v. 2, n. 45, 2022

International Journal of Health Science

EFFECTIVENESS OF LOW-COST ASSISTED OROTRACHEAL INTUBATION PROCEDURE

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Abstract: Introduction: Orotracheal intubation is one of the main life-saving procedures, which is an advanced life support care. In cases of a difficult airway, fiberoptic bronchoscopes are used to facilitate care. **Objective:** To compare the effectiveness of the procedure with the technique of assisted intubation with a low-cost video equipment compared to the conventional technique under direct vision. **Methods:** This is a prospective, comparative and quantitative study. Twenty-eight undergraduate medical students with previous theoretical and practical content on the subject were selected. A mini-course and a practical demonstration were presented, leveling the knowledge of the participants. Then, they were divided into two groups. The control group, which performed the procedure using the conventional technique, and the experimental group, which performed the technique with low-cost equipment. They were evaluated through total intubation time; number of attempts to success; number of hits and misses, and the satisfaction of the participants. **Results:** The intubation time to perform the procedure (p=0.082), as well as the number of attempts (p=0.631) and errors (p=0.773) showed no statistically significant differences between the two scenarios. However, in the evaluation of participants' satisfaction, when asked about better visualization of the oral cavity, the experimental group showed greater satisfaction (p= 0.003). **Conclusion:** From this, a statistically significant difference was identified regarding the satisfaction of the experimental group, mainly in relation to better visualization of the oral cavity.
Keywords: Intubation; Laryngoscopy ; Low cost technology.

INTRODUCTION

Orotracheal intubation (OTI) is one of the main potentially life-saving procedures when dealing with critically ill patients. Refers to an advanced life support procedure. In this sense, its main indication is in situations in which there is a loss in the maintenance of airway permeability.[1]

Thus, the conventional OTI procedure is performed with the aid of a laryngoscope, with a *Macintosh* or *Miller blade.* Before starting the procedure, the patient must be prepared, performing the hyperextension of the neck, in order to align the axes of the oral cavity, pharynx and larynx.[2]

Another important aspect to be analyzed is the appropriate size of the orotracheal tube, which must be chosen according to the patient's age, body constitution and type of surgery.[2]

Another alternative for performing OTI is the use of fiber optics, to assist in the procedure when a possible difficulty in the airway is anticipated. For example, in relation to difficulties with the uncooperative patient and the presence of secretions in the airway that may prevent the visualization of important factors.[2]

Flexible fiberoptic bronchoscope (FOI) intubation has become a difficult airway mainstay in awake, sedated, or anesthetized patients;[2] transmission of a visual image through an optical fiber was first reported in 1954.[3] This technology is based on very thin (8-25 mm diameter) and flexible glass fibers that are capable of transmitting light across their length. A fiber optic beam is attached to a light source providing illumination while the lens is at the tip of the eye's range providing an image to the wearer. A more recent evolution of the bronchoscope is the addition of a charge-coupled device camera, where a captured digital image is then electronically transmitted to an external monitor screen. [5]

The need for FUO can be anticipated based on a history of difficult intubation and several anatomical and anthropometric features that

can predict difficult laryngoscopy,[5] such as reduced neck mobility, inability to predict, oropharyngeal type classification, and obesity.[4]

Some studies show that the videolaryngoscopy technique has positive factors such as higher success rates and better visualization of the oral cavity. Thus, these advantages ensure greater patient safety. However, video laryngoscopes are expensive equipment and therefore inaccessible to a portion of medical centers and educational institutions. On the other hand, there is a scarcity of studies evaluating IOT using the video technique with low-cost equipment. Thus, this study was proposed with the objective of observing and comparing the technique of orotracheal intubation through a system composed of an inspection bronchoscope that transmits the image to a *smartphone,* being a low-cost system, with the conventional intubation technique. under direct view.

METHODS

This is a prospective, comparative and quantitative study, in which 28 students were selected from the 2nd to 6th years of undergraduate medicine at Faculdade de Medicina de Itajubá – FMIt, who had the theoretical and practical content of IOT and accepted participate and signed the Free and Informed Consent Term (ICF).

The minimum number of participants per group was calculated to detect a 20% increase in academic performance for unpaired quantitative variables.[4]

$$n = (S_a^2 + S_b^2) \cdot \left(\frac{Z_{\frac{\alpha}{2}} + Z_\beta}{d} \right)^2 .$$

Considering:

$Z_{\frac{\alpha}{2}}$ = 1.96;

Z_β=0.84;

d = 20% of the total time until intubation [5] = (0.2*47.7s)=9.54;

$S_a^2 + S_b^2$ = 111.4 (Obtained from the analysis of tests performed previously).

n=(1111.4)*((1.96+0.84)/9.54)^2=32* 0.87=9.59 – approximately 10 participants per group. It is worth mentioning that a significance level of 5% was considered, that is, a p-value lower than 0.05 shows that one orotracheal intubation technique is more efficient than the other.

The study took place at the Simulation Laboratory of Hospital de Clínicas de Itajubá, from October 2018 to February 2019 and involved the use of a head and neck dummy for airway management, endotracheal tube, *Macintosh laryngoscope,* batteries, low-cost video equipment (Figure 1.) acquired on an *online* shopping *site,* in June/2018, with an approximate cost of fifty reais and a *smartphone with Android* operating system, as a means of transmitting the image of the video equipment.

Figure 1. Low cost video shooting equipment.

Initially, a pilot study was carried out with four participants of the 5th grade, who were recruited through an instant messaging application and a day and time was previously agreed with the students. This activity aimed to evaluate factors such as time, the quality of the mini-course presentation, better ways to demonstrate

the practice, evaluation of instruments and the dynamics of the entire data collection activity. Subsequently, the students were divided into a control group (CG) (n=2) and an experimental group (EG) (n=2) using the coin toss technique, with "heads" for the CG and "tails" for the experimental group. The same steps for data collection were performed. At the end of the pilot, it was possible to make some adjustments and organizations for the data collection itself, such as, for example, the adequacy of the mini-course and demonstration times and a better organization of the application of the instruments.

Regarding the data collection itself, it was divided into three moments. In the first moment, the participants were recruited, who were invited to participate in the research, by the researchers themselves, through an instant messaging application. A day and time was previously agreed with all 28 students to carry out the first moment of the research, according to their availability. At that moment, a mini-course was presented (Appendix D) and a practical demonstration of the procedure. The mini-course consisted of a *Microsoft Power Point*® 2010 presentation on IOT, which addressed the following topics: its definitions, intubation indications, materials and care during the procedure, which had a total duration of 10 minutes. After the end of the theoretical class, a practical demonstration was performed (Figure 2) with the presentation of the conventional technique and the intubation technique assisted with low-cost equipment, by the researchers themselves, with an average duration of 10 minutes. At the end of the class, all students were able to ask questions and handle the equipment used during the procedure.

Figure 2. Demonstration of the IOT technique by the researchers.

Both the theoretical class and the practical demonstration aimed to level the knowledge of all participants. All students received the same guidance and performed the IOT procedure, but with different techniques.

In the second moment, immediately after the theoretical class and the practical demonstration, the participants were randomly divided into two groups, which was performed using the coin toss technique, thus forming two groups: a control group (CG) (n =14) and an experimental group (EG) (n=14). At that moment, before starting the collection, they answered the sociodemographic questionnaire, created specifically for the present research, by the researchers, composed of nine items that aimed at the sociodemographic characterization of the participants of the aforementioned study (Appendix A).

In the third and last moment of the research, each participant individually performed the IOT procedure, having up to five chances, in order to maintain a maximum number of attempts per participant. The CG students performed the intubation procedure using the conventional technique and the EG performed the technique using equipment costing BRL 50.00 (fifty reais), which had a camera for viewing the oral cavity. At that moment, as

the participants performed the technique, the following evaluation parameters were recorded: total intubation time; number of attempts to success; number of hits and misses (Appendix B). The time counting started when the participant finished assembling the laryngoscope, and ended with the first ventilation of the lungs. All participants were timed and the parameters noted by the researchers.

In addition to the above data, still in the third moment of collection, at the end of each procedure, the participants answered the satisfaction assessment questionnaire, which contained six questions that evaluated their perception of the technique performed, with regard to the ease of use. and safety in performing the procedure in both techniques (Appendix C). At the end of the interventions, the students who performed the technique through direct visualization were allowed to perform the procedure again using the equipment with a low-cost visualization camera, if they wished.

After collecting the data, they were tabulated in an electronic spreadsheet using the *Microsoft Excel* ® program, and later imported into the *Minitab® software version 17, to proceed with the statistical analysis in which the Student* t test was used for independent samples and analysis. description of the data.

The study was approved by the Research Ethics Committee of the Faculty of Medicine of Itajubá - FMIt (OPINION 2,900,979) and the students who agreed to participate in the research received the informed consent.

RESULTS

Thus, the study had the participation of 28 students, in which 14 (50%) students composed the CG and 14 (50%) students, the EG. The sociodemographic profile is presented in Table 1.

As for the age of the students, they were between 18 and 28 years old, with a mean age of 23 years with a standard deviation of 2.85 and a median of 22 years for the students of the CG and 23.21 with a standard deviation of 2. 29 and a median of 23 for EG students. Regarding marital status, there was a predominance of singles, 28 (100%).

When asked about the year of medical graduation they were in, 4 (14%) reported being in the second year, 11 (40%) in the third year, 4 (14%) in the fourth year, 7 (25%) in the fifth year and 2 (7%) in the sixth year.

Regarding these data, from the year of graduation of the study participants, no statistically significant differences were identified between the groups, evidencing their homogeneity.

Regarding the number of times they had already performed the OTI procedure, 18 (64%) reported having performed it only once, 3 (11%) two or three times, 2 (7%) reported 4 times and 1 (3.5%) five or seven times.

All 28 (100%) of the students reported having already performed the procedure on the head and neck dummy.

When asked if they had already performed the procedure on a real patient, only 3 (11%) said yes, 2 (14%) from the CG and 1 (7%) from the EG performed care in clinical practice with a patient.

All 28 (100%) of the students had the opportunity to perform the procedure only using the conventional technique of direct visualization, with no student who had already performed the procedure using the video technique.

It can be observed that the average time of the EG was 122 seconds and that of the CG 130.6 seconds, with a p-value of 0.082, which states that there is no statistically significant difference in time for performing the procedure in the two techniques tested, according to Table 2.

Study Variables		GC (n=14)		GE (n=14)		Total (n=28)	
		No.	Relative frequency (%)	No.	Relative frequency (%)	No.	Relative frequency (%)
Genre	Feminine	9	64%	9	64%	18	64%
	Male	5	36%	5	36%	10	36%
Marital status	Single	14	100%	14	100%	28	100%
Year in Graduation	2nd year	3	22%	1	7%	4	14%
	3rd year	4	28%	7	50%	11	40%
	4th year	1	7%	3	22%	4	14%
	5th year	5	36%	two	14%	7	25%
	6th year	1	7%	1	7%	two	7%
Number of times you have already performed the IOT procedure	1 time	7	50%	11	79%	18	64%
	2 times	two	14%	1	7%	3	11%
	Three times	3	22%	0	0%	3	11%
	4 times	1	two%	1	7%	two	7%
	5 times	0	0%	1	7%	1	3.5%
	7 times	1	7%	0	0	1	3.5%
Already performed the procedure on the head neck dummy	Yea	14	100%	14	100%	28	100%
Have performed the procedure on a patient	Yea	two	14%	1	7%	3	11%
	No	12	86%	13	93%	25	89%
Which technique have you already used to perform the procedure, whether on a dummy or patient	Conventional	14	100%	14	100%	28	100%

Table 1. Sociodemographic aspects of participants in the control group (CG) n=14, and experimental group (EG) n=14, Minas Gerais.

Source: From the authors.

groups	Number	Average time (sec)	PD	t-value	p-value [a]	GL
GE	14	122	113	-0.22	0.082	24
GC	14	130.6	92.3			

[a] *Student* t test

GL: Degree of Freedom

Table 2. Comparison between the average time to perform the procedure in the CG and EG, MG, n=28.

Source: From the authors.

Following the same procedure, the values related to the number of errors that occurred in the EG and CG during care delivery were performed. It can be seen in Table 3 that there is no difference between the number of errors in performing the procedure, as there is a p-value of 0.773.

Sample	No	average of errors	PD	t-value	p-value [a]	GL
GE	14	1.29	2.23	-0.29	0.773	24
GC	14	1.5	1.61			

[a] *Student* t test.

GL: Degree of Freedom.

Table 3. Comparison between the number of errors during the procedure in the GC (=14) and GE (N=14), MG.

Source: From the authors.

Similarly, the same procedure was adopted for the values of attempts to perform the procedure in the EG and CG. As observed in Table 4, these values do not differ statistically either, since the p-value is 0.631. Thus, it can be concluded that there is no statistically significant difference between the average number of attempts to perform care in the two groups.

When evaluating the students' satisfaction with the procedure performed in both techniques, it was possible to verify in Question 2, which mentions whether the technique provided greater visibility of the oral cavity, the EG's satisfaction (video technique) proved to be superior, with a statistically significant difference, with a p-value of 0.003, as shown in Table 5.

Sample	Number	Average	PD	t-value	p-value [a]	GL
GE	14	2.21	2.19	-0.49	0.631	24
GC	14	2.57	1.65			

[a] *Student* t test.

GL: Degree of Freedom.

Table 4. Comparison between attempts to perform the procedure in the CG and EG, MG, n=28.

Source: From the authors.

Questions	GC	GE	p-value [a]
	Mean (SD)	Mean (SD)	
1	6.64 (2.06)	6.85 (2.98)	0.827
two	**5.64 (2.13)**	**8.50 (2.37)**	**0.003**
3	6.07 (2.12)	7.71 (2.64)	0.082
4	5.71 (2.61)	7.14 (2.68)	0.166
5	8.00 (1.75)	7.71 (2.84)	0.751
6	8.35 (1.54)	8.35 (2.27)	1,000

[a] *Student* t test

Degree of freedom = 27 for all questions.

Table 5. Comparison between student satisfaction in performing the procedure in the GC and GE, MG, n=28.

Source: From the authors.

DISCUSSION

In the present study, one of the parameters found was the number of times the participants had performed the OTI procedure, and the result was that 64% of them had performed the procedure only once. It can be observed that this data coincides with a study carried out in a Hospital in the State of São Paulo, Brazil, with intensivists, which concluded that the knowledge and practice of OTI is still unsatisfactory.[1] Therefore, it is important to reinforce the study on the subject in medical training and the creation of a new teaching strategy to strengthen knowledge and avoid possible complications in the procedure. [1]

Furthermore, in the present study, only 3 students (11%) performed the procedure on the real patient. Although there is a case for the use of mannequins to improve medical education,[6] a study carried out in A Coruña, Spain, which evaluated videolaryngoscopy in simulators, reported limitations since the mannequin does not accurately reproduce the clinical conditions of intubation, which include the appearance of secretions or blood, being factors of difficulty in routine medical practice.[7]

As for the technique performed, all 24 participants (100%) had only used the conventional technique through the *Macintosh laryngoscope*, evidencing the work carried out with anesthesiologists in A Coruña, Spain, who, despite their area of expertise in medicine, had little familiarity with laryngoscopes. video devices such as *Airtraq ® NT, McGrath ® MAC.*[7] It must be considered that the use of videolaryngoscopy has the high cost of the devices as a limiting factor,[2] which makes it difficult to spread its use in teaching and medical routine.

However, in the present study, the use of low-cost equipment was proposed, so that this would not limit its use on a large scale for the Brazilian medical reality.

When evaluating the difference in intubation time between the CG and EG, it was possible to verify that there was no statistically significant difference between the two techniques. This parameter has divergences in the literature, as a study carried out in a hospital in Balneário Camboriú carried out a comparison of intubation in obese patients using the *Airtraq®* versus *Macintosh* and obtained as a result a statistically significant reduction in time and better visualization of the vocal cords in the group that underwent use of *Airtraq®.*[8]

In contradiction, a study carried out in a university hospital in Turkey with the objective of comparing the *King Vision* video laryngoscope (VLKV) versus the *Macintosh laryngoscope* found that experienced anesthesiologists can obtain similar rates of success in the first intubation attempt, and in trauma of the airways. airways with the VLKV and the *Macintosh laryngoscope.* In addition, VLKV was reported to be inferior to the *Macintosh laryngoscope* in terms of time to better glottic visibility and intubation time.[9]

As for the satisfaction of the students in the present study, there was statistical significance in the satisfaction of the EG when asked about the best visualization of the oral cavity. This fact corroborates with that presented in a study carried out in Spain, which made a comparison between *Airtraq® NT, McGrath® MAC* and *Macintosh* for nasotracheal intubation in easy and difficult airway simulation on simulators. The conclusion was that the *Airtraq* and *McGrath laryngoscopes* appeared more useful than the *Macintosh laryngoscope.* Both devices were associated with shorter intubation times, fewer attempts, and greater provider satisfaction, possibly because of better visualization and fewer additional maneuvers for better vision.[7]

In the present study, they did not find statistically significant differences in the comparison of trial and error rates between

CG and EG participants in performing the procedure. However, the study carried out in an anesthesiology service in Turkey by Kilicaslan *et al.* performed a review of intubation attempts and failures using a *Macintosh laryngoscope,* in which the *C-MAC video laryngoscope* was used as the primary rescue device. The result was successful intubation in 86% of cases on the first attempt and 14% of cases on the second attempt. Thus, it confirmed the efficiency and safety of the *C-MAC video laryngoscope* as a rescue device in unexpected unsuccessful intubations.[10]

Regarding the experience of the participants, EG was composed of a higher percentage (n=11) (79%) of students who had performed the procedure only once and, therefore, there may have been greater difficulty in handling the device due to the lack of familiarity with them. students with the procedure.

However, according to a study by Mathieson in a Canadian hospital, to have experience it is necessary to perform at least 30 intubation attempts with the *GlideScope®* (another type of videolaryngoscope), with a low correlation between experience in conventional laryngoscopy and success in using this video laryngoscope.[11] This shows that, for a successful videolaryngoscopy, experience with the equipment is necessary, regardless of experience with conventional laryngoscopy.

Regarding the limitations of the present study, the small sample size (n=28) can be highlighted, which made it difficult to obtain better precision in the data collected. Another aspect was the device tested in the EG, which showed resistance to being removed from the 8.0 endotracheal tube after intubation, which could hamper its use in clinical practice. In addition, there was a predominance of students from the initial years of graduation in the EG, which could have caused differences due to previous experience and knowledge.

A study was carried out in Singapore with a low-cost adapter capable of transmitting the image of the *Airtraq®* **laryngoscope** to a *smartphone.* The fact that the *Airtraq®* **laryngoscope** has the disadvantage of allowing only one person to view the image was mentioned. This way, the transmission to the *smartphone* provided the monitoring, instructions and support of the process by more team members and the study obtained a positive outcome in relation to these aspects.[12] Despite the low cost of the developed adapter, the *Airtraq®* **laryngoscope is** expensive and therefore not widely available.

Finally, it is important to emphasize that there is a scarcity of studies evaluating low-cost devices adapted to perform OTI. Most studies only evaluate the procedure with videolaryngoscopes, which, despite good results in the aforementioned studies, are expensive and may be inaccessible for expanded use in teaching, hospital and emergency institutions.

CONCLUSION

From the results found in this study, it can be seen that the low-cost video device did not provide a shorter intubation time. In addition, there was no decrease in the number of trials and errors. However, the same evidenced greater satisfaction of the participants of the EG, mainly regarding the better visualization of the oral cavity when compared to the previous experience of the participants.

Thus, the studies available in the literature currently only addressed video laryngoscopes, which are expensive and cannot be acquired by many health services.

From this perspective, the relevance of using the low-cost video device in IOT in teaching and clinical practice remains unknown until similar and more detailed studies are carried out in order to have a better understanding of the benefits and disadvantages of the method.

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APPENDIX A - SOCIODEMOGRAPHIC INSTRUMENT

This questionnaire aims to produce information about their sociodemographic profile and better understand their knowledge and experience regarding the orotracheal intubation procedure. In this sense, it is very important that you answer all these questions.

Student ID:

1 – Age in years:

2 - Gender: A ( ) Female B ( ) Male

3 – Marital status: A ( ) Single B ( ) Married C ( ) Lives with( ) Separated / widowed

4- Year of graduation: _____

5- Have you ever performed the IoT procedure?
A - Yes B ( ) No

6 – If yes, how many times? _____

7 – On a mannequin?
A - Yes B ( ) No

8 – In a real patient?
A - Yes B ( ) No

9 – What technique did you use?
A ( ) Conventional under direct vision. B ( ) Equipment with video

APPENDIX B - IOT TECHNIQUE OBSERVATION INSTRUMENT

Participant ID: _____
Date:____/_____/_____
Technique performed: _____

time	
hit rate	
error rate	
number of attempts	

APPENDIX C - STUDENT SATISFACTION ASSESSMENT INSTRUMENT

Note: Grade 1 is the lowest grade and refers to total dissatisfaction, and grade 10 is the highest grade and refers to fully satisfied.

Participant ID: _____

Date:_____/_____/_____

Technique performed: _____

1. The technique made it easier for me to perform the orotracheal intubation procedure.
1 ( ); 2 ( ); 3 ( ); 4 ( ); 5 ( ); 6 ( ); 7 ( ); 8 ( ); 9 ( ); 10 ( );

2. The technique provided me with greater visibility of the oral cavity.
1( ); 2 ( ); 3 ( ); 4 ( ); 5 ( ); 6 ( ); 7 ( ); 8 ( ); 9 ( ); 10 ( );

3. The technique provided me with greater security to perform the procedure.
1 ( ); 2 ( ); 3 ( ); 4 ( ); 5 ( ); 6 ( ); 7 ( ); 8 ( ); 9 ( ); 10 ( );

4. The technique provided me with greater speed to perform the procedure
1 ( ); 2 ( ); 3 ( ); 4 ( ); 5 ( ); 6 ( ); 7 ( ); 8 ( ); 9 ( ); 10 ( );

5. I would adopt this technique for use in my clinical practice.
1 ( ); 2 ( ); 3 ( ); 4 ( ); 5 ( ); 6 ( ); 7 ( ); 8 ( ); 9 ( ); 10 ( );

6. I would recommend the adoption of the technique for teaching in medical schools.
1 ( ); 2 ( ); 3 ( ); 4 ( ); 5 ( ); 6 ( ); 7 ( ); 8 ( ); 9 ( ); 10 ( );