Journal of Anesthesia and Patient Care
Volume 1 | Issue 1
ISSN: 2456-5490

Research Article Open Access

# C-MAC Video Laryngoscopy Versus Flexible Fiberoptic Laryngoscopy in Patients with Anticipated Difficult Airway: A Randomized Controlled Trial

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**Citation:** Salama AK, Hemy A, Raouf A, Saleh N, Rady S (2022) C-MAC Video Laryngoscopy Versus Flexible Fiberoptic Laryngoscopy in Patients with Anticipated Difficult Airway: A Randomized Controlled Trial. J Anesth Pati Care 1(1): 101.

**Received Date:** March 10, 2022 **Accepted Date:** March 25, 2022 **Published Date:** March 30, 2022

## Abstract

**Background and Objectives:** Tracheal intubation is one of the most common medical procedures performed in hospitals. On one hand, it is highly successful and easy to perform using a rigid laryngoscope. On the other hand, hypoxic brain damage and death may result rapidly if it is unsuccessful. The aim of the present study was to investigate laryngoscopic view and intubation success using the new C-MAC in comparison with traditional flexible fiber-optic laryngoscopy in patients with anticipated difficult airway.

**Patients and Methods:** In this prospective randomized controlled study 120 patients with ASA physical status I-II, aging 20-50 years with anticipated difficult airway were randomly allocated into two groups, 60 patients in each group, using Storz C-MAC video laryngoscope in group [1] and Fiberoptic bronchoscopy in group [2].The study compared the techniques for time of intubation, hemodynamic changes, success rate, number of attempts and complications in both groups.

**Results:** Intubation time was significantly higher in patients intubated using the fiberoptic laryngoscopy (62.97 ± 37.54 seconds) compared to patients intubated using the new C-MAC laryngoscopy (22.13 ± 2.83 seconds), also number of attempts was higher with video laryngoscope from first attempt (100%) compared to fiberoptic laryngoscope (73.3%) from first attempts and (23.3%) from second attempts and (3.3%) from the third attempt, hemodynamic variables and complications were comparable in both groups.

**Conclusion:** C-MAC Video laryngoscope has become a good alternative and associated with better visualization of laryngeal structures in shorter time and less intubation attempts as compared to traditional flexible fiber-optic laryngoscopy.

**KeyWords:** C-MAC; Fiberoptic laryngoscopy; Intubation

## Introduction

Tracheal intubation is an essential skill in the care of the unconscious, anesthetized or critically ill patients. Tracheal intubation can be difficult and may result in many complications, the most serious being hypoxemic brain damage and death. Soft tissue damage can be caused by traumatic attempts at intubation. Maintenance of oxygenation must take precedence over all other considerations when difficulty with intubation is experienced and intubation attempts should be deferred until oxygenation is restored [1].

Laryngoscopy occupies a unique position in anesthesia because it is a procedure which is only a means to an end. The ultimate aim is to safely and atraumatically intubate the trachea and secure the airway. Rarely, visualizing the upper airway, vocal cords, removing a foreign body or placing TEE probe may necessitate a laryngoscopy [1].

The unexpected difficult airway is always a challenge for experts as well as for trainees. Fiberoptic intubation is still the gold standard in the management of the difficult airway. A good alternative for difficult intubation is the video laryngoscope with indirect laryngoscopy which may be as effective as flexible laryngoscopy in difficult airway patients. However, the judgment of the clinician is critical to avoid the inappropriate use of a video laryngoscopy when flexible bronchoscopy is the better choice [1].

In the last decade, multiple video laryngoscopies have been introduced into clinical practice [2].

The C-MAC video laryngoscopy (C-MAC) is a recently introduced video laryngoscopy that is conceptually and structurally different from other video laryngoscopies. The C-MAC incorporates a conventional Macintosh-type blade, with the addition of a micro video camera on the distal portion of the blade [3]. So, the C-MAC has the advantage of being able to be used as a direct laryngoscope, as well as a video laryngoscope. This could be useful if the video view becomes obscured by gross contamination of the camera lens during video laryngoscopy. Additionally, this allows supervising physicians to monitor direct laryngoscopy when trainees are using the C-MAC since the student is enabled to follow an ideal intubation process on the video screen, and thereafter the instructor may directly observe the student's intubation attempts [4].

Preliminary studies of the C-MAC in the operating room and out-of-hospital setting have demonstrated promising results [4,5].

## Patients and Methods

Following approval of ethics committee, and after obtaining written informed consent, 120 patients with ASA physical status I–II, aged 20-50 years, of both sexes, scheduled for elective surgeries under general anesthesia with endotracheal intubation and with El-Ganzouri score [6] (Table 1) as 2, 3, 4 in Kasr Alainy hospital in the period between October 2013 and August 2014 were included in this study. Patients who may need a surgical airway (e.g. patients with highly obstructing laryngeal lesions such as cancer), patients with laryngeal or craniofacial trauma or El-Ganzouri scores of 0, 1 and 5 or more were excluded.

Based on El-Ganzouri score the expected difficulty was classified as follow:

**Airway score 0:** Proceed with routine management, difficult intubation or ventilation is not expected.

**Airway score 1-2:** Check fiber optic scope availability, proceed with routine management. If difficult intubation encountered, ventilate the patient and call for fiber optic help.

**Airway score 3-4:** Have a stand-by fiber optic scope if anesthesia personnel decided to general anesthesia and encountered failed direct laryngoscopy, call for help while ventilating the patient, and either do asleep or awake fiber optic intubation.

**Airway score 5 or more:** Awake intubation is strongly recommended by any preferred method in which the personnel is experienced; however, fiber optic is preferred.

Difficult airway cart that includes different size oral airways, endotracheal tubes, different size face masks and laryngeal airway masks was prepared, suction apparatus was ready for use. C-MAC video laryngoscopy was prepared and the fiberscope used was (Karl Storz size 2.8 mm, tuttlingen, Germany). The tube was mounted over the fiberscope before the procedure. Routine preoperative assessment including, airway assessment in the form of mouth opening, thyromental distance, head and neck movement, Malampati scoring (ref) and bucking of the teeth history taking including history of difficult intubation, clinical examination, and laboratory tests.

In the preparation room under local anesthesia intravenous cannula was inserted, midazolam 2 mg and ranitidine 50 mg were given to all patients. Then patient was transferred to the operating room, standard monitors were applied (noninvasive blood pressure, pulse oximetry, electrocardiogram) and capnography after induction of anesthesia. Patients were randomly allocated and divided into two equal groups using computer generated tables and then concealed in opaque closed envelops.

Patients were then preoxygenated via face mask for three minutes and atropinized using 0.01 mg/kg atropine to dry secretions and facilitate vision of the glottis view then general anesthesia was induced using fentanyl 1-2 μg/kg followed by propofol 2 mg/kg then ventilation was assessed using face mask and manual ventilation and if proved satisfactory neuromuscular blocking agent was given in the form of atracurium 0.5 mg/kg the patient is mechanically ventilated using face mask until full relaxation is established after 3-5 minutes. Then intubation is done using C-MAC laryngoscopy in group 1 or using fiberoptic laryngoscopy in group 2. If oxygen saturation decreased to 90% during the intubation attempt, the event was recorded as a hypoxic episode and the patient was ventilated either manually or by laryngeal mask airway to optimize the oxygen saturation around 100%.

The laryngoscopic view was graded according to Cormak and Lehane's scale [7]:

**Grade 1:** View of the entire glottic opening.

**Grade 2:** Only a portion of the opening is visible.

**Grade 3:** Visualization of only the arytenoids or the epiglottis.

**Grade 4:** Inability to see the glottis or epiglottis at all.

In group 1, patients intubated with C-MAC laryngoscopy as follow:

The operator used the left hand to introduce the video laryngoscope into the midline of the oropharynx and gently advanced until the blade tip pass the posterior portion of the tongue then the operator turned his or her eyes to the video screen in order to manipulate the scope and obtain the best view of the glottis, the glottic view is optimized by a combination of advancing or withdrawing the laryngoscope slightly while increasing the tilt on the blade to seat the device in the vallecula or on the posterior surface of the epiglottis to obtain the best glottic view. All of this is done using video visualization with the eyes directed at the video screen the entire time. When the VL is appropriately positioned, the glottic aperture is seen in the center of the upper third of the video display.

The operator immediately started to insert the ETT and attempt to navigate it through the glottic aperture while continuously visualizing the video screen, it is better to maintain the laryngoscopic position in the mouth with the left hand but to avert the eyes from the video screen back to the patient's open mouth. The ETT, which is shaped by the stylet to match the bend of the VL blade, is then inserted under direct vision until the distal tip of the ETT is judged to be very near the distal tip of the laryngoscope blade.

While in group 2 patients intubated with fiberoptic laryngoscopy as follow: the endoscopist was standing at the head of the bed. Simple chin lift and jaw thrust may improve the view through the fibrescope and also help to prevent airway obstruction. The endotracheal tube lumen should be lubricated to facilitate its subsequent advancement into the trachea. It must be appreciated that the tip of the scope can be flexed in only one plane using the control lever located at the handle. Movement of the tip of the scope in other planes requires rotation of the entire instrument. Generally, the proximal control section of the scope is held in the non-dominant hand with the index finger on the suction port and the thumb on the lever which regulates the distal tip angulations. The other hand holds the shaft of the scope distally and guides its advance. The tongue can be grasped by an assistant with gauze or Magill forceps. Pass the scope superior to the tongue into the oropharynx then passed it between the vocal fold until visualization the tracheal ring and carina. The endotracheal tube is then threaded over the distal tip of the scope, fed proximally and fixed in position adjacent to the control handle.

Intubation time was recorded using stopwatch which is the time from the insertion of C- MAC or fiberoptic bronchoscope till the passage of the endotracheal tube in the glottis view, hemodynamic variables were measured during baseline (just before induction of anesthesia), intubation, 1 minute, 2 minutes and 5 minutes post intubation and success rate and number of attempts were recorded.

Assuming an α error of 0.05 and a β error of 0.1, sample size was calculated based on previous studies, and using Herbert Arkin equation with confidence interval of 95% and standard deviation of 1.69 with standard error SE of 0.05 so sample size (n) = 46 so 60 patients were satisfactory in each group

$$n = \frac{p(1-p)}{(SE \div t) + [p(1-p) \div N]}$$

### Statistical analysis

Data were coded and entered using the statistical package SPSS version 21. Data was summarized using mean, standard deviation (SD), median, minimum and maximum for quantitative variables and frequencies (number of cases) and relative frequencies (percentages) for categorical variables. Comparisons between groups were done using unpaired T test in normally distributed quantitative variables while non-parametrical Mann-Whitney test was used for non-normally distributed variables. Comparisons between values measured at baseline, at intubation and after 1, 2 and 5minutes were done using repeated measure ANOVA. For comparing categorical data, Chi square ($\chi^2$) test was performed. Exact Fischer's test was used instead when the expected frequency is less than 5. P-values less than 0.05 were considered as statistically significant.

## Results

There was no statistically significant difference between the two groups as regarding demographic data (age, sex, body mass index, height and ASA physical status) (Table 2), hemodynamic variables (Figure 1, 2, 3) and predictors of difficult intubation (Table 3) and no serious complications

| Assessment | 0 point | 1 point | 2 point |
|---|---|---|---|
| **Interincisor gap(cm)** | > 4 cm | < 4 cm | Can't open mouth |
| **Mallampati classification** | Class 1 | Class 2 | Class 3 |
| **Head/neck movement** | > 90 | = 90 | < 90 |
| **Buck teeth** | Can prognanth or edentulous | Approximate teeth only | Can't approximate teeth |
| **Thyromental distance** | > 6.5 cm | 6-6.5 cm | < 6 cm |
| **Body weight** | < 90 kg | 90-110 kg | > 110 kg |
| **History of difficult intubation** | None | Questionable | Definite |

**Table 1:** El-Ganzouri multivariate risk index for difficult Tracheal intubation [6]

| | Group 1 (n=60) | Group 2 (n=60) | P value |
|---|---|---|---|
| **Age(years)** | 38.13 ± 7.41 | 37.00 ± 8.19 | 0.428 |
| **Weight(kg)** | 93.77 ± 16.02 | 90.03 ± 10.88 | 0.138 |
| **Body mass index(kg/cm²)** | 32.31 ± 2.55 | 32.51 ± 2.53 | 0.677 |
| **Sex (no,%)** • **Male** • **Female** | 34 (56.7%)<br>26 (43.3%) | 44 (73.3%)<br>16 (26.7%) | 0.056 |
| **ASA (no,%)** • **ASA I** • **SA II** | 28 (46.7%)<br>32 (53.3%) | 30 (50.0%)<br>30 (50.0%) | 0.715 |

**Table 2:** Patients' demographic characteristics. Data were presented as (mean ± SD) or no (%)

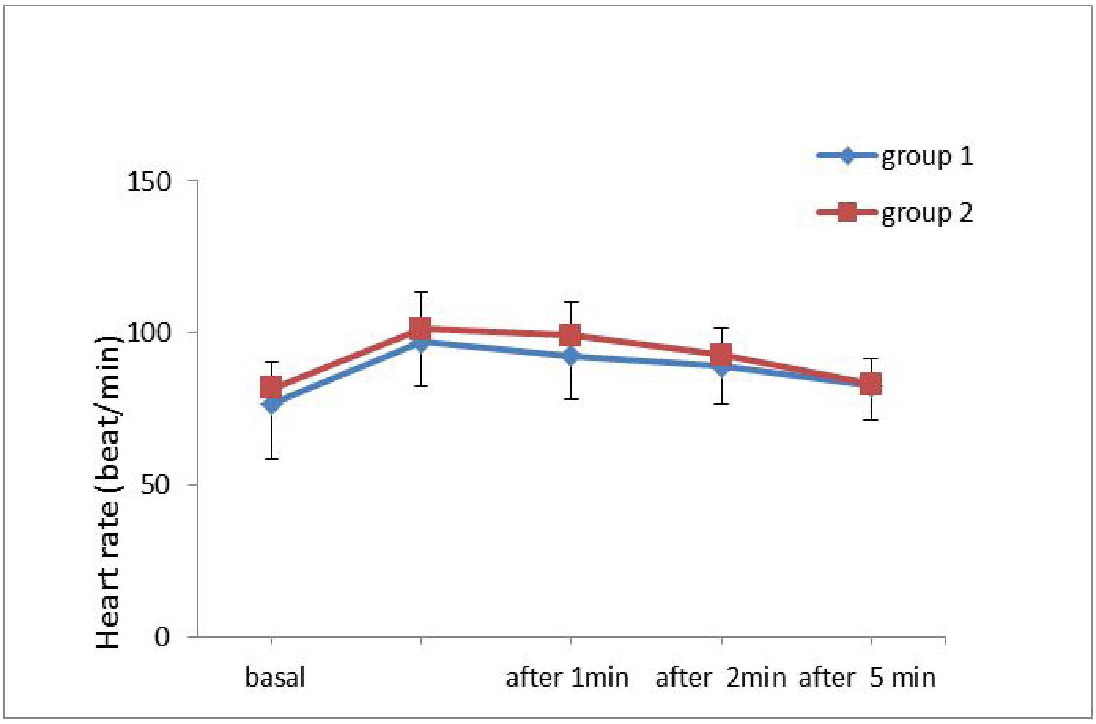


**Figure 1:** Heart rate changes between both groups (beat/minute). Values were presented as mean ± SD

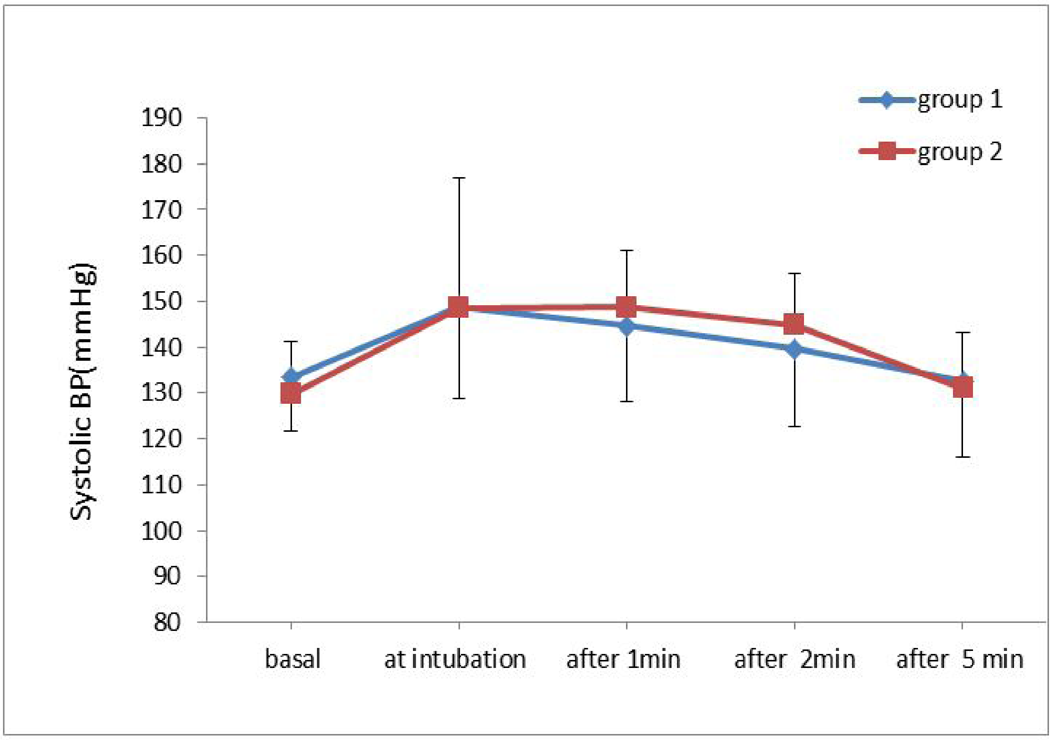


**Figure 2:** Systolic blood pressure changes between both groups (mmHg). Values were presented as mean ± SD

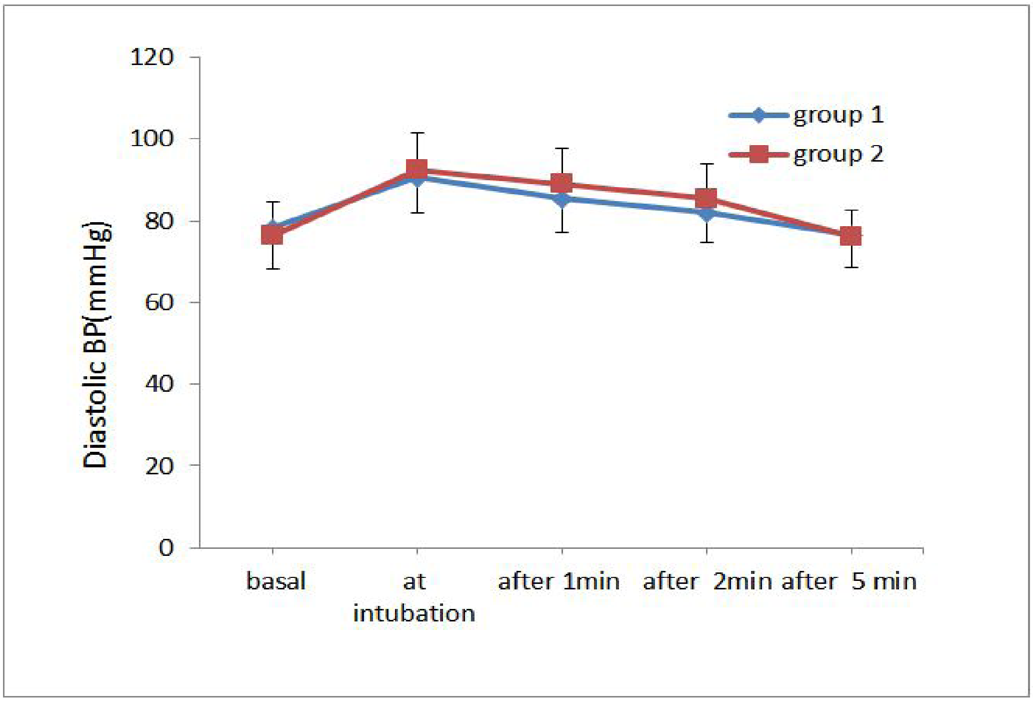


**Figure 3:** Diastolic blood pressure changes between both groups (mmHg). Values were presented as mean ± SD

| | Group 1 (n=60) | Group 2 (n=60) | P value |
|---|---|---|---|
| Interincisor gap(cm) | 4.93 ± .45 | 5.00 ± .58 | 0.504 |
| Thyromental distance(cm) | 7.38 ± .61 | 7.27 ± .67 | 0.321 |
| Head&neck movement<br>• =>90⁰<br>• =90⁰<br>• <90⁰ | <br>46 (76.7%)<br>14 (23.3%)<br>0 (.0%) | <br>53 (88.3%)<br>7 (11.7%)<br>0 (.0%) | 0.093 |
| Malampati classification<br>• Class1<br>• Class2<br>• Classs3 | <br>0 (0%)<br>22 (36.7%)<br>38 (63.3%) | <br>0 (.0%)<br>22 (36.7%)<br>38 (63.3%) | 1 |
| Buck teeth<br>• Can prognath mouth<br>• Can prognath teeth<br>• Can't prognath | <br>60 (100.0%)<br>0 (.0%)<br>0 (.0%) | <br>60 (100.0%)<br>0 (.0%)<br>0 (.0%) | ------ |
| History of difficult intubation<br>• No<br>• Yes<br>• Questionable | <br>60 (100.0%)<br>0 (.0%)<br>0 (.0%) | <br>60 (100.0%)<br>0 (.0%)<br>0 (.0%) | ------- |

**Table 3:** Predictors for potentially difficult airway were presented as (mean ± SD) or no (%)

The success rate was 100% in both groups, Intubation time was significantly higher 62.97 ± 37.54 seconds in group 2 compared to 22.13 ± 2.83 seconds in group1, p value < 0.05 (Table 4). As regard number of attempts, all of intubation were successful from the first attempt in group1,while the intubation were successful from the first attempt only in 44 patients in group 2 and 14 patients from the second attempt and 2 patients from the third attempt.

| | Group 1 (n=60) | Group 2 (n=60) | P value |
|---|---|---|---|
| Duration of intubation (seconds) | 22.13 ± 2.83 | 62.97 ± 37.54 | <0.001* |
| Number of attempts<br>• 1 attempts<br>• >1 attempts | <br>60 (100.0%)<br>0 (.0%) | <br>44 (73.3%)<br>16 (26.7%) | <0.001* |
| Success rate | 60 (100.0%) | 60 (100.0%) | --- |

**Table 4:** Time for intubation, no of attempts, success rate in both studied groups (Seconds). Data were presented as (mean ± SD) or no (%)

## Discussion

Although Fiberoptic bronchoscope (FOB) is considered the gold standard for tracheal intubation in patients with anticipated difficult intubation, The aim of the present study was to investigate that C-MAC video laryngoscope would become the "golden" standard for all intubations, not only those predicted to be "difficult". But also will be used in all elective intubation [8].

The C-MAC video laryngoscope is a relatively new device with the unique advantage that it provides the possibility to obtain both a direct laryngoscopic view and a camera view that is displayed on the video screen, in contrast to many previous video laryngoscopes [9].

The results of the present study showed statistically significant difference in intubation time between the two studied groups. It was significantly longer in patients intubated using the fiberoptic laryngoscopy compared to patients intubated using the new C-MAC laryngoscopy.

These results were comparable with results of Ofelia L. et al [10] during their study on a randomized prospective study comparing tracheal intubation with the C-MAC video laryngoscope device to fiberoptic bronchoscope in patients undergoing cervical spine surgery which showed that the procedures times (including the time required to obtain glottic view, and to secure the airway with a tracheal tube) were consistently shorter in the C-MAC group, but only the time to confirm correct placement using end tidal $CO_2$ waveform tracing was significantly shorter in C-MAC group (60 ± 30 seconds vs. 84 ± 30 seconds, p value < 0.05).

Thus in anticipated difficult airway, C-MAC video laryngoscope has been shown to perform better in terms of shorter intubation time.

Also coincide with the study done by Tomasz Gaszyński [11] in his study in morbidly obese patients using the V-MAC video laryngoscope) an earlier version of the C-MAC) in the morbidly obese. The C-MAC video laryngoscope proved to be very effective and easy to use even for anesthetists with limited experience of using video laryngoscopes.

In contrast to this study Abdelmalak, et al [12] found that in obese patients, securing tracheal intubation under general anesthesia using the glidescope was not faster than with the flexible fiberoptic bronchoscope Intubations required < 1 min using either technique – a result that does not support the claim that fiberoptic intubation is a time-consuming technique, However, the time required surely depends upon operator experience.

As concern with the number of attempt the result of the present study showed high success rate with video laryngoscope from first attempt (100%) compared to fiberoptic laryngoscope (73.3%) from first attempts (23.3%) from second attempts and (3.3%) patients from the third attempt.

In line with this trial were Ruediger et al. [13] who studied endotracheal intubation using the C-MAC video laryngoscope or the Macintosh laryngoscope: A prospective, comparative study in the ICU. In this prospective study of 247 consecutive patients over a 2-year period, endotracheal intubation was associated with a high rate of difficult laryngeal visualization and a high number of repeated intubation attempts. The use of the C-MAC® video laryngoscope improved visualization of the glottis during airway management in the ICU. Patients with a potential difficult airway had a higher success rate for intubation at the first attempt when the video laryngoscope was used.

The use of C-MAC as a usual tool was limited as it is expensive device, and the use of fiberoptic bronchoscope needs more experience and training.

## Conclusion

In conclusion, C-MAC video laryngoscope had become a good alternative and was associated with better visualization of laryngeal structures in shorter time and less intubation attempts as compared to traditional flexible fiberoptic laryngoscopy.

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