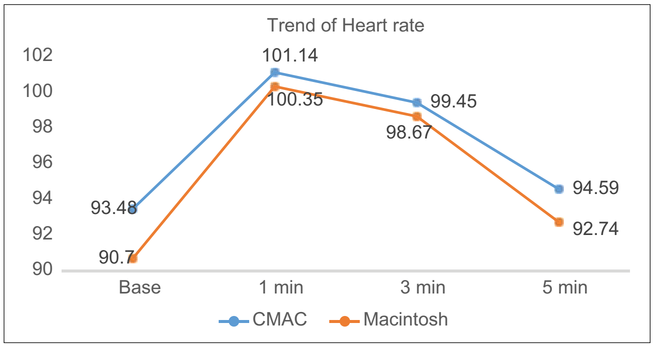

Figure 2: Trend for Heart rate in beats/min.

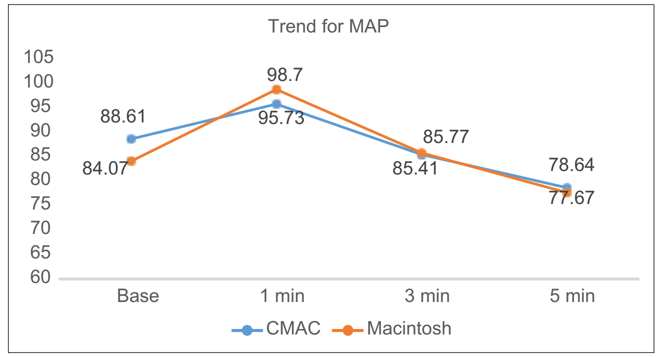

Figure 3: Trend for mean arterial pressure (MAP) in mm Hg.

Table 1: Baseline demographic and airway characteristics

	Macintosh (*n*=43)	CMAC (*n*=44)
Age (years)	40.4	36.3
BMI (kg/m2)	22.5	22.1
Men	28(65.1)	29(65.9)
ASA 1	21(48.8)	30(68.2)
ASA 2	17(39.5)	12(27.3)
ASA 3	5(11.6)	2(4.6)
Mallampatti I	11(25.6)	13(29.5)
Mallampatti II	18(41.9)	24(54.5)
Mallampatti III	14(32.6)	7(15.9)
Mouth opening >4.5cm	42(97.8)	43(97.8)
Normal Neck movement	38(88.4)	39(88.6)
Normal Jaw Movement	41(95.3)	42(95.5)

Data is presented as mean or number (%) of patients, BMI- Body Mass Index, ASA- American Society of Anesthesiologists, MP - Mallampatti

may need to perform a DLT intubation. We feel that the learning curve for video laryngoscopic intubation of DLT may be more than 15 intubations. Inexperienced operators tend to use the video laryngoscope similar to the Macintosh laryngoscope by keeping the tip of the blade in the vallecula, resulting in difficulty in intubation despite a better glottic view. Consultants who were regularly posted in the cardiothoracic theatres were able to visualize the cords and intubate much faster as compared to the trainees, irrespective of the type of scope. Macintosh is commonly used for all DLT insertion and this familiarity may be one reason for similar intubation times. Our study was conducted in patients with no anticipated difficult airway where CMAC blade improved the view but not intubation times.

When used by the trainees, the amount of lifting force required and laryngeal pressure applied was however lesser with the CMAC blade, which is significant. However, this did not translate to faster intubation.

Unlike Hsu *et al.*, we used height as a criterion and tried to use the largest DLT, which could be introduced. We also used three complete $ETCO^2$ traces for confirmation. Despite this, our intubation times were comparable with the more experienced operators in Hsu's study.[6]

Unlike the Glidescope and Mcgrath series 5, CMAC MAC3 is not an angulated blade, which necessitates curving the DLT to match its shape. This can result in a rigid tube, getting impinged at subglottis. This may explain the intubation difficulties in some of the studies using Glidescope (Russel, Yao).[9,10] With CMAC MAC 3, we curve the bronchial lumen about 10 cm from the tip to match a normal ET tube.

We removed the stylet immediately after the bronchial cuff negotiated the vocal cords, which made the tube less rigid and probably reduced trauma and the incidence of sore throat. Further, the incidence of first attempt failures and malpositions were less in our study.

We noticed that the time taken to intubate improved during the course of the study for the primary investigator and other trainees. This observation was similar to El Thahan *et al.*[11] and could be due to the steeper learning curve to learn DLT insertion with video laryngoscope.

The hemodynamic response to intubation was not significantly different between the groups due to the comparable time taken for intubation. The subjective feeling of force exerted on the tongue is significantly less with CMAC blade, which may make it a good option for individuals in whom hypertension and tachycardia may be detrimental.

The difference in IDS score for Macintosh and CMAC was significant, implying a subjective ease for DLT insertion with CMAC scope as compared to the Macintosh scope. CMAC offered a significantly better laryngoscopy grade and significant reduction in external laryngeal manipulations to facilitate intubation.

The better view of the laryngeal inlet with CMAC did not translate to faster intubation, probably because a good view on the video laryngoscopy does not require the alignment of

Table 2: Over all Efficacy Analysis

	CMAC (*n*=44)	MACINTOSH (*n*=43)	Difference‡ (95% CI)	*P*
Intubation times	42.8±14.8	42.5±11.5	0.3 (−5.3, 6.0)	0.908
First attempts at Intubation	42 (95.5)	39 (90.7)	4.8 (−5.8, 15.4)	0.376
Additional anesthetist required	2 (4.5)	6 (14.0)	−9.5 (−21.5, 2.5)	0.125
Lifting force required	5 (11.4)	16 (37.2)	−25.8 (−43.0, -8.6)	0.005
Laryngeal pressure applied	7 (15.9)	21 (48.8)	−32.9 (−51. 3, -14.6)	0.001
Cormarck Lehene Grade 1	36 (81.8)	20 (46.5)	35.3 (16.5, 54.1)	0.001
Blood on the blade	1 (2.3)	2 (4.7)	−2.4 (−10.1, 5.3)	0.542
Laceration	1 (2.3)	1 (2.3)	-	-
Sore throat	10 (22.7)	12 (27.9)	−5.2 (−23.5, 13.1)	0.577

Data is presented as mean±SD or number (%) of patients

Table 3: Efficacy by experience in years

	CMAC	MACINTOSH	Difference‡ (95% CI)	*P*
Experience (≤3 Years)	*n*=23	*n*=28		
Intubation time(s)	45.7±13.4	44.4±12.8	1.3 (−6.1, 8.7)	0.731
First attempts at intubation	21 (91.3)	25 (89.3)	2.0 (−14.4, 18.2)	0.811
Additional anesthetist required	1 (4.3)	3 (10.7)	−6.4 (−20. 5, 7.7)	0.397
Lifting force required	3 (13.0)	13 (46.4)	−33.4 (−56.4, −10.4)	0.011
Laryngeal pressure applied	3 (13.0)	16 (57.1)	−44.1 (−67.0, −21.2)	0.001
Cormarck Lehene Grade 1	19 (82.6)	14 (50.0)	32.6 (8.5, 56.8)	0.015
Blood on the blade	1 (4.3)	1 (3.6)	0.7 (−10.1, 11.5)	0.898
Laceration	0	1 (3.6)	−3.6 (−10.5, 3.3)	0.358
Sore throat	6 (26.1)	6 (21.4)	4.7 (−18.8, 28.2)	0.694
Experience (>3 Years)	*n*=21	*n*=15		
Intubation time(s)	39.7±15.9	38.9±7.7	0.8 (−8.2, 9.8)	0.862
First attempts at Intubation	21 (100.0)	14 (93.3)	6.7 (−5.9, 19.4)	0.229
Additional anesthetist required	1 (4.8)	3 (20.0)	−15.2 (−37 0.4, 7.0)	0.153
Lifting force required	2 (9.5)	3 (20.0)	−10.5 (−34.3, 13.3)	0.369
Laryngeal pressure applied	4 (19.0)	5 (33.3)	−14.3 (−43.4, 14.9)	0.328
Cormarck Lehene Grade 1	17 (81.0)	6 (40.0)	41.0 (11.1, 70.9)	0.012
Blood on the blade	0	1 (6.7)	−6.7 (−19.4, 6.0)	0.229
Laceration	1 (4.8)	0	4.8 (−4.3, 13.9)	0.389
Sore throat	4 (19.0)	6 (40.0)	0.21 (−50.9, 8.9)	0.165

Data is presented as mean±SD or number (%) of patients

the airway axes.[12] Also, the new DLT, when unpacked, has a well defined oropharyngeal curve and a small bronchial curve, which needs to be curved to match the shape of the laryngoscope. This is especially important when angled blades like Glidescope or CMAC D blades are being used.

Our results were different from Shah *et al*.[1] who had only 55% of tube insertions in the first attempt and a much higher incidence of bleeding and trauma with the Macintosh scope. This significant difference could be attributed to Shah *et al*. including patients with difficulty airway, while such patients were excluded from our study and all our operators had experience in intubating with DLT and also using the CMAC video laryngoscope.

Videolaryngoscopy offers an advantage over traditional laryngoscopy when it comes to teaching residents on how to intubate with DLT as they can observe the manipulations done by an experienced anesthetist. However, this did not translate to a faster intubation time.[13] The limitations of this study were, firstly, that the study was not blinded as it was difficult to hide the scope, which is used to intubate.

Secondly, we did not include patients with difficult airway in our study. Hence, our results cannot be extrapolated to patients with difficult airway. Thirdly, the difficulty level was assessed using an intubation difficulty scale and subjective feel of lifting force required or the need for external laryngeal manipulations, which were all operator dependent and not objectively measured variables. Finally, we did not measure the time to visualize the cords with either scope, which may have been less with CMAC due to camera optics.

We had two cases of torn tracheal cuff in the CMAC group. Clinicians are advised to look into the mouth during the introduction of video laryngoscope, then obtain the desired view on screen and look in for initial introduction of the tube[14] A videolaryngoscope has lesser flange height of 1.6 cm as compared to 2.5 cm in case of a Macintosh laryngoscope. A reduced space as well as the wrong technique of looking only at the screen resulted in the two instances of cuff tears.

Conclusion

CMAC video laryngoscopes can be a useful alternative to traditional Macintosh laryngoscope for the insertion of DLT in patients with uncomplicated airway. There is an improved laryngoscopy grade, lesser pressure is applied on the tongue, and lesser external laryngeal pressure is required while using CMAC video laryngoscope. However, the time taken and hemodynamic response to intubation are similar to those with Macintosh laryngoscope.

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Conflicts of interest

There are no conflicts of interest.

References

1. Shah SB, Bhargava AK, Hariharan U, Mittal AK, Goel N, Choudhary M. A randomized clinical trial comparing the standard mcintosh laryngoscope and the c-mac d blade video laryngoscope™ for double lumen tube insertion for one lung ventilation in Onco surgical patients. Indian J Anaesth 2016;60:312-8.
2. Nabecker S, Grubhofer G, Hager H, Goliasch G, Fischer H, Bernardi M, *et al*. Hemodynamic and humoral response to intubation with double- lumen endotracheal tubes versus single-lumen tubes combined with an endobronchial blocker: A randomized clinical trial. J Anesth Clin Res 2014;5:377.
3. Sakles, John C, Mosier J, Patanwala AE, John Dicken. Learning curves for direct laryngoscopy and GlideScope® video laryngoscopy in an emergency medicine residency. West J Emerg Med 2014;15:930-7.
4. Xue FS, Li HX, Liu YY, Yang GZ. Current evidence for the use of C-MAC videolaryngoscope in adult airway management: A review of the literature. Ther Clin Risk Manag 2017;13:831-41.
5. Jonathan L. Benumof; intubation difficulty scale: Anticipated best use. Anesthesiology 1997;87:1273-4.
6. Hsu HT1, 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;67:411-5.
7. Lange M, Frommer M, Redel A, Trautner H, Hampel J, Kranke P, *et al*. Comparison of the Glidescope® and Airtraq® optical laryngoscopes in patients undergoing direct microlaryngoscopy. Anaesthesia 2009;64:323-8.
8. Hannallah MS1, Benumof JL, Ruttimann UE. Ruttimann. The relationship between left mainstem bronchial diameter and patient size. J Cardiothorac Vasc Anesth 2015;9:119-21.
9. 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;68:1253-8.
10. Yoo JY, Park SY, Kim JY, Kim M, Haam SJ, Kim DH. Comparison of the McGrath videolaryngoscope and the macintosh laryngoscope for double lumen endobronchial tube intubation in patients with manual in-line stabilization. Medicine 2018;97:e0081.
11. El-Tahan, MR. Videolaryngoscopes for placement of double lumen tubes: Is it time to say goodbye to direct view?. Saudi J Anaesth 2016;10:218-27.
12. Adnet F, Borron SW, Lapostolle F, Lapandry C. The three axis alignment theory and the sniffing position: Perpetuation of an anatomic myth?. Anesthesiology 1999;91:1964-5.
13. Herbstreit F, Fassbender P, Haberl H, Kehren C, Peters J. Learning endotracheal intubation using a novel videolaryngoscope improves intubation skills of medical students. Anesth Analg 2011;113:586-90.
14. Karalapillai D, Darvall J, Mandeville J, Ellard L, Graham J, Weinberg L. A review of video laryngoscopes relevant to the intensive care unit. Indian J Crit Care Med 2014;18:442-52.