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Comparative assessment of intubating conditions in adult patients using C-MAC® Video laryngoscope and Macintosh direct laryngoscope in routine intubations

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Abstract

Background and Aims: Securing the airway with an endotracheal tube is considered the standard of care for surgeries requiring general anaesthesia. The Macintosh laryngoscope is the most commonly used device for directly visualising the structures of the larynx and facilitating tracheal intubation. Video laryngoscopes (VLS) which work on the principles of indirect laryngoscopy is found to improve the visualisation of larynx and increase success rate with laryngoscopy and intubation in manikin studies and difficult airway scenarios. Its usefulness in routine intubations in operative settings is yet to be evaluated.

Material and Methods: After institutional ethical committee approval and patient consent, eighty ASA I/II patients, aged 18 to 60 years, with normal airway, who underwent elective surgeries under general anaesthesia were included in the study. Patients were randomly allocated into two groups of 40 each, to undergo laryngoscopy and oro-tracheal intubation using either Macintosh direct laryngoscope (group D) or C MAC® video Laryngoscope (Group V) following induction of general anaesthesia. Cormack Lehane laryngoscopy grading, number of attempts required for intubation, need for stylet, backwards upwards rightwards pressure (BURP) manoeuvre, duration of intubation, haemodynamics during laryngoscopy and intubation, and overall ease of intubation were compared.

Results: Duration of intubation was more in group V in contrast to group D which was statistically significant (29.5±19.12 s Vs 12.22±9.25 s). There was also a significant increase in the usage of stylet in group V in comparison to group D (12 Vs 1). Combined usage of both BURP and Stylet was required in 8 patients of group V in contrast to one patient in group D.

Conclusion: C-MAC® Video laryngoscope though improved the Cormack and Lehane grading, its use is associated with longer time for intubation, higher combined use of stylet and BURP manoeuvres to negotiate the endotracheal tube through the vocal cords in comparison with Macintosh laryngoscope in adult patients with normal airway.

Keywords: C-MAC® Video laryngoscope, Macintosh laryngoscope, Normal airway, Oro-tracheal intubation, Routine operative settings, Intubation difficulty scale(IDS)

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Introduction

Securing the airway using an endotracheal tube is considered the standard of care for surgeries requiring general anaesthesia. Endotracheal intubation may be challenging and its failure is a leading cause of morbidity and mortality in the operative and emergency settings. The Macintosh laryngoscope is the most commonly used device for directly visualising the structures of the larynx and facilitating tracheal intubation. In recent years, video laryngoscopes (VLS) based on the principles of indirect laryngoscopy have been introduced into clinical practice.[1-3] When compared with direct laryngoscopy, VLS is found to provide a significantly better view of the larynx, which may be useful in situations of difficult intubation.[2-5] VLS are developed with the aim of improving the visualisation of laryngeal structures, particularly in the setting of the difficult airway. The key novel feature of these 'indirect' laryngoscopes compared with the Macintosh laryngoscope is that they facilitate the visualization of the vocal cords without the need to align the oral, pharyngeal, and tracheal axes.[3]

The C-MAC® video laryngoscope[1,4] is one of VLS, which is available in the standard Macintosh blade sizes 2, 3 and 4, Miller blade sizes 0,1 and 3, and D blade for difficult intubation. The Macintosh blade of C-MAC® VLS is flattened, resulting in a very slim blade profile (maximum 14 mm), and the edges are slanted to avoid damage to the mouth and teeth. C-MAC® VLS incorporates the smallest possible (2-mm) digital camera and a high-power light-emitting diode, located laterally in the distal third of the blade. Thus, reduced image quality due to damaged optical fibres, need for white colour balance and focusing, and immobility due to external light source were eliminated. The view obtained, includes the tip of the blade and therefore, allows visual guidance of the tip of the blade into the vallecula. A colour image is displayed on a lightweight, portable high-resolution liquid crystal display monitor(Fig. 1).

Fig. 1: Laryngeal view before and after intubation through C-MAC® VLS

It offers several distinct advantages over Macintosh direct laryngoscope. The familiarity of the Macintosh blade, and the ability to use the C-MAC® as a direct or indirect laryngoscope, may be advantageous. It provides magnified view of laryngeal structures for anaesthesiologist and supporting staff leading to easier recognition of the anatomical structures and anomalies and thus facilitating manipulation of airway devices. When assistance is required, the operator and assistant can coordinate their movements because each sees exactly the same image on the video monitor. The system was very effective in a large study in patients with a difficult intubation scenarios in manikins [5]. Whether it can improve the intubating conditions in routine operative settings is yet to be confirmed with a large sample size.

Materials and Methods

After approval by the institutional ethical committee, this prospective randomised controlled study was conducted at Vijayanagar Institute of Medical Sciences, Ballari during the period from December 2010 to September 2012. Eighty patients of either sex in the age group of 18 to 60 years with American Society of Anesthesiologists (ASA) physical status I and II, posted for elective surgery under general anaesthesia with orotracheal intubation were selected for the study, after obtaining their consent to participate in this study. Patients with all Mallampati grading(Modified) included in the study. Patients with ASA physical status III and more, respiratory tract infections, body mass index more than 30, limited mouth opening (less than 4cm), limited neck mobility, patients with orofacial anomalies and patients at risk of gastric aspiration were excluded from the study.

A thorough preanaesthetic evaluation along with a detailed airway assessment was done which included modified Mallampati grading, Rule of 1-2-3 and other routine tests.

Patients were randomly allotted by computer generated randomisation to one of study groups; Group D to undergo conventional direct laryngoscopy using Macintosh laryngoscope and Group V to undergo video laryngoscopy (indirect laryngoscopy) using Storz C-MAC® video laryngoscope (Karl Storz, Tuttlingen, Germany).

In the operating room, standard monitoring was instituted which included a pulse oximeter, electrocardiogram(ECG) and non-invasive blood pressure(NIBP). Baseline values of systolic blood pressure(SBP), diastolic blood pressure(DBP), mean arterial blood pressure(MAP), heart rate(HR), oxygen saturation(SpO_2) were noted and were recorded every minute from the time of induction of anaesthesia till five minutes after the intubation and confirmation of endotracheal tube placement, and then at five-minute interval for the next fifteen minutes.

All patients were premedicated with given inj.Glycopyrrolate (10µg/kg), inj.Midazolam 1mg and inj.Fentanyl (1.5 µg/ kg) intravenously(IV).After preoxygenation with 100% oxygen for 3 minutes, IV induction was done by using inj. Propofol (2.5 mg/kg) followed by inj.Vecuronium (0.1mg/kg). Patients were then maintained on oxygen, nitrous oxide (33:67) with 0.5% end tidal isoflurane for 4 minutes. For next one-minute nitrous oxide discontinued. At 6th minute, after confirming the adequate relaxation of jaw, laryngoscopy was performed in group D with Macintosh direct laryngoscope with blade size 3 and 4 and in group V with C-MAC® VLS with Macintosh blade sizes 3 and 4. Endotracheal intubation was performed using appropriate size endotracheal tube (7 to 8.5 mm ID) by an experienced anaesthesiologist who has performed at least 25 indirect laryngoscopies using C MAC® VLS. Correct placement of endotracheal tube was confirmed by auscultation over the chest and capnography. After endotracheal intubation subsequent anaesthetic management was continued as per the need of the case. Cormack Lehane (CL) grading, number of attempts required for intubation, need for stylet, backwards upwards rightwards pressure(BURP) manoeuvre and combination of stylet and BURP manoeuver, duration of laryngoscopy and intubation, haemodynamical changes and overall ease of intubation were recorded.

CL grading[7] was done as follows; grade I= Full view of the glottis, grade II= Partial view of the glottis or only the posterior commissure is visible, grade III =only the epiglottis visible and grade IV =neither glottis nor epiglottis visible.

Duration of laryngoscopy and intubation was defined as time taken from insertion of the laryngoscope blade between the teeth until the endotracheal tube is placed through vocal cords as evidenced by visual confirmation by the anaesthesiologist performing laryngoscopy.

Ease of intubation was assessed by using Intubation difficulty scale (IDS). IDS were used based on a previous study done by Frederic Adnet et al.[8] It has 7 parameters and each parameter is given points depending on the contribution of that component for difficult laryngoscopy and intubation (Table 1). Then a composite score was summed to provide an overall assessment of difficulty as follows; An IDS score of 0 was taken as an easy intubation, IDS scores 1 – 4 represented minor difficult intubations and score more than 5 considered as major difficult intubation.

Table 1: Intubation Difficulty Scale (IDS)

Parameter	Points
Number of supplementary attempts	1 point each
Number of supplementary operators	1 point each
Number of alternate techniques	1 point each
Cormac Lehane grade minus one	0 to 3 points
Lifting force required	Normal = 0
	Increase =1
External laryngeal pressure applied	None = 0
	Any = 1
Vocal cord mobility	Abduction = 0
	Adduction = 1

Sample size was calculated as per previous studies.[4,6] Sample sizes of 40 in each group was arrived to achieve 80% power to detect a difference between the group proportions of 0.3000. The proportion in Group V is assumed to be 0.5000 under the null hypothesis and 0.8000 under the alternative hypothesis. The proportion in Group D was 0.5000. The statistic test used was the two-sided Z test with pooled variance. The significance level of the test was targeted at 0.0500. The significance level actually achieved by this design is 0.0567.

Data were analysed using software STATA version 12 (Stata Corp LP, Texas, 2011). Results were presented as mean ± standard deviation or proportions. Paired 't' test, chi square tests used as per the data. $P < 0.05$ was considered as statistically significant.

Results

All the patients included in the study successfully completed the study. Age distribution and ASA physical status were similar between the groups. (Table 2) Patients with different grades of modified Mallampati classification were equally distributed in both study groups. (Table 2)

Table 2: Frequency table of demographic parameters and modified Mallampati grading of the patients

Parameters	Group D (n=40)	Group V (n =40)
Age(Years)		
<20	5(12.5%)	4(10%)
21-30	16(40%)	17(42.5%)
31-40	8(20%)	9(22.5%)
41-50	7(17.5%)	7(17.5%)
51-60	4(10%)	3(7.5%)
ASA physical status		
I	39(97.5%)	37(92.5%)
II	1(2.5%)	3(7.5%)
Modified Mallampati grade		
I	18(45%)	15(37.5%)
II	17(42.5%)	19(47.5%)
III	4(10%)	4(10%)
IV	1(2.5%)	2(5%)

As far as laryngeal view is concerned, 60% of patients in Group V and 40% in Group D had a CL grade of I. However, more number of patients in group D had a CL grade of 2 in contrast to Group V (22 versus 12) respectively. (Table 3)

Table 3: Cormack and Lehane grading

Cormack and Lehane grade	D group (n =40)	V group (n =40)
1	16(40%)	24(60%)
2	22(55%)	12(30%)
3	2(5%)	3(7.5%)
4	0	1(2.5%)
p value=0.125		

In present study, 22 out of 40 patients in Group D needed BURP manoeuvres for laryngoscopic view, whereas 18 out of 40 patients in Group D needed BURP manoeuver. However, this was not statistically significant (Table 4).

The need for stylet for successful intubation was significantly more in Group V (30%) whereas it was necessary in only one patient (2.5%) in Group D, which was statistically significant (p=0.001) (Table 4).

Use of both the BURP manoeuvre for laryngoscopy and stylet for intubation was needed in 8 patients in Group V as compared to only one patient in Group D, which was also statistically significant (Table 4).

Overall duration of laryngoscopy and intubation was more in Group V than Group D (29.5 ± 19.12s Vs 12.22 ± 9.25 s) which was statistically significant (p=0.000015).

Mean IDS score obtained in both groups (2.02±1.6 in group D versus 2.3±2.1 in group V) were similar and difference was statistically not significant(p=0.1272)

Table 4: Frequency table of parameters studied

Study parameter	Group D (n= 40)	Group V (n =40)	P value
Use of BURP manoeuvre			
Yes	21(52.5%)	18(%)	0.502
No	19(47.5%)	22(55%)	
Use of stylet			
Yes	1(2.5%)	12(30%)	0.001
No	39(97.5%)	28(70%)	
Combined use of BURP manoeuvre and stylet			
Yes	1(2.5%)	8(20%)	0.013256
No	39(97.5%)	32(80%)	
Duration of laryngoscopy and intubation in seconds (Mean ±SD)			
	12.22 ± 9.25	29.5 ± 19.12s	0.000015
Mean IDS score (Mean ±SD)			
	2.025 ± 1.67	2.3 ± 2.138	0.1272
Overall ease of intubation			
Easy	13(32.5%)	15(37.5%)	0.292
Minor difficulty	27(67.5)	23(57.5%)	
Major difficulty	0	2(5%)	

Haemodynamics (HR, SBP, DBP, MAP) were well maintained and comparable before intubation, at the time of intubation, at 1, 3 and 5 minutes following intubation in both Groups (Fig. 2 and 3).

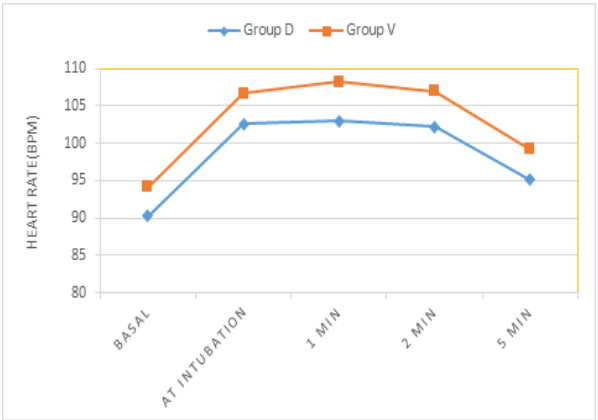

Fig. 2: Heart rate changes in the two groups

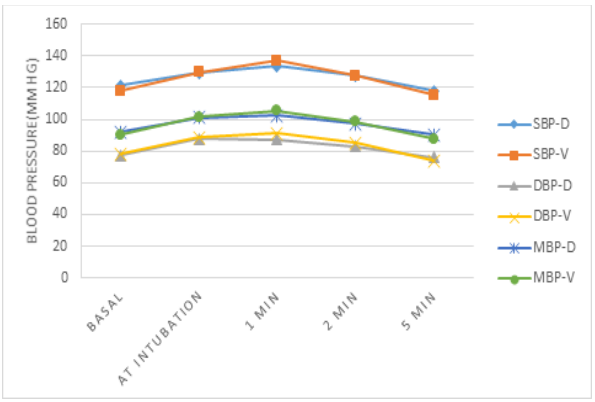

Fig. 3: Changes in SBP, DBP and MBP in the two groups

Discussion

Direct laryngoscopy using Macintosh laryngoscope[9] has been used for laryngoscopy and intubation since 1943.Videolaryngoscope has been introduced to provide better laryngoscopic view on a video monitor and it can also potentially improve ease of intubation. The use of video laryngoscope in intubation is well established and has been extensively supported in the literature for managing the difficult airway.[5,6] But its use for routine elective cases has not been studied in detail. Thus we prospectively evaluated the intubating conditions in adult patients.

We have included all grades of Mallampati in this study as the single usage of the Mallampati classification has limited discriminative power for difficult tracheal intubation.[10]

Though there were no significant differences in airway assessment was between 2 groups, more number of patients in group V (24 Vs 16) had better CL grading but that was statistically not significant. This can also be explained by the fact that the blades of C-MAC® and Macintosh are identical in design and the skills acquired using one device should be transferable to the other device as demographical profile were similar in 2 groups.

Need for using BURP manoeuvre was almost similar in both the groups, although more patients in Group V had CL grade I. Intubation could be facilitated by use of stylet in 12 cases in Group V, whereas only one patient needed stylet in Group D. More patients in Group V (8 Vs 1) needed use of both BURP and Stylet together for laryngoscopy and intubation. Though similar view of laryngeal structures can be obtained in C Mac laryngoscope camera without aligning the oropharyngo-laryngeal axis, to achieve successful intubation some alignment of oropharyngo- laryngeal axes is invariably required. This could have led to the higher need for combined use of stylet and BURP Manoeuver in group V. Other reasons for the higher need of stylet and BURP manoeuvers may need to be identified and studied.

In anticipated difficult airway, C-MAC® video laryngoscope has been shown to perform better in terms

of shorter intubation time, higher success rate and less number of optimising manoeuvres.[4] On contrary our study results showed statistically significant difference in the mean duration of intubation between C-MAC® VLS and Macintosh laryngoscopes 29.57±19.12s and 12.22±9.25s (p value=0.0000). Though our Study results are comparable with results of a contemporary study by Hodgetts V et al,[11] good hand-eye co-ordination is very much essential for viewing the glottis on monitor and intubating the patient. Routine use of C-MAC® VLS may narrow the gap between mean intubation duration between 2 groups in our study.

Additional cognitive processing required for indirect laryngoscopy may affect the total intubation time and success rate when used in routine clinical practice, particularly when used by novices. The first stage of learning is the verbal cognitive phase, where the operator needs to understand what is to be achieved; whilst the second stage is task execution. Stage one of cognitive learning would have been a learned skill, requiring minimal cognitive processing. Therefore, we may hypothesize that delay in time to achieve laryngoscopy and intubation using the video laryngoscope, must reflect the second stage of learning, which is task execution.[12]

Although video laryngoscopes provide a good view of the larynx, they may not guarantee an easy tracheal intubation[13] and may prolong the time required for successful intubation as seen in our study.

Intubating difficulty scale score was introduced by Frederic Adnet et al[8] in year 1997. It is a quantitative scale of intubation difficulty useful for objectively comparing the complexity of endotracheal intubation. IDS is a quantitative measure of the total intubation difficulty encountered during a chosen procedure. The values of the individual components are documented to offer detail of the difficulties encountered. Each of these parameters has been demonstrated to contribute to the degree of difficulty of airway management by endotracheal intubation. In our study overall IDS scores and hence ease of intubation was found to be similar in both the groups.

Haemodynamics before, during and after laryngoscopy were comparable in both Groups despite prolonged duration of intubation in Group V. This may be explained by the fact that better CL grading in group V might have led to less lifting pressure exerted by the anaesthesiologist.

In spite of difference in need for additional manoeuvre for laryngoscopy and intubation, there was no significant difficulty in intubation in Group V. Both the patients who had major difficulty as per IDS score had grade IV Mallampati Airway and both patients were successfully intubated.

Major limitation of the study is that the anaesthesiologist performing the laryngoscopy and intubation could not be blinded to the devices used in the study.

Conclusion

C-MAC® Video laryngoscope though improved the Cormac and Lehane grading, its use is associated with longer time for intubation, higher combined use of stylet and BURP manoeuvres to negotiate the endotracheal tube through the vocal cords in comparison with Macintosh laryngoscope in adult patients with normal airway in routine operative settings.

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