Comparison of laryngeal mask airway CTrach™ and Airtraq® videolaryngoscopes as conduits for endotracheal intubation in patients with simulated limitation of cervical spine movements by manual in-line stabilization

Madhu Rao, Lokvendra S. Budania, Vamsidhar Chamala, Kush Goyal
Department of Anesthesia, Kasturba Medical College, Manipal, Karnataka, India

Abstract

Background and Aims: Laryngeal mask airway (LMA) CTrach™ and Airtraq® videolaryngoscopes are useful for endotracheal intubation in patients with limited cervical spine movements and other predicted difficult airways. We aimed to compare LMA CTrach™ and Airtraq® videolaryngoscopes as conduits for endotracheal intubation in patients with simulated limitation of cervical spine movements by manual in-line stabilization (MILS).

Material and Methods: This was a prospective, randomized study including 50 patients undergoing elective surgeries under general anesthesia. Patients were assigned to undergo intubation using Airtraq® (n = 25) or LMA CTrach™ (n = 25) by an experienced anesthesiologist, while MILS was provided. Laryngoscopy and intubation were compared in terms of time taken to obtain optimal laryngeal view, successful intubation, total time, percentage of glottis opening (POGO) score, maneuvers required for optimal laryngeal view and alignment of endotracheal tube, and number of attempts and complications. An integrated score was calculated to classify the attempt as good, restricted, or poor.

Results: Time taken to obtain optimal laryngeal view, successful intubation, and total time in both groups were comparable. POGO score >50% was seen in 25 and 21 patients in Groups A and C. Seventy-six percent and ninety-six percent in Groups A and C, respectively, had a good integrated score; 6% and 1% had restricted score; none had a poor score; and the difference between them was statistically significant (P = 0.042).

Conclusions: LMA CTrach™ and Airtraq® are similar with respect to time taken for obtaining optimal laryngeal view, successful intubation, and total time when used for intubation in patients with simulated limitation of cervical spine movements.

Keywords: Airtraq®, cervical spine, laryngeal mask airway CTrach™, manual in-line stabilization

Introduction

Conventional intubation requires sniffing position for the alignment of the oral, pharyngeal, and laryngeal axes to achieve a direct line of vision from the mouth to the vocal cords. This involves flexion of the lower cervical spine, extension of the upper cervical spine, and the atlanto-occipital joint.[1–2]

Although conventional intubation with a direct laryngoscope offers fastest and easiest way of securing airway in normal patients, it may not be the same in patients requiring cervical spine immobilization where direct laryngoscopy with manual in-line stabilization (MILS) is performed.[3–5] This technique offers a difficulty for intubation because of limitation of cervical spine movements.[6–8] Introduction of video-assisted intubation has made handling of anticipated and unanticipated difficult
airways easier and hence has found a role in the current American Society of Anesthesiologists (ASA) difficult airway algorithm. Airtraq® videolaryngoscope and laryngeal mask airway (LMA) CT rach™ are two such devices that provide preformed channels to ease the passage of the endotracheal tube (ETT) into the trachea. Applications of Airtraq® include anticipated difficult laryngoscopy, rescue device following failed direct laryngoscopy, airway management of morbidly obese patients, polytrauma patients with suspected cervical spine injury requiring immobilization, patients with limited mouth opening, and for fiberscope teaching. LMA CT rach™ has been used in morbidly obese patients and patients with anticipated difficult airways and simulated difficult airways. Although these devices provide excellent glottic views in difficult airway situations such as cervical immobilization, one limitation is the inability to pass the ETT into the larynx through the preformed channels with a tendency to migrate posteriorly into the esophagus. Previous studies have shown that Airtraq® when compared to LMA CT rach™ takes lesser time to achieve optimal laryngeal view as well as intubation. We felt that this could probably be attributed to the fact that an additional step of check ventilation is done when CT rach™ is used, before attaching the monitor to the device. Finally, as these two devices are commonly preferred in our institution to intubate patients with cervical immobilization, we wanted to compare their performance as conduits for endotracheal intubation. Thus, our primary objective was to compare the LMA CT rach™ and Airtraq® with respect to time taken to obtain an optimum laryngeal view, successful endotracheal intubation, and total time in patients with simulated limitation of cervical spine movements by MILS. The secondary objectives included grading of laryngeal view before and after manipulation, additional maneuvers required to optimize the view, maneuvers required to aid endotracheal intubation, and number of intubation attempts and complications.

**Material and Methods**

After obtaining approval from Institutional Ethics Committee, this prospective and randomized study was commenced with 50 consenting patients who were undergoing elective surgical procedures requiring general anesthesia with endotracheal intubation. Patients aged between 18 and 60 years belonging to the ASA physical status I and II were included in this study. Those undergoing emergency surgeries, with high risk of aspiration, limited mouth opening (<2 finger breadth), oral or maxillofacial pathology, known cardiorespiratory diseases, and body mass index (BMI) >35 kg/m² were excluded from this study. Patients were randomized into two groups using computer-generated random sequence. In Group A, endotracheal intubation was done under Airtraq® visualization and in Group C, CT rach™ was used. Group allocation was concealed using sealed envelopes which were opened by the anesthesiologist who performed endotracheal intubation. There were two observers: Observer 1 performed the preoperative evaluation, performed the MILS, and recorded the observations. Observer 2 was an anesthesiologist, who was experienced with the use of Airtraq® and CT rach™ and performed all the intubations. Experience being defined as having used both devices in >20 patients before commencing the study. On the day of surgery, all patients were monitored with electrocardiogram Lead II, noninvasive blood pressure, pulse oximeter, and capnograph. General anesthesia was induced with propofol 2–2.5 mg/kg, and fentanyl 2 µg/kg. Muscle relaxation was achieved with vecuronium 0.1 mg/kg and patients were ventilated with 2% isoflurane in 100% oxygen. After 3 min, check laryngoscopy was done with an appropriate-sized Macintosh laryngoscope blade by observer 2 and those patients with Cormack and Lehane Grade 4 were excluded from the study. Now, with the head in neutral position, cervical spine immobilization was achieved using MILS by observer 1. Standing to the left of the patient and facing him/her, both mastoid processes were grasped by the thumb and the occiput was cupped in the hands. While avoiding axial traction, forces equal and opposite to those created by the anesthesiologist who was intubating was applied so as to prevent or minimize the head and neck movement. A stopwatch was placed next to the patient’s head and immediately started and required timings were noted. Endotracheal intubation was performed by observer 2 with continued MILS as per group allocation.

In Group A, preloaded Airtraq® of size 3 for females with a 7.0 mm ETT and size 4 for males with 8.0 mm ETT inserted in the preformed channel was used after attaching the adaptor for remote wireless imaging. The blade was passed into the mouth in the midline over the center of the tongue until the tip reached the vallecula, and the epiglottis was lifted to get the glottis in the center of the view on the remote wireless monitor. Glottic view was graded using percentage of glottis opening (POGO) scale from 0 to 100%. If the view was poor, that is, <25%, maneuvers such as inclusion of epiglottis with the Airtraq® blade, rotation, or angulation were performed and the best grade obtained after manipulation was noted. This was considered the optimal glottic view. The preloaded ETT was passed into the trachea under vision and correct placement was confirmed by the passage of black line into the glottic opening. In Group C, a preloaded CT rach™ of size 3 for small adult (30–50 kg) with 7.0 mm ETT and size 4 for normal adult (50–70 kg) with 8.0 mm ETT was used. The device was inserted using one-handed rotational technique...
and cuff was inflated with air to achieve a “just airtight seal” or to a maximum pressure of 60 cm H₂O (maximum air volumes: size 3 = 20 ml; size 4 = 30 ml). Viewer was attached to the connector and glottic view was graded using POGO scale. If the view was poor, i.e., <25%, maneuvers such as Chandy’s maneuver[21] and up-down movement were performed and the best grade obtained was noted again after manipulation and considered the optimal glottic view. The ETT was then passed into the trachea under vision.

Time taken to obtain optimal laryngeal view was recorded as time from the insertion of the device in the mouth beyond incisor to obtaining optimal glottic view on the respective video monitors. Time taken for successful intubation was recorded as time from exit of the ETT from the tip of the device to the confirmation of successful placement by the passage of the black line into the glottic opening. Total time was a sum of the above two parameters. In both groups, an attempt was considered failed if intubation remained unsuccessful or saturation dropped below 95% or if time exceeded 120 s. If an intubation attempt failed, the patient was mask ventilated with 100% oxygen and isoflurane 1.5–2%, and the second attempt with the same device was allowed with continued MILS. If this also failed, conventional intubation was performed. Complications such as the presence of soft-tissue trauma or dental trauma, blood on the device introduced or ETT or dental trauma, blood on the device introduced or ETT on removal indicating lower airway trauma, and sore throat at 12 h were recorded. Based on the previously recorded parameters, an integrated score was calculated to summarize the secondary objectives [Table 1]. Intubating conditions were graded based on the total score as poor for a score of 5–6, restricted for a score of 7–8, and good for a score of 9–10.

Based on the results obtained from a pilot study on 10 patients, five in each group, the mean and standard deviation in Group A and Group C were 51.6 ± 19.9 s and 33.9 ± 8.17 s, respectively. The sample size was determined to be 25 to detect a difference of 30 s in total time allowing for an alpha error on 0.05 and power of 80%. Continuous, quantitative data with normal distribution such as age, weight, and BMI were analyzed using independent t-test. Chi-square test was used to analyze gender, ASA physical status, ease of insertion, POGO scoring, maneuvers required for optimal laryngeal view and to align the ETT, number of attempts taken, complications, and to calculate integrated score. Mann–Whitney U-test was used to analyze quantitative data with nonnormal distribution such as time for optimal laryngeal view, successful intubation, and total time. SPSS version 20.0, Armonk, NY: IBM Corp was used to compute the above-mentioned statistics.

**Results**

The age, gender, ASA physical status, weight, height, and BMI in both the groups were comparable [Table 2]. There was an equal distribution of Cormack and Lehane Grades 1, 2, and 3 and no patients with Grade 4 on check laryngoscopy.

The median time for optimal laryngeal view, time for successful intubation, and total time were comparable between the two groups [Table 3]. POGO score was statistically significant in favor of Group C [Table 3]. In Group A, three patients required external laryngeal manipulation and one patient needed inclusion of epiglottis with the blade to optimize laryngeal view. Only one patient in Group C required additional Chandy’s maneuver for optimization of the laryngeal view. To align the ETT, one patient required rotation of the tube and four required external manipulations in Group A. While in comparison, the maneuvers required in Group C were rotation of the tube in two and external laryngeal manipulations in five patients, respectively. Most of the patients in both groups were intubated in the first attempt. In terms of complications, one patient in Group A had blood on the videolaryngoscope and also sore throat postoperatively,

| Parameters                          | 2 | 1 |
|-------------------------------------|---|---|
| Best laryngeal view as per POGO score before/after manipulation (if required) | >50% | <50% |
| Additional maneuvers to optimize view | Not required | Required |
| Additional maneuvers to guide ETT into glottis | Not required | Required |
| Number of attempts                  | 1 | >1 |
| Complications                       | No | Yes |

POGO=Percentage of glottis opening, ETT=Endotracheal tube

**Table 1: Integrated score parameters**

| Demographic data                        | Group A | Group C | P  |
|-----------------------------------------|---------|---------|----|
| Age (years)                             | 44.1 ± 14.1 | 37.6 ± 12.6 | 0.302 |
| Gender, n (%)                           | 12 (48) | 18 (72) | 0.074 |
| Male                                    | 13 (52) | 7 (28) |
| Female                                  |         |         |
| ASA physical status, n (%)              | 17 (68) | 22 (88) | 0.085 |
| ASA 1                                   | 8 (32)  | 3 (12)  |
| Weight (kg)                             | 59.0 ± 10.3 | 61.7 ± 12.5 | 0.317 |
| Height (cm)                             | 162.0 ± 8.5 | 164.9 ± 9.4 | 0.678 |
| BMI (kg/m²)                             | 22.5 ± 3.4 | 22.5 ± 3.1 | 0.526 |

SD=Standard deviation, BMI=Body mass index, ASA=American Society of Anesthesiologists
whereas another patient in this group had complained of postoperative sore throat only. One patient in Group C had blood on the tip of the ETT seen during extubation. The overall integrated score was statistically significant in favor of Group C [Table 3].

**Discussion**

In our study, we found that one of our primary outcomes of time taken for optimal laryngeal view was more in Group A as compared to Group C, which was contrary to previous study by Arslan et al.[15] We felt that the additional step of check ventilation, which is done when CT rach™ is used contributes significantly to the time taken to obtain a laryngeal view. We thus eliminated the check ventilation, as we wanted to compare the devices for their property to behave as conduits for endotracheal intubation. Accordingly, this additional time got reduced in Group C and made these devices comparable. The results achieved with reference to total time were in concordance with the study conducted by Arslan et al., although the difference was much higher in their study.[15]

In a study conducted by Liu et al., view of the larynx with LMA CT rach™ was found to be difficult as compared to the direct laryngoscopy.[22] In our study, we found out that the best possible laryngeal view using POGO score was better (>50%) with LMA CT rach™ as compared to Airtraq® (P = 0.037). All the patients in LMA CT rach™ group had a POGO score of >50% and only one patient required Chandy’s maneuver to improve the score. In the Airtraq® group, initial POGO score of <25% was seen in four patients and application of additional maneuvers improved POGO score for two patients while the remaining two patients continued to have a POGO score of <50%. Because the CTrach™ shape is based on magnetic resonance imaging of the human airway that enables a close fit with the oropharynx and optimal alignment with the laryngeal inlet, especially after cuff inflation, the views were good. To some extent, the similarity of the CTrach™ to the regularly used proseeal LMA could also have contributed to easy insertion and better placement of the device and hence better views.

Patients in both the groups were successfully intubated in the first attempt in most of the cases which is in consensus with previous studies conducted by Maharaj et al. and Swadia et al., where patients were intubated in the first attempt in a comparison of Airtraq® and direct laryngoscopy with Macintosh blade and CTrach™ and Macintosh blade, respectively.[15,23,24] Even Bilgin and Bozkurt studied the LMA CTrach™ in patients undergoing MILS and demonstrated a higher rate of successful tracheal intubation on the first attempt when compared with the intubating LMA and McCoy laryngoscope.[25]

To summarize our secondary objectives, we used an integrated score and found that it was significantly better in the LMA CTrach™ group as compared to the Airtraq® group. Restricted score was seen in the Airtraq® group mainly due to the combination of poorer glottic views requiring external manipulations, maneuvers to align the ETT, and

---

**Table 3: Laryngoscopy and intubation characteristics**

| Parameter                                           | Group A                  | Group C                  | P       |
|-----------------------------------------------------|--------------------------|--------------------------|---------|
| Time to obtain optimal laryngeal view (s)           | 28.2 (20.7-39.5)         | 24.0 (18.4-36.0)         | 0.347   |
| Time for successful intubation (s)                  | 8.9 (4.3-25.0)           | 14.1 (9.4-18.6)          | 0.304   |
| Total time (s)                                       | 40.3 (32.1-55.0)         | 42.7 (32.5-51.6)         | 0.786   |
| Percentage of glottis opening score, n (%)          |                          |                          |         |
| <50%                                                | 4 (16)                   | 0                        | 0.037*  |
| >50%                                                | 21 (84)                  | 25 (100)                 |         |
| Maneuvers to optimize laryngeal view, n (%)         | 4 (16)                   | 1 (4)                    | 0.157   |
| Maneuvers to align ETT, n (%)                        | 5 (20)                   | 7 (28)                   | 0.508   |
| Attempts, n (%)                                      |                          |                          |         |
| 1                                                   | 22 (88)                  | 23 (92)                  | 0.637   |
| 2                                                   | 3 (12)                   | 2 (8)                    |         |
| Complications, n (%)                                 | 2 (8)                    | 1 (4)                    | 0.552   |
| Integrated score, n (%)                              |                          |                          |         |
| Good (9-10)                                          | 19 (76)                  | 24 (96)                  | 0.042*  |
| Restricted (7-8)                                     | 6 (24)                   | 1 (4)                    |         |
| Poor (5-6)                                           | 0                        | 0                        |         |

*P<0.05 is statistically significant. ETT=Endotracheal tube*
complications in the form of blood on ETT or sore throat. To some extent this could be attributed to the fact that previous studies with Airtraq® have shown that the bulk of this device sometimes causes external trauma contributing to lower score as seen in our study.[26] Another contributing factor being migration of ETT posteriorly into the esophagus requiring external manipulation to guide the ETT from the preformed channel of Airtraq® into the trachea. And finally, the combination of more than one factor in the same patient has made the score less in this group.

There are a few limitations of this study. We could not blind the observers who performed the laryngoscopy and provided MILS. Furthermore, the intubations were performed on patients with normal anatomy of the cervical spine with MILS in situ. Extrapolating the findings to patients with instability of the cervical spine will need further evaluation in that specific cohort of patients. Finally, our integrated score is not a standard validated score. However, as it gives an overall summation of our secondary objectives, we proceeded to apply it for this study.

Conclusions

LMA CTrach™ and Airtraq® are similar with respect to time taken for obtaining optimal laryngeal view, successful intubation, and total time when used for intubation in patients with simulated limitation of cervical spine movements.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

References

1. Magill IW. Endotracheal intubation. Am J Surg 1936;24:450-5.
2. Bannister PB, MacBeth RG. Direct laryngoscopy and tracheal intubation. Lancet 1944;1:651-4.
3. Robitaille A. Airway management in the patient with potential cervical spine instability: Continuing professional development. Can J Anesth 2011;58:1125.
4. Rao BK, Singh VK, Ray S, Mehra M. Airway management in trauma. Indian J Crit Care Med 2004;8:98-105.
5. Theron A, Ford P. Management of acute cervical spine injury. Update Anaesth 2009;90:31-4.
6. Majernick TG, Bieniek R, Houston JB, Hughes HG. Cervical spine movement during orotracheal intubation. Ann Emerg Med 1986;15:417-20.
7. Hastings RH, Wood PR. Head extension and laryngeal view during laryngoscopy with cervical spine stabilization maneuvers. Anesthesiology 1994;80:825-31.
8. Gerling MC, Davis DE Hamilton RS, Morris GF, Vilke GM, Garfin SR, et al. Effects of cervical spine immobilization technique and laryngoscope blade selection on an unstable cervical spine in a cadaver model of intubation. Ann Emerg Med 2000;36:293-300.
9. Niforopoulou P, Pantazopoulos I, Demesticha T, Kouidouna E, Xanthos T. Video-laryngoscopes in the adult airway management: A topical review of the literature. Acta Anaesthesiol Scand 2010;54:1050-61.
10. Channa AB. Video laryngoscopes. Saudi J Anaesth 2011;5:357-9.
11. Maharaj CH, Costello JF, Harte BH, Laffey JG. Evaluation of the Airtraq and Macintosh laryngoscopes in patients at increased risk for difficult tracheal intubation. Anaesthesia 2008;63:182-8.
12. Ndoko SK, Amathieu R, Tual L, Polland C, Kamoun W, El Housseini L, et al. Tracheal intubation of morbidly obese patients: A randomized trial comparing performance of Macintosh and Airtraq laryngoscopes. Br J Anaesth 2008;100:263-8.
13. Koh JC, Lee JS, Lee YW, Chang CH. Comparison of the laryngeal view during intubation using Airtraq and Macintosh laryngoscopes in patients with cervical spine immobilization and mouth opening limitation. Korean J Anaesthesiol 2010;59:314-8.
14. Saracoglu A, Dal D, Baygin O, Gogus FY. Airtraq, LMA CTrach and Macintosh laryngoscopes in tracheal intubation training: A randomized comparative manikin study. Turk J Anaesthesiol Reanim 2016;44:76-80.
15. Arslan ZI, Yildiz T, Baykara ZN, Solak M, Toker K. Tracheal intubation in patients with rigid collar immobilisation of the cervical spine: A comparison of Airtraq and LMA CTrach devices. Anaesthesia 2009;64:1332-6.
16. Swadia VN, Patel MG. Our Preliminary Experience with LMA C-Trach. Indian J Anaesth 2009;53:312-7.
17. Timmermann A, Russo S, Graf BM. Evaluation of the C-Trach – An intubating LMA with integrated fiberoptic system. Br J Anaesth 2006;96:516-21.
18. Malik MA, Subramaniam R, Churasia S, Maharaj CH, Harte BH, Laffey JG. Tracheal intubation in patients with cervical spine immobilization: A comparison of the Airwayscope, LMA CTrach, and the Macintosh laryngoscopes. Br J Anaesth 2009;102:654-61.
19. Hirabayashi Y, Fujita A, Sato N, Sugimoto H. A comparison of cervical spine movement during laryngoscopy using the Airtraq or Macintosh laryngoscopes. Anaesthesia 2008;63:635-40.
20. Levitan RM, Ochroch EA, Kush S, Shofer FS, Hollander JE. Assessment of airway visualization: Validation of the percentage of glottic opening (POGO) scale. Acad Emerg Med 1998;5:19-23.
21. Person DZ, Rosenblatt WH, Johansen MJ, Osborn I, Ossavasapian A. Use of the intubating LMA-Fastrach in 254 patients with difficult-to-manage airways. Anesthesiology 2001;95:1175-81.
22. Liu EH, Goy RW, Chen FG. The LMA CTrach, a new laryngeal mask airway for endotracheal intubation under vision: Evaluation in 100 patients. Br J Anaesth 2006;96:396-400.
23. Maharaj CH, Buckley E, Harte BH, Laffey JG. Endotracheal intubation in patients with cervical spine immobilization: A comparison of Macintosh and Airtraq laryngoscopes. Anaesthesiology 2007;107:53-9.
24. Maharaj CH, O’Croinin D, Curley G, Harte BH, Laffey JG. A comparison of tracheal intubation using the Airtraq or the Macintosh laryngoscope in routine airway management: A randomised, controlled clinical trial. Anaesthesia 2006;61:1093-9.
25. Bilgin H, Bozkurt M. Tracheal intubation using the ILMA, C-Trach or McCoy laryngoscope in patients with simulated cervical spine limitation. Anesthesiology 2010;54:1050-61.
26. Holst B, Hodzovic I, Francis V. Airway trauma caused by the Airtraq laryngoscope. Anaesthesia 2008;63:889-90.