Comparative Evaluation of Performance of McGrath® and GlideScope® Videolaryngoscopes with Conventional Macintosh Laryngoscope for Laryngoscopy and Intubation in Patients with Immobilised Cervical Spine – A Randomised Controlled Trial

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***Abstract*-Videolaryngoscopes are nowadays very commonly being used. This study evaluated McGrath®, GlideScope® and Macintosh laryngoscopes for intubation in patients with normal airways but immobilised cervical spine, thereby simulating a difficult airway scenario.This prospective, randomised controlled trial was conducted on60 adult ASA I/II patients of either sex, between 18-60 years of age undergoing elective surgical procedures requiring general anaesthesia with tracheal intubation.Patients were randomly allocated to one of the three groups, depending on the laryngoscope used for intubation; Group MVL, McGrath® videolaryngoscope; Group GVL, GlideScope® and Group ML, Macintosh laryngoscope. Cervical collar was applied after induction of anaesthesia. Success rate of intubation in the first attempt was similar with all three laryngoscopes.Time taken to intubate was longer with McGrath® (41.1±8.6 s) compared to GlideScope®(34.5±7.1 s) and Macintosh (31.8±9.3 s) laryngoscopes. The mean percentage of glottic opening(POGO) score was significantly better with McGrath® (p=0.004) and GlideScope®(p=0.001) than with Macintosh laryngoscope.Cormack Lehane grading with both videolaryngoscopeswas also better thanthat with Macintosh (p=0.042 and p=0.003 vs. McGrath® and GlideScope® respectively). Laryngoscopy difficulty score and intubation difficulty score with GlideScope® werecomparable to McGrath®butlowerthan Macintosh laryngoscope. Both videolaryngoscopes, McGrath® and GlideScope®, provided better glottic view compared to Macintosh laryngoscope in patients with immobilised cervical spine. GlideScope® allowed easier laryngoscopy and intubation with minimum manoeuvres as compared to Macintosh laryngoscope.**

***Index Terms*- Airway: adult, cervical fracture: intubation techniques, laryngoscopic view: grading,GlideScope®; McGrath®; Macintosh laryngoscope**

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I.INTRODUCTION

Cervical spine injury is present in around 3.7% of trauma victims and approximately 42% of these patients have unstable cervical spine[1].Minimizing movement with a cervical collar or by manual-in-line-stabilisation (MILS) becomes necessary in such cases. This makes laryngoscopy and tracheal intubation using conventional Macintosh laryngoscope more difficult. Various devices have been tested for tracheal intubation insuch patients e.g., supraglottic airway [2], fiberoptic bronchoscope[3],lighted stylet[4], or videolaryngoscopes (VLS)[5].Videolaryngoscopes have the advantage of containing miniature video cameras that provide indirect glottic view without requiring oral, pharyngeal and laryngeal axes alignment[6]. McGrath® and Glidescope® are two commonly used VLS. There are only a fewrandomised controlled trialscomparingMacintosh laryngoscope with either McGrath®[7], or GlideScope® [8], [9] for time to intubate and success rate of intubation in patients with immobilised cervical spine. No trial has compared the three laryngoscopes with each other in patients with immobilised cervical spine.We hypothesised that the VLS would have a higher success rate of intubation in the first attempt compared to Macintosh laryngoscope. Therefore, the present study was designed to evaluate and compare the performance of McGrath®, GlideScope® and Macintosh laryngoscopesfor intubation in patients with immobilised cervical spine. The success rate of intubation in the first attempt,time for successful intubation, number of attempts, glottic view, difficulty in laryngoscopy and intubation and complications were evaluated.

II.MATERIALS AND METHODS

Thisprospective, randomised, single blind, controlled trial was conducted after obtaining approval from the institutional ethics committeeandwritten informed consent from all the participants.SixtyASA I/II patients of eithersex, aged 18-60 years,undergoing elective surgical procedures requiring general anaesthesia with tracheal intubation were recruited.Patients who did not give consent to participate in the trial; those having cervical spine disorders or anticipated difficult airways; or requiring surgeries of oral cavity, larynx, pharynx and neck were excluded.The patients were randomly allocated to one of the three groups with 20 patients each,depending on the laryngoscope used for intubation of their tracheas,using a computer generated random number table. In group MVL, McGrath® Series 5 videolaryngoscope (Aircraft Medical Ltd, Edinburgh, UK); in group GVL, GlideScope® (Verathon Inc., Bothell, WA, USA); and in group ML, Macintosh laryngoscope was used for intubation.

Preoperative evaluation and airway assessment was done as per the standard protocol.The patients were kept nil per orally overnight before surgery. In the operating room, lead II electrocardiography, pulse oximetry and non-invasive oscillometric blood pressure monitoring was established. Hard cervical collar was applied after induction of anaesthesia with morphine 0.1 mg/kg i.v. and propofol 2.0-2.5 mg/kg i.v. Vecuronium 0.1 mg/kg i.v. was administered for muscle relaxation to facilitate laryngoscopy and placement of endotracheal tube (ETT). Capnography was instituted after induction of anaesthesia. Patients were ventilated with O_2, N_2O and isoflurane. All laryngoscopies and intubations were performed by either of the two anaesthesiologists who had more than five years of experience in performing laryngoscopy and intubatiob and had performed at least 25 intubations with that particular laryngoscope. The head was kept in the neutral position during laryngoscopy and intubation.Initial size of laryngoscope blade was chosen as per the patient profile. The laryngoscopic view was graded according topercentage of glottis opening (POGO) score[10] and Cormack Lehane (CL) grading[11].Trachea was intubated using an appropriately sized styletted ETT. Correct placement of ETT was confirmed by auscultationof breath sounds and appearance of end tidal carbon dioxide ($EtCO_2$). Time to successful intubation was noted from the start of laryngoscopy to confirmation of successful ventilation by appearance of three $EtCO_2$ waveforms[12]and ETT was fixed after confirming equal air entry in bilateral lung fields.

Difficulty in laryngoscopy was graded as: Easy Laryngoscopy without any maneuver (grade I); Laryngoscopy requiring an increased anterior force (grade II); Change of laryngoscope blade to one size higher (grade III); Change of laryngoscope blade with increased anterior force (grade IV). Number of laryngoscopy attempts was noted. If the laryngoscope blade was removed from the oral cavity and reinserted to facilitate the glottic view or intubation, it was counted as another attempt.Difficulty in intubation was graded on the Intubation difficulty score as follows:Intubation easy (grade I); Intubation possible with change of blade size or increased anterior force (grade II); Requirement of bougie for intubation (grade III); Requirement of release of neck collar (grade IV).In case, intubation required release of neck collar i.e., grade IV, or more than three attempts were required for intubation, it was considered as failure to intubate with the particular laryngoscope for this study purpose. If the ETT could not be negotiated through the oral cavity or the vocal cords and was reinserted after removal from the oral cavity, it was counted as another attempt and the number of attempts was noted.Anaesthesia was maintained according to the standard guidelines practiced for all general anaesthesia cases. Trauma to lips, teeth, structures in oral cavity and larynx or presence of blood on the laryngoscope blade and ETT were recorded at the time of laryngoscopy, intubation and just before extubation. The demographic variables and duration of surgery were alsorecorded for all the patients.

Sample size was calculated based on previous studies where a success rate of 100% for McGrath® and 59% for Macintosh laryngoscope [7] and 100% for GlideScope® compared to 93.3% for Macintosh laryngoscope[13] has been reported. Taking the average success rate for Macintosh from both these studies i.e. 76% and 100% success rate for both videolaryngoscopes, to estimate an absolute difference in success rate as 30% on either side at 90% power and 95% confidence interval, a sample of 19 cases in each group was required. So, 20 patients were included in each group. Statistical analysis was done using SPSS software version 20.0 (SPSS Inc., Chicago, IL, USA). Demographic variables, POGO scores, number of intubation and laryngoscopy attempts, time to intubate were analysed using one way ANOVA followed by Tukey's test at 5% level of significance. Cormack Lehane grading, difficulty in laryngoscopy and intubation were analysed using Fischer's exact test.

III.RESULTS

The mean age, weight, gender distribution, ASA status, Mallampatti Classand duration of surgeryare shown in Table I.

Table I: Characteristics of patients undergoing intubation with McGrath®, GlideScope® and Macintosh laryngoscopes. Values are mean ± SD.

Characteristic	Group MVL[a] *(n=20)*	Group GVL[b] *(n=20)*	Group ML[c] *(n=20)*
Age (years)	39.3±12.5	33.25±15.3	30.9±12.3
Weight (kg)	54.2±12.9	50.8±7.7	54.1±12.2
ASA Physical status (I:II)[d]	15:5	19:1	17:3
Male:Female	8:12	5:15	12:8
MP Class (I:II)[e]	18:2	13:7	16:4
Mean duration of surgery (min)	132.5±44.9	136.5±47.5	149.0±74.2

[a]MVL: McGrath® Videolaryngoscope; [b]GVL: GlideScope® Videolaryngoscope; [c]ML: Macintosh Laryngoscope; [d]ASA: American Society of Anesthesiologists; [e]MP: Mallampatti

Tracheal intubation was successful in the first attempt in 90% patients in McGrath® group, 100% patients in GlideScope® group and 95% patients in Macintosh group (p=0.306) (Table II).The mean time taken to intubate was 41.1 ± 8.6 s in McGrath® group, 34.5 ± 7.1 s in GlideScope® group and 31.8 ± 9.3 s in Macintosh group. McGrath® laryngoscope took significantly longer time to intubate when compared to the rest of the two laryngoscopes (p=0.003).The number of laryngoscopy and intubation attempts were statistically comparable in all the groups (p=0.212 and 0.306 respectively). Only one patient in McGrath® group required third attempt for intubation of trachea (Table II). (Insert table II here)

Fig. 1 shows the scatter diagram of POGO Score of each patient in the first laryngoscopy attempt in the three groups. The mean POGO score was 79±25.7%, 90.5±16.7% and 49.5±35.4% with McGrath®, GlideScope® and Macintosh laryngoscope respectively

Table II: Laryngoscopy and intubation attempts with McGrath®, GlideScope® and Macintosh laryngoscopes. Values are Number (proportion)

	Laryngoscopy			Intubation		
No. of attempts	1	2	3	1	2	3
Group MVL[a] *(n=20)*	18 (90%)	1 (5%)	1 (5%)	18 (90%)	1 (5%)	1 (5%)
Group GVL[b] *(n=20)*	20 (100%)	0 (0%)	0 (0%)	20 (100%)	0 (0%)	0 (0%)
Group ML[c] *(n=20)*	16 (80%)	4 (20%)	0 (0%)	19 (95%)	1 (5%)	0 (0%)

[a]MVL: McGrath® Videolaryngoscope; [b]GVL: GlideScope® Videolaryngoscope; [c]ML: Macintosh Laryngoscope

(p<0.001). On group wise analysis, it was found that POGO Score was significantly lower in Macintosh group compared to McGrath® (p=0.004) and GlideScope® (p=0.001) groups; but was comparable in the two videolaryngoscope groups (p=0.837).Fifty percent patients with McGrath®, 70% patients with GlideScope® and 20% patients with Macintosh laryngoscope had 100% POGO score. The number of patients having 100% POGO score wascomparable between McGrath® and GlideScope® (p=0.515); and McGrath® and Macintosh laryngoscopes (p=0.097). However, significantly larger number of patients in GlideScope® group had 100% POGO score than in Macintosh laryngoscope (p=0.001). Two patients (10%) with McGrath®, none (0%) with GlideScope® and six patients (30%) with Macintosh laryngoscope had POGO scores<25% in the first attempt.After changing the laryngoscope blade size in these patients, the scores improved in both the patients in McGrath®group compared to improvement in four out of six patients in the Macintosh group. In the rest of the two patients in Macintosh group, both change of blade size andincreased anterior force were applied to facilitate glottic view.Cormack Lehane grade I laryngoscopic view (corresponding to POGO score 100%) was found in 10 (50%), 14 (70%) and four (20%) patients with McGrath®, GlideScope® and Macintosh laryngoscopes respectively.Cormack Lehane grade II view was seen in rest of the 10 (50%) patients in McGrath® group, six (30%) patients in GlideScope® group and 11 (55%) patients in Macintosh group. Cormack Lehane grade III and IV views were found in four (20%) patients and one (5%) patient in Macintosh laryngoscope group (Fig. 2). Thus all the patients in McGrath® and GlideScope® groups had CL grades I/II; whereas 25% patients in Macintosh group had CL grades III/IV. Significantly better views were seen with McGrath® compared to Macintosh laryngoscope (p=0.042) and with GlideScope® compared to Macintosh laryngoscope (p=0.003). Both the videolaryngoscopes were however comparable with respect to CL grades (p=0.197).

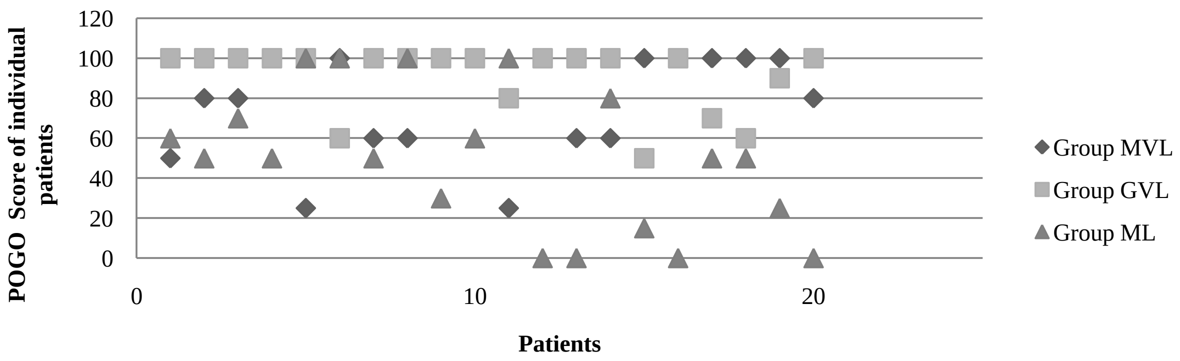

Fig. 1 Glottic View: POGO Score of individual patients

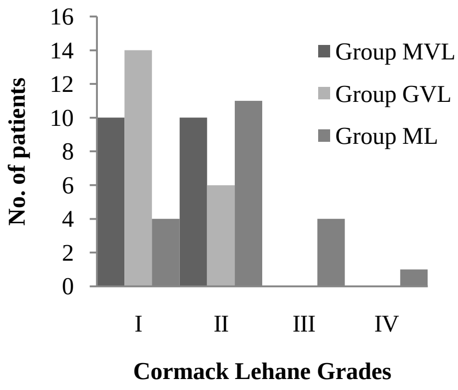

Fig. 2 Glottic View: Cormack Lehane Grade

The difficulty in laryngoscopy with McGrath® was comparable to GlideScope® (p=0.487) and Macintosh laryngoscope (p=0.092) (Fig. 3). But laryngoscopy with GlideScope® was found to be significantly easier than with Macintosh (p=0.003). Similar to laryngoscopy, difficulty in intubation with McGrath®was comparable to GlideScope® (p=0.487) and Macintosh laryngoscopes (p=0.127) (Fig. 4). Intubation with GlideScope® was easier compared to Macintosh laryngoscope (p=0.008). None of the patients in any of the three groups required removal of neck collar (Grade IV). There was no incidence of failed intubation in this study.

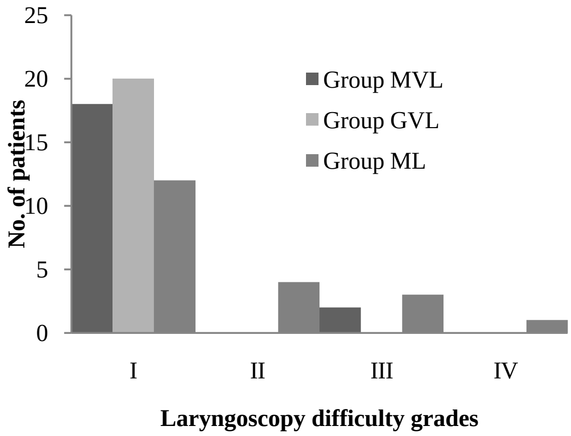

Fig. 3 Laryngoscopy difficulty score

The initial size of laryngoscope blade chosen to intubate tracheas in all the patients was size 3 except one patient in McGrath® group where size 4 was chosen. Two patients in McGrath®and six patients in Macintosh group required a change of blade from size 3 to size 4 to improve glottic visualisation compared to none in GlideScope® group. Two patients out of the six in Macintosh group required increased anterior force in addition to change of blade size to improve glottic visualisation and facilitate intubation; whereas no patient in the other two groups required this manoeuvre (p=0.487). Overall, McGrath® was comparable to both GlideScope® (p=0.487) and Macintosh laryngoscope (p=0.407) as far as use of manoeuvres is concerned, whereas, Macintosh laryngoscope required significantly more number of manoeuvres compared to GlideScope® (p=0.020).None of the patients in any of the three groups had any evidence of trauma during laryngoscopy, intubation and at the time of extubation.

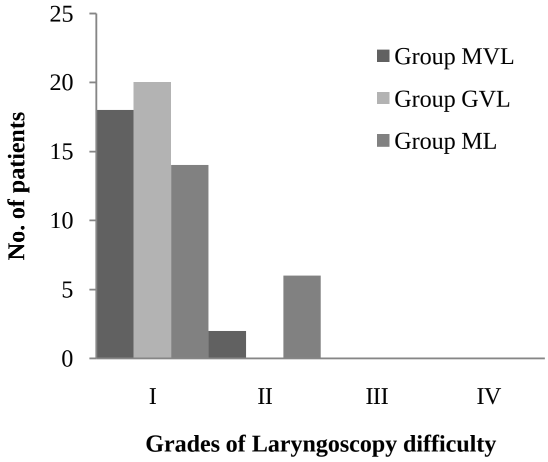

Fig. 4 Intubation difficulty score

IV.DISCUSSION

In trauma victims, cervical spine injury should be suspected until it is ruled out. Securing the airway may be required during elective procedures for corrective surgeries or as an emergency measure to prevent hypoxia to the brain, obstruction of the upper airway or aspiration. Intubation conditions may be suboptimal and neck movements may have to be restricted by using rigid cervical collar or manual in line stabilisation (MILS) to minimize the injury to cervical spine and underlying vital structures. Thus these patients may require tracheal intubation with head in the neutral position. In this position, the oro-pharyngeal-laryngeal axes are not aligned, thereby resulting in a difficult intubation scenario. Videolaryngoscopes do not require alignment of these axes for successful intubation [14]and hence are an attractive aid for intubation in such scenarios.

The McGrath® has an LCD screen which is attached to its handle. The laryngoscope is inserted from the right side of the mouth, sweeping the tongue to the left side. GlideScope® has a colour camera embedded in a curved, high impact laryngoscope blade which angulates upwards at an angle of about 60^0. It is to be inserted from the center of the mouth and rotated around the tongue to line up the camera lens with the glottis. In the present study, on comparing McGrath®, GlideScope® and Macintosh laryngoscopes for intubation in patients withimmobilised cervical spine,it was seen that the success rate of intubation in the first attempt and the total number of laryngoscopy and intubation attempts required were similar with all the three laryngoscopes.Both videolaryngoscopes provided better glottic view compared to Macintosh laryngoscope; however, the time taken to intubate was significantly longer with McGrath® thanthe other two laryngoscopes. Laryngoscopy and intubation was easiest with GlideScope® compared to the other two laryngoscopes.

Taylor et al in a recent study on 88 patients with simulated difficult airway found that all patients could be successfully intubated with McGrath® compared to only 59% success rate with Macintosh laryngoscope[7].Inour study, the success rate of intubation in the first attempt was similar, ranging from 90-100% with all the three laryngoscopes; however, a greater number of manoeuvres was required with Macintosh laryngoscope as compared to Glidescope®. Our results are supported by the results of Nasim and co-workers who compared Macintosh, GlideScope® and Pentax Airway Scope in both easy intubation scenarios and in cervical spine immobilisation scenarios[6]. The overall success rate in two attempts was reported comparable with all the three laryngoscopes; however, the number of cases requiring manoeuvres were much more with Macintosh laryngoscope (97%) compared to only 4% with GlideScope® and none with Pentax Airway Scope[6].In simulated difficult airway situations, GlideScope® and Macintosh laryngoscope are reported to take comparable time to intubate[15] and these have been found to secure the airway faster than McGrath® laryngoscope[12], [16]Though the learning curves of both McGrath® and GlideScope® are steep, yet the time taken to intubate has been reported to be more with McGrath® compared to GlideScope® and Macintosh laryngoscope[16]. The findings in our study also mirror the same as McGrath® took longer time for successful intubation compared to the rest of the two laryngoscopes. The time taken to intubate with McGrath® laryngoscope was 7-8 sec longer than that for GlideScope®. Although this difference was statistically significant, it was not of much clinical significance.

Glottic view obtained with both videolaryngoscopes was excellent in our study. With Macintosh laryngoscope also, we obtained higher mean POGO scores compared to those reported by Taylor et al (49% vs. 13%). This difference in findings with Taylor et al[7]in glottic view as well as success rate may be because their study design did not permit any manoeuvres during laryngoscopy and intubation, whereas, in ours, increased anterior force and change of laryngoscope blade were permissible to improve glottic view and facilitate intubation. Also, they used manual-in-line stabilisation in comparison to cervical collar use for spine immobilisation in our study. Despite a good glottic view at laryngoscopy in all the patients with videolaryngoscopes, a few patients in McGrath® group required more than one attempt for successful intubation. Previously also difficulty during intubation with McGrath® laryngoscope has been reported despite excellent glottic views[7]. The proposed explanation for the same is that the blade angulation of McGrath® improves glottic visualisation, but for successful passage through the glottic inlet, the ETT also needs to be angulated more anteriorly[7]. Intubation with GlideScope® has been reported as easy, requiring less number of optimization manoeuvres compared to Macintosh laryngoscope[6], [15].In the present study also least number of optimisation manoeuvres was required with GlideScope®. However, in a study where resident doctors intubated the trachea, it was found that more number of manoeuvres were required with GlideScope® compared to Macintosh laryngoscope[16].In our study, all tracheal intubations were performed by the anaesthesiologists who had a previous exposure of performing at least 25 successful intubations and were proficient enough for using these videolaryngoscopes.

There are a few limitations of this study. First, a preformed stylet, commercially available with GlideScope®, was used for intubation in all the three groups. This stylet has a shape which conforms best for intubation using GlideScope® and therefore may have resulted in the better performance of GlideScope®. Second, external laryngeal manipulations could not be studied as neck collar was applied. Third, although the study was conducted in patients having immobilized cervical spine resulting in airway difficulty, cases with otherwise anticipated difficult airways were excluded. Thus the utility of videolaryngoscopes in this group of patients cannot be commented upon. To conclude, both GlideScope® and McGrath®videolaryngoscopes provided better glottic view compared to Macintosh laryngoscope in patients with immobilised cervical spine. GlideScope® also allowed easier laryngoscopy and intubation with minimum manoeuvres as compared to conventional laryngoscopy.

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