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Original Article

Anaesthesia Section

A Prospective, Longitudinal Study on Effectiveness of King Vision® Video Assisted Laryngoscope and McCoy Laryngoscope in Patients with Simulated Restricted Neck Mobility

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ABSTRACT

Introduction: Successful airway management in patients with restricted cervical spine movement is always very challenging as there is no consensus regarding management of difficult airway in such patients with limited or no cervical spine mobility.

Aim: To assess whether the King Vision® Video Laryngoscope (KVVL) provides a better view of the glottis and has higher success rate of tracheal intubation than McCoy laryngoscope in patients with simulated difficult airway.

Materials and Methods: A prospective, longitudinal, comparative study was conducted with prior approval from Institutional Ethics Committee, 100 patients were divided equally (n=50) into group V {Video Laryngoscope (VL)} and group M (McCoy laryngoscope). Time required for laryngoscopy and intubation, any damage to teeth or soft tissue injury was noted and view of the glottis was graded using a modified classification reported by Cormack and Lehane. Qualitative data (sex, American Society of Anesthesiologists (ASA) physical status, Mallampati classification, Cormack and Lehane glottis view grade, number of laryngoscopic attempts, number of optimisation maneuver required etc.,) were compared between the groups. Chi-square test (χ^2) and Fisher-exact test were used.

Results: The success on first attempt of laryngoscopy was significantly greater (p=0.014), time taken to do the procedure of laryngoscopy (p<0.001) and duration of intubation (p<0.001) was significantly lesser in the group V patients as compared to group M. Incidence of procedural dental injury was totally absent in group V, whereas four cases were recorded in group M. Optimisation maneuver was required in 50% of the group M patients as compared to 10% of group V (p<0.001). Changes in baseline parameters like pulse, Blood Pressure (BP) was noted more in group M (p<0.01) probably owing to the greater mean duration of intubation.

Conclusion: KVVL appears to possess more advantages over the McCoy laryngoscope in respect to ease of viewing glottis, reduced duration of laryngoscopy and intubation, lesser complications and haemodynamic instability.

Keywords: Efficacy, Limited neck flexibility, Manual laryngoscope

INTRODUCTION

Direct laryngoscopy and tracheal intubation have been used with variable success. Chin lift, jaw thrust and direct laryngoscopy cause movement in the cervical spine and other methods of tracheal intubation may disturb cervical spine [1]. Patients with multiple trauma having cervical spine instability may develop hypoxia or end up with catastrophic consequences following an attempt to secure airway or as a result of failure to intubate [2]. Most of the chronic cervical spine pathology as seen in patients of ankylosing spondylitis, rheumatoid arthritis, long term diabetes mellitus, cause limited or no cervical spine extension at all during conventional laryngoscopy. There is no consensus regarding management of difficult airway in such patients with limited or no cervical spine mobility. This has led to non-uniform airway management practices among anaesthesiologists [3]. The prime and most important step in the management of suspected or diagnosed cervical spine instability is cervical immobilisation. Potential problems associated with cervical immobilisation are difficult intubation, respiratory distress and raised intracranial pressure.

In this study, Manual In Line axial Stabilisation (MILS) method has been followed as the method of simulation of cervical immobilisation. However, a key concern is the fact that with cervical spine immobilisation, it is more difficult to visualise the laryngeal inlet using conventional laryngoscopy, because of the angle between the oral and the pharyngeal axis which becomes acute at the base of the tongue [4]. There are several methods used to overcome the unique challenge of laryngoscopy in cervical immobilisation. For non-urgent and elective airway control, awake fiberoptic intubation technique is preferred. Although there is no proof that this method minimises cervical spine movement, it does not require atlanto-occipital extension and the head and neck stabilising devices can be left in place. The VL is a technological advancement in anaesthesia practice [5]. Presence of distinctive blade design and a video camera or chip situated close to the tip of the laryngoscope blade, can allow greater visualisation of glottis with minimal movement of cervical spine. It may not be necessary to align the oral, pharyngeal, and laryngeal axes to see the glottis directly from the outside of the patient's mouth [6,7].

The KVVL is one of the new indirect laryngoscopes with channeled and non-channeled blades. Due to the unique design of KVVL, high-quality images can be shown and can be very effective in cervical spine injury patients without much movement of the neck [8].

The McCoy levering laryngoscope is traditionally being used in some cases of anticipated difficult intubation because of its maneuvering distal tip of the blade which lifts the epiglottis and expands structures around the laryngeal aperture, thereby facilitating tracheal intubation [9,10].

The efficacy of KVVL has not been compared to McCoy laryngoscope in patients with cervical spine immobilisation. Since, it is always a challenging situation for successful airway management in patients with restricted cervical spine movement e.g., cervical spine injury or pathological diseases, this study was undertaken to assess whether the KVVL provides a better view of the glottis and have higher success rate of tracheal intubation than McCoy laryngoscope in patients with simulated difficult airway.

MATERIALS AND METHODS

A prospective, longitudinal, comparative study was conducted at Surgery and Gynaecology operation theatres of Calcutta National Medical College and Hospital, Kolkata, West Bengal, India during January 2017 to July 2018 after obtaining the approval from the Institutional Ethics Committee (CNMC/3 dated 18/11/2016).

With 5% margin of error and a 95% confidence interval considering a sample proportion of 50% and expecting a 10% dropout, the sample size was calculated around n=90 which was rounded-up to 100 patients.

Inclusion criteria: Patients between 21 to 50 years of either sex with ASA physical status I-II and Mallampati score I-II that were scheduled to undergo elective surgery of expected duration of 60 to 120 minutes, requiring general anaesthesia with endotracheal intubation were included in the study.

Exclusion criteria: Patients with Body Mass Index (BMI) >35 kg/m^2, pregnant females, with previous neck surgery, with unstable C-spine, in whom difficult intubation was anticipated, need rapid sequence intubation and having risk of pulmonary aspiration were excluded.

Following screening based on inclusion/exclusion criteria, the selected patients were further divided by odd and even sequence into group V (VL) and group M (McCoy laryngoscope) with (n=50) each, respectively. All the study participants underwent routine preoperative check-up including thorough airway examination and documentation. On the night prior to the operation all the patients received Tab. Alprazolam 0.5 mg, Tab Metoclopramide 5 mg and Tab. Ranitidine 150 mg.

In the operation room, after establishing Intravenous (IV) access, all necessary monitoring devices such as Non-Invasive Blood Pressure (NIBP), pulse oximeter, Electrocardiography (ECG) leads were attached and the baseline parameters were recorded. A pre induction reading of pulse, systolic, diastolic, mean arterial BP and SpO_2 was recorded five minutes before induction. Preoxygenation with 100% oxygen for three minutes was done in each of the patients.

All patients were given Inj. Midazolam 1-2 mg, Inj. Fentanyl 2 mcg/kg and then induction was started with Inj Propofol 2 mg/kg body weight. Inj. Lidocaine 2%, 2 mL, was administered intravenously just before to prevent pain associated with the propofol administration. On loss of verbal contact, bag mask check ventilation was done. Neuromuscular paralysis was done with Inj. Vecuronium bromide 0.1 mg/kg body wt. Before laryngoscopy, patients head was placed in the neutral position on the operating table. A trained person applied MILS by applying varying amount of force while holding the both mastoid processes and side of the neck in an effort to counteract the force of laryngoscopy, thus preventing flexion/extension or rotational movement of the head and neck.

Laryngoscopy was performed by a single trained anaesthetist throughout the whole study period. Time required for laryngoscopy and intubation was documented by separate anaesthetist, not involved in the study. The view of the glottis was graded using a modified classification reported by Cormack and Lehane where grade 1 denotes most of glottis (with or without the epiglottis) is visible and grade 4 signifies worst situation i.e., no glottis is visible, and the larynx (such as the epiglottis) cannot be located [11]. Laryngoscopy was defined as difficult when the view of the glottis was either grade 3 or grade 4. An attempt was made to improve the glottis view by the application of External Laryngeal Maneuver (ELM). If difficult laryngoscopy persisted even after ELM, then tracheal intubation was attempted using bougie or stylet guidance. In case of failure of first attempt only one extra attempt, up to 2 minutes (starting from insertion of the second blade), was allowed for tracheal intubation. If tracheal intubation failed after these two attempts, the study was terminated, MILS was released and the airway was managed as a routine clinical practice. Following tracheal intubation the lungs were mechanically ventilated throughout the whole procedure and anaesthesia was maintained with sevoflurane (1.25-1.75%) and nitrous oxide-oxygen mixture in a 2:1 ratio.

Any other medications or maneuver apart from those intended to be used in this study were strictly restricted during the vital 5 minutes data collection period after tracheal intubation. Pulse rate, systolic and diastolic BP were recorded at baseline i.e., baseline, pre intubation, 1 and 5 minutes after intubation respectively. Any dental or soft tissue injury of the oral cavity during laryngoscopy procedure was noted.

STATISTICAL ANALYSIS

The results of the observations thus obtained in each group of patients were tabulated, compiled in Microsoft excel 2007 and statistically analysed using Statistical Package for the Social Sciences (SPSS) statistics version 23.0. Qualitative data (sex, ASA physical status, Mallampati classification, Cormack and Lehane glottis view grade, number of laryngoscopic attempts, number of optimisation maneuver required etc.,) were compared between the groups with Chi-square test (χ^2) and Fisher-exact test and quantitative data (age, BMI, inter-incisor distance, thyromental distance, duration of laryngoscopy and intubation etc.,) were compared between groups with Mann-Whitney U test. Haemodynamic parameters within groups at different time intervals were compared with general linear model and repeated test. A p-value <0.05 was considered statistically significant and <0.01 was considered as highly significant. The 95% confidence interval for the mean difference between the two devices was calculated.

RESULTS

All the study participants, (n=100) of the two groups were comparable with respect to their demographic profile, baseline parameters and were statistically insignificant [Table/Fig-1]. The entire participants were analysed at the end of the study without any follow-up loss.

Parameters		Group V (n=50)	Group M (n=50)	p-value (Chi-square test)
Age (years)		35.84±9.48	33.40±8.71	0.183
Gender	Male	17 (34.0%)	18 (36.0%)	0.834
	Female	33 (66.0%)	32 (64.0%)	
BMI (Kg/m^2) M (SD)		21.15 (2.37)	20.40 (2.24)	0.109
ASA 1		36 (72%)	35 (70%)	0.826
ASA 2		14 (28%)	15 (30%)	
Inter-incisor distance (cm)		5.27±0.27	5.29±0.35	0.747
Thyromental distance (cm)		6.51±0.45	6.50±0.48	0.863
Mallampati grade 1		25 (50.0%)	30 (60%)	0.315
2		25 (50.0%)	20 (40%)	

[Table/Fig-1]: Demographic profile and baseline airway parameters of all the study participants.
BMI: Body mass index; ASA: American society of anesthesiologists

Most of the study participants were female (65%) and majority of them were between 40-50 years of age group [Table/Fig-2]. The success on first attempt of laryngoscopy were found to be statistically significant more (p=0.014) in case of video assisted group as compared to the other group and thus second attempt to do so required significantly less [Table/Fig-3]. The time taken to do the procedure of laryngoscopy required significantly lesser time (p<0.001) in the group V as compared to group M. The duration of intubation was observed to be significantly less (p<0.001) in group V and the blood stain on laryngoscope was also found to be much lesser in group V as compared to the other group. Incidence of procedural dental injury was absent in group V while there were 4 such patients in group M [Table/Fig-3]. Soft tissue injuries were just lesser in group V (p<0.03) as compared to group M. Optimisation maneuver was required in 50% of the group M patients as compared to 10% of group V was again statistically significant (p<0.001).

Age group (Years)	Male n (%)	Female n (%)	Total
<30	8 (25.0)	24 (75.0)	32
30-39	11 (34.4)	21 (65.6)	32
40-50	16 (44.4)	20 (55.6)	36
Total	35 (35)	65 (65)	100

[Table/Fig-2]: Age and sex distribution of the study subjects (n=100).

Parameters		Group V (n=50)	Group M (n=50)	p-value (Mann-Whitney U Test)
Laryngoscopy 1st attempt success		48 (96.0%)	40 (80.0%)	0.014
Laryngoscopy 2nd attempt success		2 (4.0%)	10 (20.0%)	
Duration of laryngoscopy (sec) Mean±SD		10.7±2.13	15.2±2.50	<0.001
Duration of intubation (sec)		15.9±3.02	21.4±4.16	<0.001
Blood stain on laryngoscope	Yes	4 (8.0%)	15 (30%)	0.005
	No	46 (92%)	35 (70%)	
Dental injury	Yes	0 (0.0%)	4 (8.0%)	0.041
	No	50 (100.0%)	46 (92%)	
Soft tissue injury	Yes	3 (6.0%)	10 (20.0%)	0.037
	No	47 (94.0%)	40 (80.0%)	
Optimisation maneuver required	1	5 (10.0%)	21 (42.0%)	<0.001
	2	0 (0.0%)	4 (8.0%)	

[Table/Fig-3]: Comparison of various outcome parameters between both the study groups.
p-value <0.05 statistically significant

[Table/Fig-4] exhibits that group V patients were graded 1 as per Cormack and Lehane view in 76% cases with no grade 3 and 4 occurrence as compared to group M, which was statistically highly significant (p=0.002).

Cormack and Lehane glottic view grades	Group V (n=50)	Group M (n=50)	p-value (Fisher-exact test)
1	38 (76%)	21 (42%)	0.002
2	12 (24%)	27 (54%)	
3	0 (0%)	2 (4%)	
4	0 (0%)	0 (0%)	

[Table/Fig-4]: Difference in Cormack and Lehane glottic view of the two study groups.

There were significant (p<0.01) changes in pulse rate, systolic BP and diastolic BP in group M as compared to group V owing to the greater mean duration of intubation [Table/Fig-5].

Parameters	Group V (n=50) Mean±SD	Group M (n=50) Mean±SD	p-value (Mann-Whitney U Test)
PR1 (Baseline/Before induction)	80.66±8.77	80.82±6.65	0.918
PR2 (After induction, Pre-intubation)	74.04±10.23	74.48±6.93	0.802
PR3 (1 min after intubation)	82.43±10.39	86.70±11.09	0.049
PR4 (5 min after intubation)	78.48±8.78	84.96±9.89	0.001
SBP-1 (Baseline/Before induction)	125.64±9.85	126.12±10.58	0.815
SBP-2 (After induction, Pre-intubation)	104.80±10.56	103.32±9.93	0.472
SBP-3 (1 min after intubation)	119.08±13.10	130.88±17.18	<0.01
SBP-4 (5 min after intubation)	115.36±12.36	124.88±10.58	<0.01
DBP-1 (Baseline/Before induction)	77.64±5.45	77.76±5.04	0.909
DBP-2 (After induction, Pre-intubation)	69.56±5.45	68.92±5.53	0.561
DBP-3 (1 min after intubation)	74.64±6.19	79.56±8.65	0.001
DBP-4 (5 min after intubation)	74.48±5.92	78.84±8.22	0.003

[Table/Fig-5]: Comparison of various haemodynamic parameters between both the study groups.
PR: Pulse rate; SBP: Systolic blood pressure; DBP: Diastolic blood pressure

DISCUSSION

To reduce the difficulty of tracheal intubation in patients of limited cervical spine mobility, a variety of techniques has been developed including McCoy levering blade laryngoscope and VLs with highly curved blades like King Vision®, Pentax Airwayscope, McGrath MAC, Airtraq etc., and intubating Laryngeal Mask Airway (LMA) like CTrach®. McCoy laryngoscope has traditionally been used in patients with restricted neck movement. Recent studies have demonstrated that VL with highly curved channeled blade poses several advantages over conventional laryngoscopes [6,12]. In addition, the VL also appears to cause less cervical spine movements during tracheal intubation when compared with the Macintosh or McCoy laryngoscopes. The present study was designed to evaluate the relative efficacies of these novel devices in tracheal intubation in patients with simulated restricted neck mobility undergoing general anaesthesia.

Although the first attempt success rate was 96% for KVVL and 80% for McCoy laryngoscope [Table/Fig-3], Aziz MF et al., and Shravanalakshmi D et al., studied that success rate of tracheal intubation in patients with cervical spine immobilisation with KVVL were 100% with first attempt success rate of 93.3% and second attempt 6.7% [6,13]. In the current study, it was found that the overall success rate of laryngoscopy and intubation by video laryngoscopy in the setting of simulated restricted neck mobility was 100%, significantly higher from the McCoy laryngoscopy group (77%). Regarding the glottic view (Cormack and Lehane scores), it was observed that group V had more grade 1 Cormack and Lehane glottis view, shorter duration of laryngoscope and intubation less requirement of ELM leading to less haemodynamic stimulation than the group M. It can be concluded that this equipment provides a view of the glottis without much necessity to align the oral, pharyngeal, and tracheal axis.

Study conducted by Shravanalakshmi D et al., found that VLs provided better visualisation despite immobilisation of cervical spine and Ng I et al., conducted a randomised controlled trial and found that Mc Grath, a highly curved VL produced more grade 1 glottic view than C-MAC, a conventionally curved blade [13,14].

The authors also observed better glottic view with KVVL. It was observed that the duration of successful laryngoscopy and intubation were significantly longer in group M compared to group V, whereas Shravanalakshmi D et al., found that duration of intubation in seconds was significantly faster with conventional C-MAC VL (23.3±4.7) compared to King Vision (24.9±7.2) [13]. Group M, in this study, required a greater number of optimisations maneuvers (50%) to facilitate tracheal intubation while it was very less (10%) in case of KVVL [Table/Fig-3].

The incidence of tooth breakage and airway laceration was found with McCoy laryngoscope [Table/Fig-3]. In the study by Ng I et al., they found a total seven minor oropharyngeal mucosal injuries as a result of the intubation, six from using the McGrath VL and one from the C-MAC VL of the 65 patients in each group [14].

Unlike the findings of the study by Ng I et al., where incidences of dental injury were only 8% with Mcintosh laryngoscope against 0% with video laryngoscope with minor oesophageal injury [14], this study also demonstrated 8% dental injury with McCoy and 0% with video laryngoscope. In another study done by Malik MA et al., [15] where it was as high as 30% incidence of appearance of blood over Mcintosh laryngoscope was observed in contrast revealed much lesser such incidences [15]. There was no incidence of oesophageal intubation in both the group. Arterial haemoglobin Oxygen Saturations (SpO_2) were well maintained in both the groups.

Limitation(s)

The study was conducted in a single institute on a limited number of selected patients with specific operative indications excluding challenging cases involving paediatrics or restricted neck mobility patients. Levels of catecholamines like adrenaline, noradrenaline regulating the haemodynamic status and its variability with procedures like laryngoscopy was not assessed during this study.

CONCLUSION(S)

Patients having simulated cervical spine immobilisation, undergoing elective abdominal surgery under general anaesthesia with tracheal intubation, KVVL appears to possess more advantages over the McCoy laryngoscope in respect to easy of viewing glottis, reduced duration of laryngoscopy and intubation, lesser complications and haemodynamic instability. To attain external validity, accurate and acceptable findings, a multicentric study incorporating large sample size may help in substantiate the current observation.

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