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Original Article

Impact of Universal Use of the McGrath Videolaryngoscope as a Device for All Intubations in the Cardiac Operating Room. A Prospective Before-After VIDEOLAR-CAR Study

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Objective: Tracheal intubation in cardiac surgery patients has a higher incidence of difficult laryngoscopic views compared with patients undergoing other types of surgery. The authors hypothesized that using the McGrath Mac videolaryngoscope as the first intubation option for cardiac surgery patients improves the percentage of patients with "easy intubation" compared with using a direct Macintosh laryngoscope.
Design: A prospective, observational, before-after study.
Setting: At a tertiary-care hospital.
Participants: One thousand one hundred nine patients undergoing cardiac surgery.
Intervention: Consecutive patients undergoing cardiac surgery were intubated using, as the first option, a Macintosh laryngoscope (preinterventional phase) or a McGrath Mac videolaryngoscope (interventional phase).
Measurements and Main Results: The main objective was to assess whether the use of the McGrath videolaryngoscope, as the first intubation option, improves the percentage of patients with "easy intubation," defined as successful intubation on the first attempt, modified Cormack-Lehane grades of I or IIa, and the absence of the need for adjuvant airway devices. A total of 1,109 patients were included, 801 in the noninterventional phase and 308 in the interventional phase. The incidence of "easy intubation" was 93% in the interventional phase versus 78% in the noninterventional phase ($p < 0.001$). First-success-rate intubation was higher in the interventional phase (304/308; 98.7%) compared with the noninterventional phase (754/801, 94.1%; $p = 0.005$). Intubation in the interventional phase showed decreases in the incidence of difficult laryngoscopy (12/308 [3.9%] *v* 157/801 [19.6%]; $p < 0.001$), as well as moderate or difficult intubation (5/308 [1.6%] *v* 57/801 [7.1%]; $p < 0.001$).
Conclusions: The use of the McGrath videolaryngoscope as the first intubation option for tracheal intubation in cardiac surgery improves the percentage of patients with "easy" intubation," increasing glottic view and first-success-rate intubation and decreasing the incidence of moderate or difficult intubation.

The study is an investigator-initiated trial. Support was provided solely from institutional, departmental, or both sources.
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TRACHEAL INTUBATION is a commonly performed procedure both in the operating room for patients requiring general anesthesia during surgical procedures and in critical care settings.[1-3] The usual intubation technique in the operating room involves direct laryngoscopy using a standard Macintosh laryngoscope. However, although the incidence of difficult intubation conditions in the operating room is relatively low, several studies have demonstrated that patients scheduled for cardiac surgery have a higher risk of a poor direct laryngoscopic view compared with those scheduled for general surgery.[4-6]

To facilitate tracheal intubation, numerous authors recommended the use of videolaryngoscopes. Randomized studies have demonstrated that videolaryngoscopes provide an improved view of the laryngeal structures, leading to a reduction in the number of intubation attempts and associated complications during tracheal intubation, as well as benefits for patients with a difficult airway.[7-13] Recently, several authors have proposed the universal adoption of videolaryngoscopy for all intubations in anesthesia and intensive care departments, recommending it as the first intubation option, regardless of whether the patient presents predictors of a difficult airway. The goal is to enhance the laryngoscopic view of patients undergoing intubation, thereby reducing the difficulty of the procedure and the incidence of complications.[14-20]

Consequently, the authors decided to incorporate a McGrath videolaryngoscope into each of the authors' 2 cardiac surgery operating rooms at the Hospital. The aim of this study was to assess if using the McGrath videolaryngoscope as the first intubation option for all patients undergoing cardiac surgical procedures enhances the percentage of patients with "easy intubation" (defined as successful intubation on the first attempt, modified Cormack-Lehane grades of I or IIa, and the absence of the need for additional airway devices during intubation) compared with the conventional Macintosh laryngoscope. The authors hypothesized that using the McGrath videolaryngoscope as the first intubation option would increase the proportion of patients with easy intubation while reducing complications associated with the intubation process.

Material and Methods

The authors evaluated the implementation of a McGrath Mac videolaryngoscope as the first intubation option for all patients requiring intubation for cardiac surgical procedures in a prospective before-after study conducted at a University Clinical Hospital. The authors included all adult patients consecutively intubated for elective or urgent procedures between January 1, 2020, and December 23, 2023. Exclusion criteria were pregnancy, age younger than 18 years, and patients intubated using a bronchoscope. All intubations were conducted by attending anesthesiologists or anesthesia residents under the supervision of attending anesthesiologists. Each of them had training and experience in the use of both direct laryngoscopes and indirect videolaryngoscopes. The study was approved by the hospital's institutional review board as a quality improvement initiative (September 2019), and by the ethics committee of Galicia (Santiago-Lugo, code No. 2023/116). Due to the observational, noninterventional, and noninvasive design of this study, the requirement for written consent was waived.

Two phases were conducted, a noninterventional phase and an interventional phase, separated by a period of training. During the noninterventional phase (36 months, January 2020 to December 2022), anesthesiologists performed all tracheal intubations in the operating room following the standard of care, using the standard Macintosh direct laryngoscope as the first intubation option. Anesthesiologists had access to a videolaryngoscope or fiberoptic bronchoscope, which were used as secondary options in cases of difficult intubation with direct laryngoscopy or as the first intubation option for suspected difficult airways. The reasons for needing an alternative device instead of the standard Macintosh direct laryngoscope were recorded. During the training period (1 month, January 2023), the 2 cardiac operating rooms were equipped with the McGrath Mac videolaryngoscope (McGrath Mac, Medtronic B.V., Heerlen, The Netherlands), and all anesthesiologists received formal education and practical training using mannequins. Anesthesiologists were required to use the videolaryngoscope as the first intubation option in at least 50% of the intubations performed during this period. In the interventional phase (11 months, February 2023 to December 2023), anesthesiologists performed all tracheal intubations using the McGrath Mac videolaryngoscope as the first intubation option. Anesthesiologists had access to a standard Macintosh direct laryngoscope or a fiberoptic bronchoscope, which could be used when deemed necessary. The reasons for using an alternative device instead of the videolaryngoscope were recorded.

In the 2 phases, patients were monitored for electrocardiogram, oxygen saturation, and arterial blood pressure. Preoxygenation, anesthesia technique, drugs (sedatives and neuromuscular blocking agents), size of blades, and use of adjuvant airway devices were at the discretion of the attending anesthesiologists. After each tracheal intubation, the operator completed a data collection form, which included the following information: patient demographics, Mallampati classification score (I-IV), type of cardiac surgery, sedative agent, paralytic agent, the best modified Cormack–Lehane glottic view, number of attempts of tracheal intubation, the need of adjuvant airway devices during intubation (such as gum elastic bougie, videolaryngoscope, or others), the operator-reported difficulty of intubation, and complications during tracheal intubation.

The primary outcome was to compare in the 2 phases (noninterventional versus interventional) the percentage of patients with "easy intubation," defined as intubation on the first attempt, modified Cormack-Lehane grades of I or IIa, and the absence of the need for adjuvant airway devices during intubation. Secondary outcomes included the incidence of difficult laryngoscopy (modified Cormack-Lehane glottic view IIb, III, or IV), technical difficulty of intubation (number of intubation attempts, operator-reported difficulty of intubation and the need for adjuvant airway devices during intubation), and the incidence of complications during the procedure (hypoxia, hypotension, esophageal intubation, and others).

Intubation on the first attempt was defined as the successful placement of an endotracheal tube into the trachea after the insertion of a laryngoscope into the oral cavity without removing the laryngoscope from the mouth. Adjustment of the laryngoscopic blade counted as a single attempt. The laryngoscopy view was graded according to the modified classification of Cormack and Lehane: Grade I, equivalent to a full view of the glottis; Grade IIa, partial view of the glottis; Grade IIb, arytenoid or posterior part of the vocal cords only just visible; Grade III, only epiglottis visible; and Grade IV, neither glottis nor epiglottis visible. A grade IIb, III, or IV laryngoscopy was considered difficult. Operator-reported difficulties of intubation were classified as no difficulty, mild, moderate, or severe. Complications during intubation included esophageal intubation, arrhythmia, hypoxemia (oxygen saturation <90%), hypotension (systolic blood pressure lower than 80 mmHg), and severe hypotension (systolic blood pressure lower than 65 mmHg) during or within 15 minutes after intubation.

Statistical Analysis

In this study, the authors aimed to detect a difference of at least 5% between the percentage of patients with "easy intubation" in the noninterventional phase (90%) and in the interventional phase (95%).[14] Assuming a 95% confidence level and 80% statistical power, the authors opted for a 3:1 patient ratio from the noninterventional phase to the interventional phase. The authors planned to analyze the results using the Chi-square test. The necessary sample size was estimated to be at least 783 patients for the noninterventional phase and 261 patients for the interventional phase. In the final analysis, 801 patients were recruited into the noninterventional phase and 301 patients into the interventional phase.

All continuous data are presented as mean with SD, and categorical data are expressed as numbers (%). Comparisons between the noninterventional and the interventional phases were conducted using the Chi-square test for categorical data. For continuous data, the choice between the Student's t-test or Mann–Witney test depended on the distribution, as determined by the Shapiro–Will test for normality. The Student's t-test was applied to data with normal distribution, and the Mann–Witney test was used for data that did not follow a normal distribution.

Results

During the study period, a total of 1,108 patients were tracheally intubated in the operating room for cardiac surgical intervention. Of these, 801 patients were intubated during the noninterventional phase and 308 patients during the interventional phase. Ten patients of the noninterventional phase were excluded from the analysis because they were intubated with a bronchoscope. Table 1 shows patient characteristics, medications, and devices used for intubation in the 2 phases studied. Both groups were comparable. Macintosh laryngoscopy was used in 88.8% (711/801) of intubations in the noninterventional phase, and McGrath videolaryngoscopy in 94.8% (292/308) of intubations in the interventional phase.

Tracheal intubation during the interventional phase was associated with a higher incidence of "easy intubation" (287/308, [93.2%]) compared with tracheal intubation in the noninterventional phase (627/801, [78.3%]; $p < 0.001$). Glottic visualization was better in the interventional phase compared with the noninterventional phase (Table 2, $p < 0.001$). The incidence of difficult laryngoscopy was 12 out of 308 (3.9%) in the interventional phase compared with 157 out of 801 (19.6%) in the noninterventional phase ($p < 0.001$). The proportion of first-success-rate intubation was 98.7% (304/308) in the interventional phase, higher than in the noninterventional phase (754/801, 94.1%; $p = 0.005$). The incidences of moderate and difficult intubation reportedly decreased in the interventional phase (5/308 [1.6%]), compared with the noninterventional phase (57/801 [7.1%]). The need for adjuvant airway devices during intubation was reduced in the interventional phase (16/308 [5.2%]) compared with the noninterventional phase (118/801, [14.7], $p < 0.001$).

There was no significant difference between the 2 phases in the incidence of complications (Table 2).

Discussion

In the present study, the authors compared the McGrath videolaryngoscope with the standard Macintosh laryngoscope as the first intubation option in consecutive patients requiring intubation for cardiac surgery at their Hospital. The authors observed that tracheal intubations performed with the McGrath videolaryngoscope were associated with a higher incidence of "easy intubation" compared with the Macintosh laryngoscope. Additionally, the use of the McGrath videolaryngoscope was associated with a greater rate of successful intubation on the first attempt, improved glottic views, reduced need for supplementary airway devices during intubation, and decreased operator-reported difficulty compared with the standard Macintosh laryngoscope.

Recently, several authors have proposed the use of a videolaryngoscope as the first intubation option for all intubations, regardless of whether the patient has predictors of a difficult airway. The goal is to improve the laryngoscopic view during intubation, thereby reducing intubation difficulty and the occurrence of complications.[14-23] In a multicenter randomized study, Kriege et al. compared the McGrath Mac videolaryngoscope with a conventional laryngoscope in 2,092 adult patients without predicted difficult airways requiring tracheal intubation for elective surgery.[21] They observed a higher first-attempt intubation success rate with the McGrath videolaryngoscope (94%) compared with direct laryngoscopy (82%). In a similar multicenter randomized study involving 564 pediatric patients without airway abnormalities that would complicate intubation, investigators compared a standard blade videolaryngoscope with direct laryngoscopy.[22] They observed an improved first-attempt success rate (93% *v* 88%), a decrease in severe complications (2% *v* 5%), and a reduction in esophageal intubations (<1% *v* 3%) with the standard blade

Table 1
Specific Variables Recorded in Intubated Patients

Characteristic	All Patients (N = 1,109)	Noninterventional Phase (n = 801)	Interventional Phase (n = 308)	p Value
Demographics				
Age, mean (SD), y	68.3 (10.5)	68.6 (10.8)	67.6 (9.5)	0.159
Male sex − No. (%)	763 (68.9)	543 (68.0)	220 (71.4)	0.264
Weight, mean (SD), Kg	77.5 (14.2)	77.7 (14.2)	76.9 (14.2)	0.358
Height, mean (SD)	164.2 (9.5)	164.3 (9.6)	163.9 (9.2)	0.516
BMI, mean (SD)*	28.7 (4.5)	28.8 (4.5)	28.6 (4.5)	0.521
Surgery indication, No. (%)				0.041
Coronary procedure	257 (23.2)	172 (21.5)	85 (27.7)	
Valve replacement	556 (50.2)	410 (51.2)	146 (47.6)	
Coronary procedure + valve replacement	125 (11.3)	93 (11.6)	32 (10.4)	
Aortic root replacement	113 (10.2)	90 (11.2)	23 (7.5)	
Other	57 (5.1)	36 (4.5)	21 (6.8)	
Urgency of surgery procedure, No. (%)				0.297
Urgent	35 (3.2)	28 (3.5)	7 (2.3)	
Elective	1074 (96.8)	773 (96.5)	301 (97.7)	
Mallampati score, No. (%)				0.011
I	242 (21.8)	189 (23.6)	53 (17.2)	
II	554 (50.0)	403 (50.3)	151 (49.0)	
III	287 (25.9)	195 (24.3)	92 (29.9)	
IV	26 (2.3)	14 (1.7)	12 (3.9)	
First device used for intubation, No. (%)				< 0.001
Macintosh laryngoscope	711 (64.1)	711 (88.8)	0 (0.0)	
McGrath Mac videolaryngoscope	292 (26.3)	0 (0.0)	292 (94.8)	
McGrath Xblade videolaryngoscope	12 (1.1)	0 (0.0)	12 (3.9)	
C-MAC D Blade videolaryngoscope	77 (6.9)	73 (9.1)	4 (1.3)	
Airtraq	17 (1.5)	17 (2.1)	0 (0.0)	
Medications used for intubation, No. (%)				< 0.001
Propofol	802 (72.3)	544 (67.9)	258 (83.8)	
Etomidate	142 (12.8)	126 (15.7)	16 (5.2)	
Sevoflurane	165 (14.9)	131 (16.4)	34 (11.0)	
Other	-			
Neuromuscular blocking drugs, No. (%)				< 0.001
Succinylcholine	99 (8.9)	92 (11.5)	7 (2.3)	
Rocuronium	975 (87.9)	675 (84.3)	300 (97.4)	
Cisatracurium	32 (2.9)	31 (3.9)	1 (0.3)	
No neuromuscular blocking drugs used	3 (0.3)	3 (0.4)	0 (0.0)	

NOTE: Data presented as number (%) or mean (SD).
Abbreviations: BMI, body mass index.
* Calculated as weight in kilograms divided by height in meters squared.

videolaryngoscope. A recent Cochrane review, which included 222 studies with 26,149 patients, compared videolaryngoscopy with direct laryngoscopy for adult patients requiring tracheal intubation, concluding that videolaryngoscopes were associated with improved glottic views, fewer failed attempts, and increased rates of successful intubation on the first attempt.[11]

Although evidence from these studies[11,21-22] has demonstrated the advantages of videolaryngoscopy over direct laryngoscopy, the universal adoption of videolaryngoscopes for all intubations in operating rooms remains limited to only a few hospitals. Cook et al.[15] were pioneers in implementing routine videolaryngoscope use in their anesthesia and intensive care departments, which operators perceived as positively impacting patient safety, team dynamics, human factors, quality of care, and training quality. In a recent before-after observational study, De Jong et al.[14] demonstrated that having a videolaryngoscope available in all operating rooms and routinely using it for first-attempt intubation increased the proportion of "easy airway management" (from 94.3% to 98.7%) and improved laryngoscopic vision, decreased the need for rescue techniques, and reduced the operator-reported difficulty of intubation compared with the standard Macintosh direct laryngoscope. However, the adoption of videolaryngoscopy was only partial (66%), and important outcomes, such as the rate of successful intubation on the first attempt, were not included. In this study, the authors opted for the universal use of the videolaryngoscope for all intubations in the cardiac operating room because patients scheduled for cardiac surgery are at a higher risk of a poor direct laryngoscopic view compared with those scheduled for general surgery.[4-6]

In the present study, the primary outcome was to compare "easy intubation," defined as successful intubation on the first attempt, modified Cormack-Lehane grades of I or IIa, and the absence of the need for additional airway devices during intubation. Although De Jong et al.[14] did not include "intubation on the first attempt" as one of their outcomes, the authors

Table 2
Characteristics of the Intubation Procedure

Outcome	Noninterventional Phase (n = 801)	Interventional Phase (n = 308)	p Value
Primary outcome			
Patients with "easy intubation"	627 (78.3)	287 (93.2)	< 0.001
Secondary outcomes			
No. of insert attempts, No. (%)			0.005
1	754 (94.1)	304 (98.7)	
2	43 (5.4)	4 (1.3)	
3 or more	4 (0.5)	0 (0.0)	
Modified Cormack-Lehane grade, No. (%)			< 0.001
I, Full view of the glottis	525 (65.5)	252 (81.8)	
IIa, Partial view of the glottis	119 (14.9)	44 (14.3)	
IIb, Posterior part of the vocal cords only just visible	97 (12.1)	10 (3.2)	
III, Only epiglottis visible	58 (7.2)	2 (0.6)	
IV, Neither glottis nor epiglottis visible	2 (0.2)	0 (0.0)	
Difficult laryngoscopy, Modified C-L grade IIb-III-IV	157 (19.6)	12 (3.9)	< 0.001
Need of adjuvant airway device for intubation, No. (%)	118 (14.7)	16 (5.2)	< 0.001
Gun elastic bougie	98 (83.1)	15 (93.8)	
C-MAC D Blade videolaryngoscope with bougie	13 (11.0)	1 (6.3)	
C-MAC D Blade videolaryngoscope with stylet	3 (2.5)	0 (0.0)	
C-MAC + bougie + fiberscope	1 (0.8)	0 (0.0)	
Airtraq	1 (0.8)	0 (0.0)	
Airtraq with bougie	2 (1.7)	0 (0.0)	
Difficulty of intubation			< 0.001
No difficulty	587 (73.3)	279 (90.6)	
Mild	157 (19.6)	24 (7.8)	
Moderate	54 (6.7)	5 (1.6)	
Severe	3 (0.4)	0 (0.0)	
Complications, No. (%)	186 (76.8)	244 (79.2)	0.383
Hypotension <80 mmHg	168 (21.0)	63 (20.5)	0.849
Hypotension <65 mmHg	42 (5.2)	21 (6.8)	0.310
Hypoxemia <90%	6 (0.7)	1 (0.3)	0.424
Esophageal intubation	10 (1.2)	0 (0.0)	0.049
Arrhythmia	17 (2.1)	2 (0.6)	0.090

Abbreviations: SD, standard deviation; %, percentage; No, number.

decided to incorporate it into their study because it provides an objective and clinically relevant measure of laryngoscope performance.[21,24] The need for more than one intubation attempt has been associated with a higher incidence of complications.[25,26] To assess glottic visualization, the authors used the modified Cormack-Lehane classification with 5 grades. In this classification, grade II is further divided into IIA (partial view of the vocal cords) and IIB (only the arytenoids and epiglottis are seen). The authors used this modified classification because it is easy to measure and provides more information than the original.[27] Several studies have shown that grade IIb is associated with a significantly higher incidence of difficult intubation compared with grade IIa.[2,27-28] In the authors' institution, anesthesiologists know and routinely use this classification associated with documenting relevant information such as the number of intubation attempts, the need for adjuvant airway devices for intubation, or operator-reported difficulty.[29-30]

There is a wide variety of different videolaryngoscopes available, with different types of blades, such as Macintosh-type blades, hyperangulated blades, or channeled blades.[11] The McGrath Mac videolaryngoscope was chosen for the interventional phase of this study due to its portability, relatively inexpensive cost, and similarity to the Macintosh laryngoscope blade. It can function as both a direct and indirect laryngoscope, and offers the possibility to change the blade easily to a hyperangulated X3 blade to facilitate intubation in difficult airway scenarios. Comparative studies have demonstrated its superiority over other videolaryngoscopes with similar characteristics, requiring fewer hyperangulated blades and providing greater ease of use.[18] Additionally, the McGrath Mac video laryngoscope was the device selected for comparison with the Macintosh direct laryngoscope in 2 recent studies conducted in surgical patients.[14,21]

Study Limitations

First, this was an observational, nonblinded study. However, despite the lack of randomization, the data were prospectively recorded, and the 2 groups were comparable. Observational studies with a before-after analysis offer the advantage of closely resembling real-life conditions within a health system and do not adhere strictly to the protocols of randomized studies.[14,20] Second, the study was conducted in the cardiac operating room of a single center, and this should be taken into consideration when extrapolating the results to other clinical

settings. A multicenter study covering different types of surgery has been proposed to validate the findings of this study (Clinical trials gov: NCT 05850260). Third, all intubations in this study were performed by attending anesthesiologists or anesthesia residents with more than 2 years of intraoperative experience. All of them had experience in the management of tracheal intubation, both with direct laryngoscopy and with the McGrath Mac videolaryngoscope. It is unclear if similar outcomes would be achieved with operators with different skill levels or without the supervision of an attending anesthesiologist. Fourth, the videolaryngoscope used was the McGrath Mac videolaryngoscope. There are different types of videolaryngoscopes, including channeled or nonchanneled devices, different blade types (Macintosh, hyperangulated), and screens with different sizes or locations. It remains uncertain if comparable results would be obtained using a different videolaryngoscope from that used in the present study.

Conclusions

In conclusion, for cardiac surgery patients requiring tracheal intubation, using the McGrath videolaryngoscope improved "easy intubation" rates, increased first-attempt success, provided better glottic views, reduced the need for additional airway devices, and lowered operator-reported difficulty compared with the standard Macintosh laryngoscope.

Declaration of competing interest

None.

CRediT authorship contribution statement

Manuel Taboada: Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Ana Estany-Gestal:** Methodology, Investigation, Formal analysis, Data curation. **María Rial:** Writing – review & editing, Supervision, Investigation. **Agustín Cariñena:** Writing – review & editing, Supervision, Investigation. **Adrián Martínez:** Writing – review & editing, Supervision, Investigation. **Salomé Selas:** Writing – review & editing, Supervision, Investigation. **María Eiras:** Writing – review & editing, Supervision, Investigation. **Sonia Veiras:** Writing – review & editing, Supervision, Investigation. **Esteban Ferreiroa:** Writing – review & editing, Supervision, Investigation. **Borja Cardalda:** Writing – review & editing, Supervision, Investigation. **Carmen López:** Writing – review & editing, Supervision, Investigation. **Andrea Calvo:** Writing – review & editing, Supervision, Investigation. **Jorge Fernández:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Julián Álvarez:** Writing – review & editing, Methodology, Investigation, Conceptualization. **Jorge Miguel Alcántara:** Writing – review & editing, Investigation, Formal analysis, Data curation. **Teresa Seoane-Pillado:** Writing – review & editing, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

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