Original Article

Comparison of endotracheal intubation time in neutral position between C-Mac® and Airtraq® laryngoscopes: A prospective randomised study

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ABSTRACT

Background and Aims: In the recent past, many novel devices such as AirTraq® and C-MAC® video laryngoscope (VL) have been introduced in an attempt to reduce anaesthetic morbidity and mortality associated with difficult intubation. In this study, we aimed to evaluate and compare C-MAC® VL with a standard Macintosh blade and the AirTraq® optical laryngoscope as a intubating devices with the patient's head in neutral position. **Methods:** Sixty American Society of Anesthesiologist Physical Status I–II patients were randomly assigned to be intubated with C-MAC® VL (Group CM; $n = 30$) or AirTraq® (Group AT; $n = 30$) in the neutral position, with or without the application of optimization manoeuvres. The primary outcomes of this study were the success rate and the time taken to intubate. Glottic view, ease of tracheal intubation and haemodynamic responses were considered as secondary end points. **Results:** The incidence of successful intubation was similar in both the groups ($P = 1.00$). However, the time for intubation was significantly less with C-MAC® VL (Group CM = 14.9 ± 12.89 s, Group AT = 26.3 ± 13.34 s; $P = 0.0014$). There was no significant difference between the two groups in terms of ease of intubation and glottic view. However, the haemodynamic perturbations were much less with C-MAC® VL. **Conclusion:** We conclude that both the devices were similar in visualising larynx in the neutral position with similar success rates of intubation. However, the C-MAC® VL was better with respect to intubation time and haemodynamic stability.

Key words: Airway management, Aitraq®, intubation, laryngoscope

INTRODUCTION

Complications arising from difficult or failed tracheal intubation remain a leading cause of anaesthetic morbidity and mortality despite recent developments in airway management strategies.[1] It has been observed that in 96%–98% of cases airway can be managed with conventional rigid laryngoscope blades. It is only in 2%–4% of cases that alternative techniques and equipment for endotracheal intubation are required.[2] However, in the emergency medicine department and intensive care unit this may reach up to 20%.[3-7] There is no single factor or combination of factors that can definitely predict difficult intubation.[8,9] Hence, one has to be always prepared to manage a situation of unanticipated difficult airway. In an attempt to reduce the morbidity and mortality associated with such a scenario many novel devices such as AirTraq® and C-MAC® video laryngoscope (VL) have been introduced into clinical practice.

The AirTraq® laryngoscope (Prodal, Meditec, Viczaya, Spain), has a preformed curvature and a channel for installation of the endotracheal tube (ETT). It is an optical intubation device that provides a view of the

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glottic opening without aligning the oral, pharyngeal and laryngeal axes. The C-MAC® VL, on the other hand, is a fourth generation VL (Karl Storz GmbH and Co. KG, Tuttlingen, Germany) which has the CMOS (Complementary metal–oxide–semiconductor) technology to provide a clear image quality. It has standard Macintosh blade with a distal camera at two-thirds of its length which makes it an excellent tool for training of novice. It has been successfully used for visualisation of the larynx in various difficult airway cases.[10,11] The literature demonstrates that AirTraq® is very useful in difficult situations such as those precluding the sniffing position.[12-18] However, it is not clear whether the newly developed VL with standard Macintosh blade can achieve the same degree of success rate and intubation time in similar situations.

Hence, the aim of this study was to compare AirTraq® aided intubation with standard blade C-MAC® VL, in terms of success rate and intubation time as primary end points, and glottic view, ease of intubation and haemodynamic response as secondary end points, in patients without predicted difficulty in intubation and with the head in the neutral position.

METHODS

Following approval from the institutional ethical committee (D1960/FM), 60 American Society of Anesthesiology (ASA) Grade I and II patients of either sex, aged between 20 and 60 years, body mass index ≤30 kg/m^2, Mallampati (MP) I and II, posted for elective surgery under general anaesthesia during the year 2013–2015 were included in the study. Patients with predicted difficult laryngoscopy and intubation (MP Class III or IV, inter-incisor distance <3.5 cm, thyromental distance <6 cm) and cervical spine injury were excluded from the study [Figure 1]. They were then randomly divided into two groups of thirty patients each using a computer-based random number generator (www.randomization.com) to be intubated using standard Macintosh blade C-MAC® VL (Group CM) with a stylet[19] or AirTraq® size-3 laryngoscope (Group AT). The concealment of allocation was performed using sealed envelope technique. Informed written consent for the anaesthesia technique, especially the intubation device and application of manual inline stabilisation (MILS) during intubation was obtained from the patients before the procedure. The intubations were performed by a single researcher throughout the study period. The learning curve was achieved by the researcher with both the equipments by performing 20 intubations in mannequins followed by 10 intubations in patients before the commencement of study.[20,21]

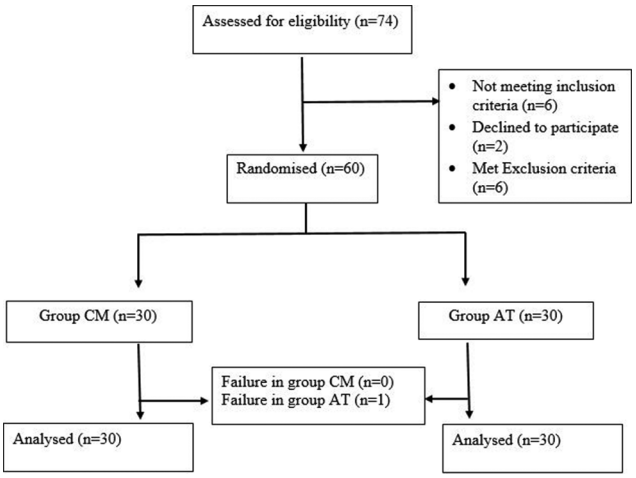

Figure 1: CONSORT flow diagram

Anaesthetic technique was standardised for all patients. Monitors including pulse oximetry, non-invasive blood pressure, electrocardiogram and end-tidal carbon dioxide ($EtCO_2$) were attached. Patients were pre-medicated with midazolam 0.03 mg/kg, ondansetron 0.10 mg/kg and fentanyl 1.5 μg/kg intravenously. Anaesthesia was induced with propofol 2 mg/kg/iv and relaxation achieved with vecuronium 0.1 mg/kg/iv. Laryngoscopy was done with either C-MAC® VL or AirTraq® device as per the study protocol and intubated with a cuffed ETT. The cuff pressure of the ETT was maintained within 20 cm H_2O. Anaesthesia was maintained using a mixture of O_2 and N_2O in the ratio of 40:60% along with isoflurane (0.5 MAC) as inhalational anaesthetic and vecuronium as a muscle relaxant. Baseline characteristics of the patients were recorded. Laryngoscopy was done initially in the neutral position with MILS, and the percentage of glottic opening (POGO) score was recorded. If the POGO score was ≥2, intubation was attempted with or without application of optimal external laryngeal manipulation (OELM) and bougie and the intubation time was recorded. If on laryngoscopy the POGO score was <2, then laryngoscopy was done in sniffing position and intubation was done with or without application of OELM and bougie [Figure 2]. The primary end points were intubation time and success rate, whereas the secondary endpoints were number of attempts, requirement for optimisation, POGO score, ease of intubation and haemodynamic changes. POGO

score was recorded by the anaesthetist performing laryngoscopy and intubation. It was assessed on a score of 1–4 (75%–100%, 50%–75%, 25%–50% and 0%–25%).[22] The duration of intubation attempt was defined as the time taken from the insertion of the blade beyond the incisors until four square wave patterns of $EtCO_2$ on the monitor. The ease of intubation was graded on three-point scale (Grade I-No external manipulation, Grade II-External manipulation required, Grade III-Failure to intubate). The haemodynamic parameters included recording of the heart rate (HR) and mean arterial pressure (MAP) at 1, 3 and 5 min. Surgery was allowed to commence only after the collection of the last haemodynamic data at 5 min post-intubation. Failure was defined if the patient could not be intubated in three attempts. In such cases, a supraglottic airway device was inserted and the case was operated. After completion of the surgery, the patient was monitored in the recovery room and complications noted if any.

Sample size was calculated by taking 10.0 s as the clinically relevant difference in intubation time ($\mu_1 = 19.6$, $\mu_2 = 30.4$ s; where μ_1 and μ_2 are means) with the common standard deviation (SD) of 13.0 s from a pilot study on ten patients per group. Using type I error $\alpha = 0.05$, and type II error $\beta = 0.2$, it was required to include 28 patients per group (PS Power and Sample Size Calculator-Version 3.0.43; Dupont WD, Plummer WD). Considering 5% drop-out, it was decided to include thirty patients per group. Statistical analysis was performed using Graph Pad Prism 5.00 (Graph Pad Software, San Diego, CA, USA). Results are presented in number, percentage, mean and SD or frequencies (%) as appropriate. Continuous data were compared using student's *t*-test, categorical data using Fisher exact test and Chi-square (χ^2) test. Data analysis was performed on an intention to treat basis. A probability value $P < 0.05$ was considered statistically significant. Considering the multiple comparisons, *post hoc* Bonferroni correction was applied and $P < \alpha/2$ (0.025) was set for significance for primary end points.

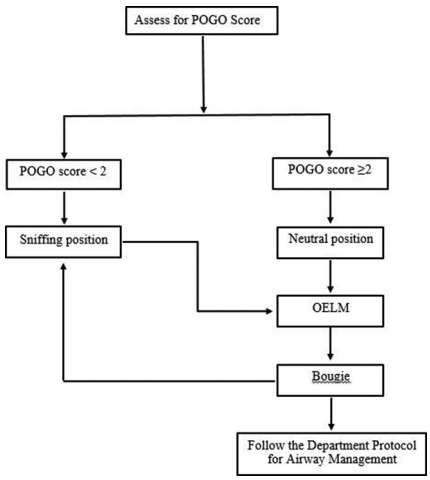

Figure 2: Algorithm for airway management

RESULTS

Both the groups were comparable with respect to age, sex, weight, ASA grade thyromental distance, inter-incisor distance or MP grading [Table 1]. There was no significant difference in the incidence of successful intubation in both the groups. The mean time for tracheal intubation was 14.9 ± 12.89 sec in Group CM as compared to 26.3 ± 13.34 sec in Group AT. The difference was statistically significant ($P = 0.0014$). In Group CM, 80% of patients were intubated in the first attempt without the requirement of OELM or bougie, whereas in Group AT 76% of patients were intubated in the first attempt without external manipulation or aid ($P = 0.73$). The POGO scoring in both the groups was comparable. The majority of patients had Grade I and II ease of intubation in both the groups. All the intubations were successful in the neutral position except one in Group AT that failed despite obtaining sniffing position and application of optimisation manoeuvres. One patient had Grade III ease of intubation in Group AT, who could not be intubated despite obtaining sniffing position and was declared failure. No significant complications were observed with the use of either of devices except three cases of minor bleeding with the use of AirTraq [Table 2]. There was a significant rise in the HR from the pre-induction to 1-min post-intubation in both the groups (CM; $P = 0.005$ and AT $P = 0.014$). The increase in HR was significantly higher in Group AT than Group CM at 1 and 3 min. However, it came down to pre-induction value within 5 min of intubation in both the groups. There was no significant intergroup and

Table 1: Patient characteristics

Patients characteristics	Group CM (*n*=30)	Group AT (*n*=30)	*P*
Age (years)	32.43±12.63	35.96±10.39	0.24
Male:female (*n*)	14:16	15:15	0.79
Weight (kg)	58.07±12.47	56.50±5.19	0.52
ASA I/II (*n*)	24/6	23/7	1.00
Thyromental distance (cm)	6.8±0.7	6.9±0.6	0.21
Interincissor distance (cm)	4.4±0.7	4.3±0.7	0.50
MP I/II (*n*)	14/16	20/10	0.12

P≤0.05 is considered significant. n – Number of patients; ASA – American Society of Anesthesiology; MP – Mallampati

intragroup variations in MAP (Group CM; $P = 0.565$ and Group AT; $P = 0.295$) [Table 3].

DISCUSSION

In the present study, we compared the efficacy of AirTraq® laryngoscope with that of standard Macintosh blade C-MAC® VL. It was observed that intubation with the C-MAC VL using conventional Macintosh blade required less time as compared to intubation with AirTraq®, with minimal haemodynamic alteration during endotracheal intubation.

The majority of patients required 10–20 s for intubation with C-MAC® as compared to 10–30 s with the AirTraq®, which was similar to the previous reports.[10,15,17] Since the demographic profile of the patients in both the groups was comparable and the laryngoscopy was performed by the same researcher, the increased time taken with AirTraq® could be primarily due to the limitations of the device. Although both these devices were rigid, the Macintosh blade had an advantage over the other device. The anaesthesiologists are usually acquainted in using Macintosh blade while performing rigid laryngoscopy from the very first day of their anaesthetic practice. As a result, the researcher could probably handle easily the real time finer adjustments required if any during laryngoscopy and intubation with C-MAC® VL. On the other hand, the AirTraq® optical device, which has a preformed curvature and a channel for installation of ETT, probably permitted limited scope for finer adjustments with the ETT during intubation. The whole assembly, with the device along with the ETT had to be manipulated for adjustments. That probably led to increase in number and duration of intubation attempts, leading to an overall increase in time to intubation with AirTraq®. However, it may be argued that a learning curve was achieved with both the device before conducting the study. The learning curves are achieved primarily in handling the device and learning the technique of intubation. The expertise is achieved early with Macintosh blade because of regular and frequent use.[23]

In the present study, the overall success rate of intubation was similar with both the devices. All the intubations were successful in the neutral position except one in AirTraq® group that failed despite obtaining sniffing position and application of optimisation manoeuvres. In a recent editorials,[24,25] it has been mentioned that in videolaryngoscopy, the success of intubation depends not only on the view obtained, but on the ease of insertion of the ETT. Accordingly, since the ease of intubation between these two devices was similar, the success rate was also similar in our study. Further, McElwain and Laffey[26] documented that the alignment of all the three axes, oral, pharyngeal and laryngeal (sniffing position) during intubation

Table 2: Intubation characteristics

Variable	Group CM (*n*)	Group AT (*n*)	*P*
Overall success rate	30/30	29/30	1.00
Intubation time (s)	14.9±12.89	26.3±13.34	0.0014
0-10	2	0	-
10-20	26	14	-
20-30	2	10	-
30-40	0	4	-
40-50	0	1	-
50-60	0	0	-
>60	0	1	-
Intubation in neutral position (%)	24 (80)	22 (76)	0.76
OELM	4	5	1.00
OELM + Bougie	2	3	1.00
Sniffing/optimisation	0/0	1/1	1.00
Total no of attempts (*n*)	30	31	-
1	28	27	-
2	2	2	-
3	0	1	-
Ease of intubation (*n*)			-
Grade I	24	22	0.76
Grade II	6	7	1.00
Grade III	0	1	1.00
POGO score (%)	79.83±15.84	84.17±19.48	0.35
I (25)	0	1	-
II (25-50)	2	1	-
III (50-75)	4	3	-
IV (75-100)	24	25	-
Blood on laryngoscope blade	0	3	0.24
Laceration	0	0	1.00
Dental or airway trauma	0	0	1.00

Data are expressed as mean±SD. *P*≤0.05/0.025 is considered significant.
n – Number of patients; OELM – Optimal external laryngeal manipulation; POGO – Percentage of glottic opening; SD – Standard deviation

Table 3: Distribution of heart rate and mean arterial blood pressure

Parameter	Group CM	Group AT	*P*
Heart rate			
Preinduction	81.00±6.53	84.80±8.37	0.13
1 min	85.80±6.18	90.47±9.02	0.02
3 min	83.47±6.03	87.60±9.00	0.04
5 min	80.80±5.74	84.13±7.51	0.06
Mean arterial pressure (mmHg)			
Preinduction	94.10±5.52	91.83±5.03	0.10
1 min	94.90±5.19	93.20±5.03	0.20
3 min	93.07±5.02	91.83±5.15	0.35
5 min	92.67±5.15	91.10±5.11	0.24

Data are expressed as mean±SD, *P*≤0.05 is considered significant.
SD – Standard deviation

with these devices was not required. They compared C-MAC® VL, AirTraq®, and Macintosh laryngoscopes in patients undergoing tracheal intubation with cervical spine immobilization (neutral position) and observed no significant difference in success rate between C-MAC VL® and AirTraq®. Similarly, in the present study, MILS was applied to the patients to mimic cervical spine immobilisation and no difference in the success rate for intubation was observed.

In the present series, the difference in the total number of attempts required for intubation in each group was not statistically significant. Further, the number of patients intubated in first and second attempt with both the devices without any external manipulation was almost similar except one patient that required the third attempt in the AirTraq® group. Most of the previous studies have also reported minimal requirement for additional manoeuvres during intubation with these devices.[12,18,27] The laryngeal view in the present study was compared using POGO score, where no significant difference was observed between the two devices. This may be due to the reason that glottic view in both of these devices was based on indirect prismatic view or distally placed camera, obviating the role of axis alignment in obtaining a good view. McElwain *et al*.,[10] in their study observed similar findings. However, their study was based on mannequins, whereas the present study was a human trial.

In both the groups, a significant increase in HR was observed from its baseline value after 1 min post-intubation but had returned to baseline within 5 min. The fluctuations in HR were more pronounced in the AirTraq® group as compared to the C-MAC® VL group. This was probably due to relative increase in duration of time to intubation and increase in number of attempts with AirTraq. However, the increase in MAP did not reach up to the level of significance with either of the devices. The haemodynamic parameters returned to the baseline in both the groups after 5 min. McElwain and Laffey in their study also found a significant change in HR and BP from baseline, with no intergroup differences.[26]

As with most of the studies, there were some limitations in the present study. First, although patients were blinded to the device being used, it was impossible to blind the anaesthesiologist to the device being used. Therefore, it was not a double-blind study and hence, there could be some element of bias. However, to minimise the level of biases the intubation was performed by the same anaesthesiologist throughout the study. Second, the patients in the C-MAC VL® group were intubated with a stylet. Third, we have not included patients with anticipated difficult intubations. Therefore, the applicability or advantage of these devices in actually difficult scenarios could not be assessed.

CONCLUSION

We conclude that C-MAC® VL is a better device than AirTraq® in terms of intubation time with similar success rate for intubation in the neutral position with MILS. The clinical implication of the present study is that both the devices would be advantageous while intubating patients with restricted head and neck movement such as patients with cervical spine fracture. Further, the C-MAC® VL may be a better device in patients as it requires less time for intubation with less haemodynamic alterations as compared to the AirTraq®. However, further larger clinical trials in patients with normal and difficult airways are necessary to confirm these initial findings.

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Conflicts of interest
There are no conflicts of interest.

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