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Comparison of the Glottic View Obtained Bythe C-Mac Videolaryngoscope and Direct Laryngoscope in Patients with a Simulated Difficult Airway-A One Year Hospital Based Case Series Study

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Abstract:
Background*: Inability to view the larynx adequately during laryngoscopy is a major problem encountered during endotracheal intubation. The ability to pass an endotracheal tube under direct vision of the glottic structures is of utmost importance to the anaesthesiologist. Difficult laryngoscopy and failed intubation result in severe morbidity related to anaesthesia. This has forced the anaesthesiologists to persue their interests in developing newer gadgets to facilitate successful and safe endotracheal intubation.One of the many devices in this category is the C-MAC videolaryngoscope which is conceptually and structurally different from many other videolaryngoscopes. Rather than using blades with acute angles, like the glidescope, the CMAC incorporates a conventional Macintosh type blade, with the addition of a micro video camera on the distal portion of the blade. It carries the advantage of being used as both, direct and indirect laryngoscope*
Materials and Methods*: In this prospective randomised controlled study, patients aged 20-60 years, of either gender, undergoing elective surgery in supine position, with general anaesthesia and endotracheal intubation, were selected with ASA physical status 1 and 2. Study was conducted over 12 months duration. Patients fulfilling the inclusion and exclusion criteria, were randomly chosen into the study group.Direct laryngoscopy (Macintosh scope) was performed with the neck collar in situ, (without applying external laryngeal pressure (BURP Maneuver). The best obtained CORMACK-LEHANE (C/L) view, modified by Yentis and Lee was identified.Immediately, laryngoscopy was performed using the C-MAC Videolaryngoscope.The two laryngoscopies were performed immediately one after the other, each taking a maximum time of 30-35 seconds. Intubation was carried out with the CMAC Videolaryngoscope, in presence of the collar The anaesthesiologist graded the subjective experience of intubation as easy (E) or difficult (D). Any situation leading to external laryngeal manipulation, more than one attempt, use of bougie etc were all categorised as 'D'. In the situation of difficulty namely inability to intubate in one attempt or inability to maintain oxygen saturation >90% with mask the neck collar was removed immediately, and patient was intubated by the conventional standard technique.*
Results*:It was observed that Grade I and II were 23.3% (14/60) and grade III and IV (RESTRICTED) in 76.7% (46/60).Chi square = 16.408P< 0.001 Significant.In our study, the intubation was attempted with the cervical collar in situ, with the C-MAC Videolaryngoscope. The intubation experience was subjectively assessed as easy (E) or difficult (D). The intubation was found to be easy (E) in 73.3% cases. The remaining, 26.7% were those where intubation was not possible in the first attempt with collar, the collar was removed and the intubation was carried out by the conventional method.*
Conclusion:*C-MAC videolaryngoscope, a new video device with original Maintosh blade design improved the glottic view in comparison to the conventional Macintosh direct laryngoscopy, for accomplishing endotracheal intubation in a simulated difficult airway setting.*
Key Word*: EndotrachealIntubation , C MAC, ASA , Direct Laryngoscopy*

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I. Introduction

The literature in Anaesthesiology abounds with anecdotal reports dealing with difficult intubation. There are moments, when the skills of an anaesthesiologist are challenged by difficult airway scenarios.Inability to view the larynx adequately during laryngoscopy is a major problem encountered during endotracheal intubation. The ability to pass an endotracheal tube under direct vision of the glottic structures is of utmost importance to the anaesthesiologist. Difficult laryngoscopy and failed intubation result in severe morbidity related to anaesthesia. This has forced the anaesthesiologists to persue their interests in developing newer gadgets to facilitate successful and safe endotracheal intubation.

Although fiberoptic laryngoscope remains the gold standard in the management of anticipated difficult airways, there is a huge gap between direct laryngoscopy and the fiberoptic laryngoscopy. Efforts have been made to bridge this gap by various modifications of the standard Macintosh laryngoscope blades, different type of laryngoscopes, various adjuncts used in difficult airway like the gum elastic bougie, stylet etc.

Off late there have been significant advances in the field of difficult airway management . The invention of the video assisted laryngoscopes, commonly called the 'videolaryngoscopes' has definitely decreased the gap between direct and fiberoptic laryngoscopy, with relative simplicity of usage and smaller easier learning curve. A wide range of such devices are now available to the anaesthesiologists worldwide.

One of the many devices in this category is the C-MAC videolaryngoscope which is conceptually and structurally different from many other videolaryngoscopes. Rather than using blades with acute angles, like the glidescope, the CMAC incorporates a conventional Macintosh type blade, with the addition of a micro video camera on the distal portion of the blade. It carries the advantage of being used as both, direct and indirect laryngoscope.[1.]

However, it is imperative to subject these newer gadgets to thorough scientific evaluation regarding their usefulness in safe endotracheal intubations, in patients with normal and difficult airway.

Simulation of a difficult airway like application of a rigid cervical collar can be instrumental in evaluation of the new gadget as well as help in better training of personnel and in achieving expertise in the difficult airway management.

Hence an attempt is being made to evaluate the glottic view provided by the CMAC as compared to the standard Macintosh laryngoscope in patients with a simulated difficult airway, using a rigid cervical immobilisation collar under general anesthesia.

II. Material And Methods

Study Design: Prospective study
Study Duration:12months
Sample size calculation Sample size was calculated using formula

$$N = \frac{4 \times p \times q}{d2}$$

N- Sample size
p- Pickup rate by the new procedure being evaluated
q- 100-p
d- Relative error
P of test is taken as 86%
(Based on results of preliminary studies evaluating the C-MAC videolaryngoscope)
Relative error taken as 8.6% (10% of p)
A total sample size of 60 patients was obtained, on the basis of references and pilot study.

Inclusion Criteria:
1. ASA physical status 1 and 2
2. Age between 18 to 60 years.

Exclusion Criteria :
1. Patient refusal
2. Patient with known/anticipated difficult airway
3. ASA grade 3 and 4.
4. Patients with potential full stomach.

Procedure methodology

After obtaining ethical committee clearance and written informed consent, 60 patients (ASA I-II) of either gender, posted for elective surgeries in the supine position, under general anaesthesia in whom tracheal intubation was indicated, were enrolled in the study. Pre anaesthetic evaluation of the patient and routine investigations were done. An IV line was secured. Standard monitoring devices were attached before induction of anaesthesia, including non-invasive arterial blood pressure, heart rate, and oxygen saturation.After 5min of pre oxygenation with a facemask (for adequate oxygen reserve), induced and premedication with injection **GLYCOPYRROLATE-0.005mg/kg, MIDAZOLAM-0.05mg/kg, PENTAZOCINE-0.5mg/kg,** General Anaesthesia wasInduced with inj**THIOPENTONE-5 mg/kg** and **SUCCINYL CHOLINE-2mg/kg.** Then a rigid cervical immobilisation collar was applied.Later, maintained on non depolarising muscle relaxants.

METHOD OF LARYNGOSCOPY

Direct laryngoscopy (Macintosh scope) was performed with the neck collar in situ, (without applying external laryngeal pressure (BURP Maneuver). The best obtained CORMACK-LEHANE (C/L) view, modified by Yentis and Lee was identified.Immediately, laryngoscopy was performed using the C-MAC Videolaryngoscope. A second anaesthesiologist, (blinded to the laryngeal view obtained under direct laryngoscopy), graded the glottic view, (CORMACK-LEHANE view) on the video monitor, using the C-MAC Video laryngoscope, without external laryngeal pressure. The position of the device was adjusted to have the glottis in the centre of the screen. The two laryngoscopies were performed immediately one after the other, each taking a maximum time of 30-35 seconds. Intubation was carried out with the CMAC Videolaryngoscope, in presence of the collar The anaesthesiologist graded the subjective experience of intubation as easy (E) or difficult (D). Any situation leading to external laryngeal manipulation, more than one attempt, use of bougie etc were all categorised as 'D'. In the situation of difficulty namely inability to intubate in one attempt or inability to maintain oxygen saturation >90% with mask the neck collar was removed immediately, and patient was intubated by the conventional standard technique.

Correct tube position, and subsequently, successful ventilation, were assessed with capnography and bilateral chest auscultation.Oxygen saturation (SpO_2), mean arterial blood pressure, and heart rate were recorded at baseline and after laryngoscopy.Anaesthesia was continued as per individual case requirement, according to standard protocol.

Statistical analysis

The observations (good glottic view) were found out from the collected data, for both, direct laryngoscopy and video laryngoscopy and analysed by Kappa Statistics.

III. Result

The present case series study was conducted to compare the C MAC Videolaryngoscope with the standard Macintosh laryngoscope in providing glottic view for endotracheal intubation in patients with a simulated difficult airway.

60 patients aged between 18-60yrs, of either sex, belonging to ASA class I and II, scheduled to undergo elective surgeries under general anaesthesia, in whom endotracheal intubation was indicated, were included in this study.

Table 1: DEMOGRAPHIC DATA - AGE

AGE GROUP	NUMBER	PERCENTAGE
≤20	6	(10.0)
21-30	25	(41.7)
31-40	17	(28.4)
41-50	8	(13.3)
51-60	4	(6.6)
TOTAL	60	(100.0)

Table 2: DEMOGRAPHIC DATA - SEX

SEX OF PATIENT	NUMBER	PERCENTAGE
MALE	28	(46.7)
FEMALE	32	(53.3)
TOTAL	60	(100.0)

Table 3: GLOTTIC VIEW GRADING UPON DIRECT LARYNGOSCOPY

GLOTTIC VIEW	I	II	III	IV	TOTAL
No. Of patients (%)	---	14 (23.3)	39 (65)	7 (11.7)	60 (100.0)

It was observed that Grade I and II were 23.3% (14/60) and grade III and IV (RESTRICTED) in 76.7% (46/60)

Table 4: GLOTTIC VIEW GRADING UPON C-MAC VIDEOLARYNGOSCOPY

GLOTTIC VIEW	I	II	III	IV
No of patients	17 (28.4)	29 (48.3)	14 (23.3)	---

Table 5: EASE OF INTUBATION with cmac

EASE OF INTUBATION	EASY (E)	DIFFICULT (D)	TOTAL
No of patients (%)	44 (73.3)	16 (26.7)	60 (100.0)

Table 6: EASE OF INTUBATION COMPARED WITH THE GLOTTIC VIEW BY C-MAC VIDEOLARYNGOSCOPY

C-MAC CL GRADE	D	E	TOTAL
I	0	17	17
II	7	22	29
III	9	5	14
IV	--	--	--

Chi square = 16.408. P < 0.001. Significant

Table 9: AGREEMENT BETWEEN TWO VIEWS – DIRECT AND C-MAC VIEW BY KAPPA STATISTICS

DIRECT GLOTTIC VIEW	C-MAC GLOTTIC VIEW				
	I	II	III	IV	TOTAL
I	0	0	0	0	0
II	7	7	0	0	14
III	9	18	12	0	39
IV	1	4	2	0	7
TOTAL	17	29	14	0	60

RELATIVE AGREEMENT	EXPECTED AGREEMENT-RANDOM AGREEMENT by kappa analysis	KAPPA QUOTIENT
47%	17.19%	0.1719

Table 8: IMPROVEMENT IN GLOTTIC VIEW (CL GRADE) WITH C-MAC

GRADES OF IMPROVEMENT	NUMBER OF CASES
SAME	20 (33.3%)
1 GRADE	26 (43.3%)
2 GRADES	13 (21.6%)
3 GRADES	1 (1.6%)

IV. Discussion and Conclusion

Difficult visualisation of the larynx(DVL) has been defined by the ASA task force as occurring when it is not possible to visualize any part of the vocal cords by conventional laryngoscopy., as Cormack Lehane grade III and IV. Endotracheal intubation is a very commonly performed procedure, in the operating room and in other settings too, usually completed with ease. The incidence of DVL has been reported to be between 1.5 to 13%, that of difficult intubation to be 1 to 4% and failed intubation between 0.1 to 0.3%.27. A closed claim analysis has shown that the most common complication in such cases was hypoxia caused by inadequate ventilation and oxygenation. In 85% of these cases, the outcome was death or brain damage.

A preplanned preinduction strategy includes the consideration of various interventions designed to facilitate intubation should a difficult airway occur. Noninvasive interventions intended to manage a difficult airway include, awake intubation, video-assisted laryngoscopy, intubating stylets or tube-changers, SGA for ventilation (e.g., LMA, laryngeal tube), SGA for intubation (e.g., ILMA), rigid laryngoscopic blades of varying design and size, fiberoptic-guided intubation, and lighted stylets or light wands. Meta-analyses of RCTs comparing video-assisted laryngoscopy with direct laryngoscopy in patients with predicted or simulated difficult airways report improved laryngeal views, a higher frequency of successful intubations, and a higher frequency of first attempt intubations with video-assisted laryngoscopy (Category A1-B evidence).

We conducted a study to evaluate the effectiveness of the C-MAC videolaryngoscope in comparison to the conventional Macintosh laryngoscope in the setting of a difficult airway. Since the videolaryngoscope is a newer device, it was decided to use it in a simulated difficult scenario initially. A difficult airway was simulated in the patient by applying the rigid cervical collar prior to performing laryngoscopy. In order to avoid patient bias both the laryngoscopes were used sequentially in the same patient, after induction of general anesthesia.

In our study, in the presence of a simulated difficult airway, restricted glottic view (CL Grade III & IV) was observed in 76.7% of patients with the conventional Macintosh laryngoscope, compared to 23.3% with

CMAC, which was comparable to 68% CL grades III & IV with the cervical collar in situ in the study by Komatsu.R et al..

76.6% of grade III & IV with direct laryngoscopy could be attributed to the fact that successful visualisation of larynx with direct laryngoscopy requires the optimum position of larynx along the line of sight. The presence of neck collar will reduce the mouth opening and restrict cervical spine flexion & extension also. With the use of CMAC, the camera lies closer to the tip of the blade, providing an indirect view of the larynx, and circumvents the problem of achieving a direct line of sight as shown in only 23.3% cases having CL grade III & IV.

In our study it was observed that glottic view improved with the use of CMAC Videolaryngoscope compared to the Macintosh laryngoscope. View improved by 1 CL grade in 43.3%, by 2 CL grades in 21.6% and by 3 CL grades in 1.6%. This is comparable to the study done by Piepho.T et al to evaluate the use of CMAC videolaryngoscope in patients who had a poor glottic view on Macintosh direct laryngoscopy, it was found that glottic view improved in 94% of the patients. In 31% cases by 1 CL grade, 62% cases improved by 2 CL grades and in 2% cases improvement was by 3 CL grades..

Initial studies for CMAC and other such videolaryngoscopes were conducted on manikins, with and without a simulated difficult airway. In one such study done by Saito.T et al comparing the airway scope and Coopdeckvideolaryngoscope portable VLP-100, the airway scope was associated with better glottic views and higher rate of successful tracheal intubations.11.Though there is improvement in the laryngeal views, videolaryngoscopes with acutely curved blades (Glidescope) still carry the risk of failure of intubation, because of the difficulty with alignment of the endotracheal tube with the oropharyngeal axis. In this regard, CMAC has a definitive advantage over the other videolaryngoscopes, as the CMAC blades resemble a standard Macintosh blade. Thus the intubation would be similar to that with direct laryngoscope.

Hofstetter.C et al conducted a study comparing conventional laryngoscopy with Macintosh videolaryngoscopy, and observed a significant improvement in the laryngeal view.

In a randomised clinical trial comparing direct Macintosh laryngoscope to the CMAC videolaryngoscope, in groups matched for predictors of difficult airway, Aziz.M.F et al observed that CL grade I & II were seen in 139/149 cases in CMAC group and 119/149 cases in Macintosh direct laryngoscope group.32. The predictors of difficult airway included were reduced cervical movements, Mallampatti class III or IV, reduced mouth opening and a history of difficult direct laryngoscopy. CL grade III & IV were in 6.7% for CMAC group and 19% in direct Macintosh group. However, presence of difficult airway predictors preoperatively does not actually mean a difficulty in intubation. Secondly, groups were matched for few of the predictors of difficulty. There can be many more causes and predictors for difficult airway that could have been present in either of groups. In our study, to avoid this bias and the basic anatomical differences of airway from person to person, the glottic views were assessed sequentially in the same patient with both the devices.

In another study by Noppens.R et al, comparing the Macintosh laryngoscopy with the CMAC in the emergency department, in patients with atleast one predictor of difficult airway, the visualisation of the glottis using Cormack Lehane grading with Macintosh laryngoscopy was frequently graded as difficult (20%, CL III & IV) compared to CMAC (7%, CL III & IV).

Another comparison between the usefulness of the CMAC and Conventional Macintosh laryngoscopy in the emergency department done by Sakles.J et al, found that for patients with restricted cervical mobility, the CMAC was successful for intubation in 82 of 83 cases(98.8%) where as direct laryngoscope was ultimately successful in 81.1% of the patients.

These data appear to validate the idea that cervical immobility hinders the ability to create a direct line of sight to laryngeal inlet with a conventional direct laryngoscopy.35. Because the C-MAC obtains a view of the glottis indirectly with the help of a micro videocamera, the view would be better. Thus providing a benefit in cervical spine immobilised patients with blunt trauma.

Byhahn.C et al evaluated the CMAC Videolaryngoscope in simulated difficult airway cases, and found that ,upon application of the collar, poor glottic view was seen in 70% cases with direct Macintosh laryngoscopy and 14% with the C-MAC.13. Observations of our study were comparable to these, being 76.6% poor view with Macintosh laryngoscope and 23.3% with C-MAC.

In our study, the intubation was attempted with the cervical collar in situ, with the C-MAC Videolaryngoscope. The intubation experience was subjectively assessed as easy (E) or difficult (D). The intubation was found to be easy (E) in 73.3% cases.

The remaining, 26.7% were those where intubation was not possible in the first attempt with collar, the collar was removed and the intubation was carried out by the conventional method.

Of the ones graded as difficult, majority of the patients belonged to a higher Cormack Lehanegarding. (CL III in direct laryngoscopy in 13 cases 21.6%, by C-MAC in 9 cases 15%) Thus reinforcing the fact that a good glottic view is paramount in successful intubation.

However, in some of the cases, intubation was difficult, despite a good view upon laryngoscopy (7 cases, 11%). This could be possibly due to the unfavourable anatomical axis that forced the tip of the tube downwards to the esophageal inlet and the poor manoeuvrability of the tube due to limited oropharyngeal space, caused by limited mouth opening with the cervical collar in place.

A study by Kaplan.MB et al, analysing the improvement in laryngoscopic view by videolaryngoscopy with a Macintosh blade in 865 unselected patients, reported a failure rate of only 0.3%..

In our study, the presence of the cervical collar made mouth opening difficult, significantly limiting the operator's ability to move the tube in a sagital plane, so as to direct the tip towards the glottic opening. This fact was likely to have had a major impact on the relatively high rate of difficult intubations in our study.

Successful intubation in such situation can be achieved by use of adjuncts like gum elastic bougie, intubating stylets, BURP manoeuvre, which has shown to improve the Cormack Lehane grades and the POGO scores.

No procedure related complication, such as obvious dental, lip or airway injury was observed in any patient. However, specific causes for difficulty in intubation in each of the cases was not studied.

Cervical immobilisation is a routine procedure in trauma patients, particularly the cervical spine injuries, quite a few of whom require endotracheal intubation in the emergency department prior to completion of the diagnostic procedures.. Reduced mouth opening and restricted cervical spine movement by the collar also simulates a difficult airway situation that could be encountered in the operation theatre. With the technique of videolaryngoscopy making its way into the difficult airway algorithm, it is essential to have sufficient training in using one, both for normal and difficult airways. The C-MAC videolaryngoscope, with its original Macintosh blade design with additional advantages, would probably have a smaller learning curve compared to the other video devices with altogether different designing.

LIMITATIONS OF THE STUDY

The Cormack Lehane grading system was proposed with reference to direct laryngoscopy with a Macintosh blade.With the use of vieolaryngoscope, both the angle and the direction of vision are completely different even with the same type of blade. While the best glottic view obtained under direct laryngoscopy also quantifies the best glottic exposure in terms of anatomy and intubating conditions, it remains a mere view with a Macintosh videolaryngoscope. Therefore Cormack Lehane grading system is ill suited to predict endotracheal intubation difficulties with view obtained by videolaryngoscope.

SCOPE FOR FURTHER STUDIES

Evaluation of the C-MAC videolaryngoscope in situations of difficult airway, in the operation theatre as well as the ICU setting.Comparison of the conventional Macintosh laryngoscopy to the other videolaryngoscopes as well as between the video devices.

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