Clinical Investigation

A prospective, randomised, clinical study to compare the use of McGrath®, Truview® and Macintosh laryngoscopes for endotracheal intubation by novice and experienced Anaesthesiologists

Address for correspondence:
Dr. Sumitra G Bakshi, Department of Anaesthesia, Critical Care and Pain, Tata Memorial Hospital, Mumbai, Maharashtra, India.
E-mail: sumitrabakshi@yahoo.in

Sumitra G Bakshi, Vinayak S Vanjari, Jigeeshu V Divatia
Department of Anaesthesia, Critical Care and Pain, Tata Memorial Hospital, Mumbai, Maharashtra, India

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ABSTRACT

Background and Aims: Video laryngoscopy has been recommended as an alternative during difficult conventional direct laryngoscopy using the Macintosh blade (MAC). However, successful visualisation of the larynx and tracheal intubation using some of the indirect laryngoscopes or video laryngoscopes (VL) requires hand-eye coordination. We conducted this study to determine whether non-channel VLs are easy to use for novices and whether there is any association between expertise with MAC and ease of tracheal intubation with VLs. **Methods:** Anaesthesiologists participating in the study were divided into three groups: Group novice to intubation (NTI), Group novice to videoscope (NVL)- experienced with MAC, novice to VLs and Group expert (EXP) experienced in all. Group NTI, NVL received prior mannequin training. VLs- Truview® and McGrath series 5 (MGR) were compared with MAC. One hundred and twenty six adult patients with normal airway were randomised to both, the intubating anaesthesiologist and laryngoscope. The time taken to intubate (TTI) and participants' rating of the ease of use was recorded on a scale of 1–10 (10-most difficult). **Results:** In Group NTI, there was no difference in mean TTI with the three scopes ($P = 0.938$). In Group NVL, TTI was longer with the VLs than MAC ($P < 0.001$). In Group EXP, TTI with VL took 20 s more ($P < 0.001$). There was significant difference in participants' rating of ease of use of laryngoscope in Group NVL ($P = 0.001$) but not in the NTI ($P = 0.205$), EXP ($P = 0.529$) groups. A high failure was seen with MGR in Group NTI and NVL. **Conclusion:** In Group NTI, TTI and the ease of use were similar for all scopes. Expertise with standard direct laryngoscopy does not translate to expertise with VLs. Separate training and experience with VLs is required.

Key words: Airway training, experience and intubation using video scopes, video laryngoscopes

INTRODUCTION

With conventional direct laryngoscopy, it is important to align the oral, laryngeal and tracheal axes to obtain the direct view of the glottic aperture to facilitate tracheal intubation.[1] With indirect laryngoscopes (IDL) and videolaryngoscopes (VL) an enhanced view of the glottis is obtained as the optics is present near the blade tip and tracheal intubation is performed while looking at the indirect view or image. The McGrath® (MGR) VL has 95% success in cases where intubation with conventional direct laryngoscopy with the Macintosh blade (MAC) has failed.[2] VLs are now included in the American Society of Anesthesiologists (ASA) difficult airway algorithm (2013) both as an initial approach in anticipated difficult airway, as well as in the non-emergency pathway as an alternative approach following unsuccessful intubation attempt with MAC scope.[3]

In case of non-channel VLs, for the introduction of the tracheal tube, additional training in the right technique of tube manoeuvring during intubation is necessary.[4] Airway learning for the novice anaesthesiologist, usually, starts with direct

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laryngoscopy and novel airway devices are dealt with in the advanced course.[5] With the current difficult airway algorithm supporting the use of VL, a few important questions that need to be answered are: (1) Does experience with MAC blade translate to better results at tracheal intubation with a VL? (2) What is the best time to introduce the technique of tracheal intubation using VLs to trainee anaesthesiologists?

Several studies have compared the time to intubation (TTI) of non-channelled VLs with the standard Macintosh laryngoscope by paramedics, novice anaesthesiologists,[6,7] and anaesthesiologist experienced in indirect laryngoscopy.[8,9] However, there is a paucity of clinical trials addressing the issue of experience and ease to intubate with VLs compared to conventional laryngoscopy. This prospective, randomised, clinical trial was designed to compare use of MGR series 5 (Manufactured by Aircraft Medical, UK) and Truview® (TVW) (Manufactured by Truphatek, Israel) laryngoscopes with the conventional Macintosh laryngoscope for endotracheal intubation by novice and experienced anaesthesiologists. This trial aimed to ascertain whether learning of VLs is as easy as direct laryngoscopy using MAC blade and whether experience with the standard MAC influences the performance of tracheal intubation with VLs. The MGR and TVW scopes were selected based on their availability at our institute and both being non-channelled IDLs.

METHODS

The study was approved by the Institutional Review Board and registered with the Clinical Trials Registry of India (CTRI No. 2012/04/002562). A written informed consent was taken from all patients.We had three groups of intubating anaesthesiologists, six in each group. Group novice to intubation (NTI), included residents who had recently commenced training in anaesthesia and had no prior experience in tracheal intubation. Group novice to videoscope (NVL), novices to VLs, included 2nd and 3rd year residents who were well experienced with MAC (performed at least 50 successful tracheal intubations) but had never used a VL.[10] Group expert (EXP) included experienced anaesthesiologists who had experience with MAC, as well as VLs. At least six prior successful intubations in patients for each VL was the criterion laid down to qualify as experienced in VLs.[6] Thus, intubating anaesthesiologists in Group NTI were novices with all types of laryngoscopes, those in Group NVL were novices to VLs, while intubating anaesthesiologists in Group EXP were experienced with all types of laryngoscopes.

Consent for participation was taken from all participants. Novices did not perform any tracheal intubations outside the study. Novices were given a lecture and demonstration on various intubation techniques (Group NTI for all laryngoscopes, Group NVL for VLs) and optimisation manoeuvres followed by hands-on training on the Laerdal Airway Management Trainer (Laerdal Medical, Stavanger, Norway). The novices had to perform 5 successful intubations with each laryngoscope on the trainer.

The study design was aimed to randomise, each patient to an intubating anaesthesiologist and a laryngoscope within one of the three pre-defined groups. The sample size was calculated using power analysis software for ANOVA design and defining two main factors of influence on our primary end point – Time to intubate (TTI): Type of laryngoscope and experience of intubating anaesthesiologist. Based on experience, there exist a moderate variation in the intubation time for the MAC scope, with a mean duration of 59 s by novices to around 29 s by experienced[11,12] with a standard deviation of 29 s (longest found in literature)[11] Using *post-hoc* multiple comparison procedure and assuming a moderate variation of mean time to intubate with a moderate standard deviation, it was found that 41 patients would be needed in each group to achieve 80% power to detect an effect size of 0.5 between the groups and a level of significance of 0.05. For the sake of simplicity, we decided to include 42 (multiple of 3) patients in each group.

American Society of Anaesthesiologists (ASA) grade I-II patients, above 18 years scheduled to undergo elective surgical procedures requiring general anaesthesia and tracheal intubation were included after obtaining written informed consent. Exclusion criteria were refusal to consent, history of difficult airway or anticipated difficult airway, that is, Mallampati Classification (MPC) III and above and or other clinical findings suggestive of difficult airway, the presence of indications for rapid sequence induction of anaesthesia and patients with body mass index (BMI) over 30. Patients were randomised to have tracheal intubation performed by an anaesthesiologist, from one of the three pre-defined groups by computer generated

program. Each intubating anaesthesiologist had a set of seven opaque envelopes containing the name of the laryngoscope in a random order. These envelopes were prepared at the very beginning of the trial, to ensure that each intubating anaesthesiologist did at least two intubations with each scope. Thus, there were 42 intubations in each group, 14 with each scope.

Baseline vitals were recorded. After pre-oxygenation for 3 min, anaesthesia was induced with propofol (1.5–2 mg/kg) and fentanyl (1–1.5 μg/kg) administered intravenously. The patients' lungs were ventilated using a 50:50 mixture of air and oxygen with isoflurane at dial setting of 1.5% and vecuronium (0.15 mg/kg) were administered for muscle relaxation. Four minutes later, tracheal intubation was done by the intubating anaesthesiologist using the allocated scope. Respective operative room consultant anaesthesiologist was present during intubation. No guidance or aid was given to the intubators during intubation, except when external manipulation of the larynx, or a stylet was asked for by the intubating anaesthesiologist. Data related to intubation were recorded by an independent observer.

The duration of the intubation attempt was defined as the time elapsed from the insertion of the blade between the dental arches to the first upwards deflection on the capnograph. A failed intubation was defined when the user could not intubate the patient's trachea after two attempts. Each attempt was terminated after 90 s or if the oxygen saturation on pulse oximeter fell below 90% whichever was earlier. After two failed attempts with the allotted laryngoscope, the attending consultant performed tracheal intubation using a technique of his choice. In case of two attempts, the time to intubate was taken as the sum of duration of each intubation attempt. However, the cases in which intubation failed as defined above, the time to intubate was not considered in the analysis with respect to intubation time.

Optimisation manoeuvres like external laryngeal pressure and airway aids required like stylet or bougie were recorded. For intubations with VLs, a pre-shaped stylet was used as recommended and was not considered as an additional intubation aid. Anti-fogging measures were standardised for both scopes.

Airway trauma assessment included blood on laryngoscope blade, visible trauma to lips, oral mucosa or teeth. In patients with blood on the laryngoscope blade; a check scopy was done by the consultant. Once tracheal intubation was accomplished successfully, the performers were asked to grade the glottis view according to the Cormack and Lehane (CL) grading and score the ease of use of the laryngoscope on a Numerical Rating Scale (NRS) (ranging from 1 for extremely easy to 10 for extremely difficult).[13]

Following surgery, the patients were evaluated for subjective symptoms of sore throat and hoarseness on NRS[14] which were then grouped as: None (0), mild (1–3), moderate (4–6), severe (7–10).

Parametric data like age, BMI were compared using ANOVA. Categorical data which included ASA status, MPC, CL grade, failure rate, optimising manoeuvres, trauma, sore throat, hoarseness were all compared using Chi-square. For all of the above analysis, a value of $P < 0.05$ was considered significant. As the time to intubate (TTI) and NRS scores were not normally distributed, a comparison was made using Kruskal–Wallis test. Comparisons between the three scopes for each group and between the three groups for each scope were done using Mann–Whitney test with Bonferroni's correction. P value was corrected to 0.016. SPSS 19.0 (IBM, NY, USA) statistical software was used to perform statistical analysis.

RESULTS

Data from 126 patients was analysed. Patients in the three groups were comparable with respect to the baseline demographic characteristics [Table 1].

TTI were compared between and within groups [Figure 1]. For the MAC blade, a significant difference in TTI was found between novices (Group NTI) and experienced intubating anaesthesiologist (Group NVL and EXP), $P < 0.001$. Similarly, novices to VL (Group NTI and NVL) took longer to intubate with VL when compared to Group EXP (MGR, $P = 0.001$, TVW, $P < 0.001$). There was no difference in TTI between scopes in Group NTI, $P = 0.938$. In Group NVL, the VLs took a longer time than MAC blade, $P < 0.001$. There was a significant 20 s increase in TTI with VL in Group EXP, $P < 0.001$.

There was no difference in NRS between scopes in Group NTI, $P = 0.205$ [Figure 2]. In Group NVL, the VLs took a longer time and were rated difficult than MAC blade, $P = 0.001$. The NRS scores were similar for all scopes in the EXP group, $P = 0.529$.

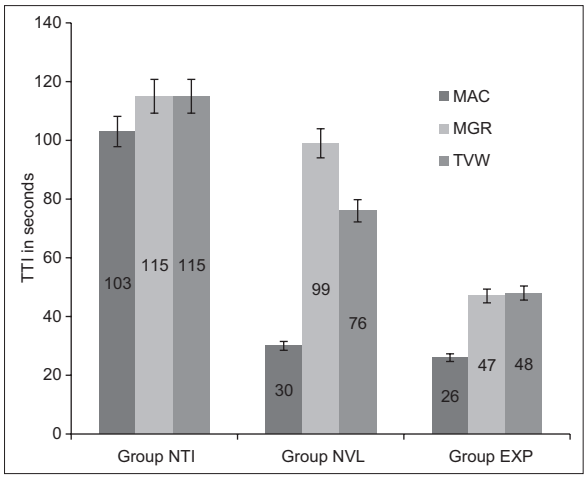

Figure 1: Time to Intubate (TTI). NTI - Novice to intubation, NVL - Novice to videoscope, EXP - Expert group. TTI was compared for each scope within and between groups using Kruskal–Wallis test, $P < 0.05$ was significant. The within-group analysis was further done using Mann–Whitney test, $P < 0.016$ was significant. For P values refer text

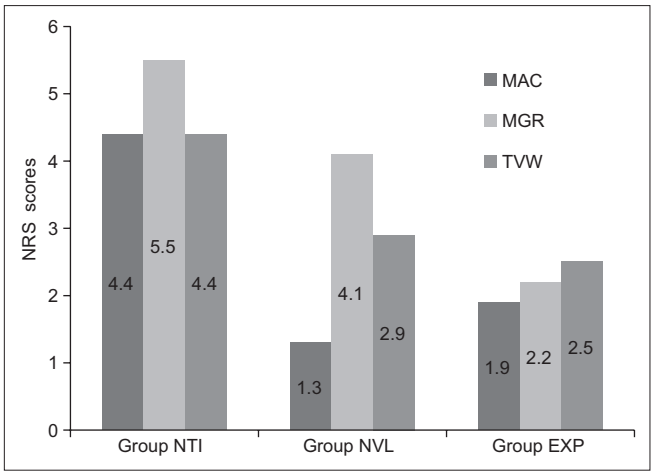

Figure 2: Ease of use of scope (Numerical Rating Scale [NRS] scores). MAC - Macintosh, MGR - McGrath, TVW - Truview scope. NTI - Novice to intubation group, NVL - Novice to videoscope group, EXP - Expert group. NRS was compared for each scope within and between groups using Kruskal–Wallis test, $P < 0.05$ was significant. The within-group analysis was further done using Mann–Whitney test, $P < 0.016$ was significant. For P values refer text

There were no failures for intubation in Group EXP. The failure rate was high (9 out of 42, 21.4%) in Group NTI ($P < 0.001$) [Table 2]. Of 12 failures with VLs, 11 failures were with MGR. All twelve failures with VLs were in those who were novices to VLs (Group NTI and NVL), with no significant difference in the failure rate between Group NTI (7/28, 25%) and Group NVL (5/28, 17.9%). In all failures, the intubation was successfully done by the attending consultant with no untowards events. The CL grades tended to be better in Group EXP ($P = 0.057$). Optimisation manoeuvres were used more with MAC than VL in Group NVL and EXP [Table 2]. The incidence of trauma was more in Group NTI ($P = 0.002$), but similar with all three scopes ($P = 0.654$). Check laryngoscopy was done in all patients with blood on laryngoscope blade. There were two instances of trauma in the posterior pharyngeal wall needing packing for a brief time, in both cases MGR was used and the intubating anaesthesiologist belonged to Group NVL. Both the patients were followed up for 2 post-operative days and had no sequel.

All patients had none to mild sore throat and hoarseness. There was no difference in the incidence of sore throat or hoarseness between groups or scopes.

DISCUSSION

This is one of the few clinical studies addressing the issue of experience and ease to intubate with non-channel VLs compared to conventional laryngoscopy amongst anaesthesiologists. The TTI in Group NTI was similar for all three scopes. Anaesthesiology residents who were experienced with MAC but were novices to VLs (Group NVL) took significantly more time with VLs compared to MAC. In addition, there was no difference in TTI and failure rates with VLs between novices to intubation (Group NTI) and those experienced with MAC but novices to VL (Group NVL). In the experienced arm (Group EXP), a 20 s difference in TTI between VL and MAC was found.

Previous mannequin study that compared intubation time and ease of use of MGR[6] with MAC by novices

Table 1: Demographic data of patients

Group	Scope	Male/ female	Age (years) Mean (SD)	ASA grade I/II	BMI (kg/m²) Mean (SD)	MPC I/II
NTI	MAC	6/8	45.8 (11.6)	9/5	22.39 (3.6)	11/3
	MGR	4/10	44.5 (15.0)	10/4	22.47 (4.8)	7/7
	TVW	4/10	46.5 (16.2)	10/4	22.60 (3.7)	9/5
	Total	14/28	45.6 (14.1)	29/13	22.4 (4.0)	27/15
NVL	MAC	7/7	42 (12.5)	12/2	22.49 (3.2)	11/3
	MGR	5/9	42.2 (13.0)	9/5	22.25 (93.2)	12/2
	TVW	4/10	52.9 (12.4)	6/8	22.4 (3.5)	9/5
	Total	16/26	45.7 (13.4)	27/15	22.3 (3.2)	32/10
EXP	MAC	6/8	49.6 (10.2)	11/3	21.5 (3.1)	11/3
	MGR	6/8	42.5 (12.0)	8/6	23.7 (3.1)	13/1
	TVW	8/6	51.3 (11.5)	10/4	21.8 (3.9)	12/2
	Total	20/22	47.8 (11.7)	29/13	22.3 (3.5)	36/6

MAC – Macintosh; MGR – McGrath; TVW – Truview scope; NTI – Novice to intubation group; NVL – Novice to videoscope group; EXP – Expert group; SD – Standard deviation; BMI – Body mass index; MPC – Mallampati classification; ASA – American Society of Anaesthesiologists

Table 2: Failure rate, CL views, optimisation maneuvers, trauma

Variable	Group NTI (*n*=42)	Group NVL (*n*=42)	Group EXP (*n*=42)	Total (*n*=126)
Failure rate				
MAC	2	0	0	2
MGR	6	5	0	11
TVW	1	0	0	1
Total	9	5	0	14
CL view (I/II and above)				
MAC	7/7	11/3	10/4	28/14
MGR	11/3	12/2	14/0	37/5
TVW	9/5	13/1	14/0	36/6
Total	27/15	36/6	38/4	101/25
Optimisation manoeuvers				
MAC	0	3	4	7
MGR	0	1	1	2
TVW	0	1	1	2
Total	0	5	6	11
Trauma				
MAC	3	0	0	3
MGR	3	2	0	5
TVW	4	0	1	5
Total	10	2	1	13

MAC – Macintosh; MGR – McGrath; TVW – Truview scope; NTI – Novice to intubation group; NVL – Novice to videoscope group; EXP – Expert group; CL – Cormack and Lehane

have found no difference between the scopes. In our clinical trial, no difference was found in the intubation time and NRS for the three scopes by the NTI group; suggesting that performance of novices is similar with the direct laryngoscopy with MAC blade as with the VLs.

There are a few clinical studies, which look at the use of VLs by novices in patients[12,15] Di Marco *et al*. in 2010 compared learning and performance of tracheal intubation by novices using the Airtraq® or MAC laryngoscopes in a randomised controlled clinical trial.[12] Airtraq® laryngoscope was judged easier and had a shorter intubation time than MAC by the novices. Airtraq® laryngoscope is a channelled VL. As tube manipulation is not tested with channelled VL, the results of this study may not be directly comparable with our study with non-channelled VLs. Nouruzi-Sedeh *et al*.,[15] in their clinical trial compared the success rate of MAC and the Glidescope® technique performed by personnel inexperienced at intubation, the Glidescope® had better success rate than MAC ($P < 0.01$). In this study, each participant intubated 5 times with each scope and an improvement in success rate and TTI was seen from the first to fifth attempt, with the VL. Hence, in order to minimise the effect of experience gained during the study, we limited the number of intubations to not more than three with each scope.

Studies have looked at the performance of VLs by anaesthesiologists[8,9,16,17] and paramedics[18] experienced with MAC blade but who had never used VL before, similar to our Group NVL. These studies also suggest that there may be differences in the performance of these intubating anaesthesiologists with different VLs. Experienced anaesthesiologists, but novices to VLs required a longer time for intubation in a standard manikin using MGR (40.7 s) compared to Venner® A.P. Advance (29.4 s) and MAC scope (26.1 s), ($P < 0.001$).[17] Lye in one manikin study compared the use of four scopes: Pentax AWS®, C-MAC®, Bonfils® and MAC by two group of physicians with different levels of airway management experience.[16] The groups included novice anaesthetists of grade medical officers versus skilled anaesthetists (with MAC scope). This study concluded that after a teaching session and familiarisation with new scopes, novices were equally successful at intubation attempts with these scopes as skilled anaesthetists, even in difficult airway scenarios. In our study, we found no difference in TTI with VLs between Group NTI and Group NVL. In the background of above studies, the results of Group NTI and NVL suggests that experience with MAC blade does not translate to better performance with VL.

Intubating anaesthesiologists from Group NVL (novice to VL, experienced with MAC) had a high failure rate with MGR. Similar results were seen in a manikin study by Sharma *et al*.[9] Only 48% of participants, who were experienced anaesthesiologists but novice to VLs could intubate within 3 min using MGR with a median of three attempts. This difference occurred despite the majority of anaesthesiologists obtaining a CL grade 1 view. This suggests that while VLs improve the visualisation of the glottis, additional skills at tube manipulation is required to guide the tracheal tube into the trachea and that these skills are not developed with experience at conventional laryngoscopy.

No guidance or aid was given to the intubating anaesthesiologists during intubation. Though all novices were explained and briefed about optimisation manoeuvres, the use of these techniques was not seen in the NTI group reflecting the lack of clinical experience of the NTI group and also as all patients had CL I/II, the novices might not have felt the need to ask for optimisation manoeuvres. Trauma with the use of stylet in with videoscope is known.[19] In our

study, two instances of trauma needing pressure in the form of throat packing was seen in the Group NVL. This may have occurred due to persistent attempts to pass the tube leading to trauma in the hands of the conventionally trained anaesthesiologist. Knowing that experience with MAC blade does not help in intubation with VLs, we propose that the introduction of VLs is best done early during training when the young minds are more cautious and patient in acquiring new skills.

Ray *et al.* in their manikin study with novices and VL found that success rate for tracheal intubation using the MAC scope was higher after using the MGR but converse was not true, suggesting that MGR can aid the teaching of direct laryngoscopy, but conventional laryngoscopy did not help in learning VLs.[6] This finding further reinforces the need to introduce VL early in training.

In the experienced group, we found TTI about 20 s longer with MGR and TVW scopes suggesting that intubation using non-channelised VL as a technique takes a little longer than direct conventional laryngoscopy by MAC. This is similar to other studies which have shown that tracheal intubation needs more time with VLs[20-22] even if the laryngoscopy time - that is, time to visualise the cords, did not differ between VL and MAC.[20]

This study is probably the only clinical trial that has compared the influence of experience with standard direct laryngoscopy on learning of VLs. The strength of this study is the comparison with three groups of varied experience-NTI, experienced in MAC but a novice to VLs and lastly experienced in MAC and VLs. The three groups help to dissect out the influence of experience on the use of VLs. However, the study has its own limitations. Both VLs included were non-channelled VL based on the availability in our institute. Hence, the results may not be applicable to other VLs, especially channelled VLs. With newer VLs and modifications of existing VLs constantly entering the market, performance assessment of such a diverse group of devices can never be perfect.[23]

The criteria laid down to qualify as experienced with VLs are based on literature, which currently is mainly from manikin studies. The possibility of narrowing out the difference in TTI between VLs and MAC, as found in our data, with further experience in VLs, cannot be ruled out.[20,21]

CONCLUSION

Novice anaesthesiologists rated the ease of intubation with VLs similar to conventional laryngoscopy. Experience with MAC did not help improve performance with VLs. One needs to gain experience in the technique and the hand-eye coordination that is needed for intubation with non-channelised VLs. With the accepted role of VLs in failed intubation, the authors propose the introduction of VLs early in the training of young anaesthesiologists.

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Announcement

Dr. TN Jha and Dr. KP Chansoriya Travel Grants

For the year 2015 the Dr. TN Jha and Dr. KP Chansoriya travel grant will be awarded to the participants from 15 states. All the states can select their candidate during their annual conference and send them with the recommendation of the Secretary. Only one candidate is allowed from each state. In case if two states have a combined annual meet but separate as per the records, have to select one candidate from each state. If more than 15 states recommend the candidates for the award, selection will be made on first come first served basis.

Dr. Venkatagiri K M
Secretary - ISA
"ASHWATHI", Opp. Ayyappa Temple, Nullippady, Kasaragod - 671121, Kerala
Email: isanhq@gmail.com / secretaryisanhq@gmail.com Mobile: 093880 30395