Original article

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COMPARISON OF THE McGRATH VIDEOLARYNGOSCOPE AND THE MACINTOSH LARYNGOSCOPE FOR ENDOTRACHEAL INTUBATION IN SURGICAL PATIENTS WITHOUT PREDICTORS OF A DIFFICULT AIRWAY

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The study analyzed and compared the effectiveness of the McGrath MAC videolaryngoscope and the Macintosh laryngoscope for endotracheal intubation in patients without predictors of a difficult airway undergoing elective surgery.

The study included 60 patients randomly divided into two groups, each consisting of 30 patients: the McGrath (MG) and Macintosh (MAC). The primary objective of our study was to determine and compare the duration of intubation and laryngeal view according to Cormack–Lehane grade (CL). Secondary objectives were the comparison of duration of laryngoscopy, first attempt intubation success rate, number of intubation attempts, adverse events (mucosal trauma, desaturation SpO2 < 90%, dental damage), number of failed attempts, Backward Upward Rightward Pressure (BURP) maneuver and the use of bougie.

The results of the study showed that the CL grade I was significantly more frequent in the MG group compared to the MAC group (80% vs. 40%, p = 0.004). Duration of laryngoscopy was significantly shorter in the MG group in comparison to the MAC group (7.87 ± 1.70 vs. 6.00 ± 0.95, p < 0.001). However, there was no statistically significant difference between the groups in duration of intubation (26.03 ± 1.32 s vs. 28.30 ± 5.66 s in the MG and MAC, respectively, p = 0.057). Successful intubation on the first attempt was in 96.7% of patients in the MG group and in 86.7% of patients in the MAC group (p = 0.350). During laryngoscopy the BURP the maneuver was significantly more frequent in the MAC group (p = 0.024). Regarding complications, there were no significant differences between the groups.

In patients without predictors of a difficult airway undergoing elective surgery, the McGrath significantly improves glottis view, reduces the duration of laryngoscopy, and the requirement for the BURP maneuver. Regarding intubation time and the rate of successful intubation on the first attempt, the Macintosh and McGrath are comparable.

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Key words: *McGrath, Macintosh, videolaryngoscopy, elective surgery*

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Introduction

Direct laryngoscopy is considered the gold standard in airway management (1). From its introduction, the Macintosh laryngoscope is the most commonly used device for direct laryngoscopy (2). For optimal glottis visualization using Macintosh, it is essential to align the oral, pharyngeal, and laryngeal axes (3). In cases when it is impossible, anesthesiologists face difficult laryngoscopy and intubation. Failed intubation is associated with a high rate of morbidity and mortality. In patients with a difficult airway, repeated attempts of laryngoscopy and intubation lead to swelling, bleeding, or tissue trauma, which additionally makes each subsequent attempt of endotracheal tube (ETT) placement more difficult.

Videolaryngoscopes (VLs) are designed to overcome these three-axes problems, as achieving an optimal glottis view during video laryngoscopy does not require the alignment of oral, pharyngeal, and laryngeal axes. They enable an anesthesiologist's indirect view of the glottis using a camera on the distal end of the blade, whereas the picture is seen on the LCD screen. Videolaryngoscopes are used in different clinical scenarios. Numerous studies have analyzed the performances of various types of VLs in emergency, trauma, difficult airway, and ICU settings, and have shown that video laryngoscopy

improves intubation success (4-6). Among VLs, there are differences in the design, and therefore, in their performance and outcome.

The McGrath videolaryngoscope is a small portable device with two types of blades: hyperangulated—McGrath X-blade and a Macintosh–type blade (C-MAC blade). Most of the studies that analyzed the efficacy of McGrath in difficult airway showed a higher success rate of tracheal intubation (7–9). In clinical practice, VLs are mostly used in the management of difficult airways and are recommended as the first rescue device in difficult intubation (10). Based on previous data of its efficacy in a difficult airway, the question arises whether the use of McGrath could further improve airway management not only in difficult but also in normal airways (11).

The study compared the effectiveness of the McGrath MAC videolaryngoscope and the Macintosh laryngoscope for endotracheal intubation in patients without predictors of difficult airways undergoing elective surgery.

Materials and Methods

Our randomized controlled study included 60 patients of both sexes, scheduled for elective surgical procedures under general endotracheal anesthesia. Inclusion criteria were age over 18 years, the American Society of Anesthesiologists (ASA) I–III grade, BMI ≤ 30 kg/m^2, elective surgery. Exclusion criteria were pregnant women, ASA IV, BMI > 30 kg/m^2, patients with difficult or anticipated difficult airway (at least one of the criteria: Mallampati classes III and IV, restrected neck movements, interincisor gap < 3 cm, thyreomental distance < 6.5 cm, sternomental distance < 12.5 cm, already known history of difficult intubation), double-lumen tube intubation, neurosurgical procedures.

After institutional ethics committee approval, the research was conducted at the Clinic of Anesthesia and Intensive Therapy, University Clinical Center Niš, in the period from January to February 2025. Written informed consent was obtained from all patients before recruitment. Patients were randomly divided into two groups with a randomization ratio of 1:1. The MAC group included patients intubated using the Macintosh laryngoscope (blade size 4), while patients in the MG group were intubated using the McGrath MAC videolaryngoscope (McGrath® MAC, Aircraft Medical Ltd., 10 Edinburgh, United Kingdom; McGrath MAC blade size 4). Intubations were performed by two anesthesiologists with more than 200 intubations using Macintosh and 50 intubations using McGrath MAC. All patients underwent a preanesthetic check before surgery. Standard monitoring was used intraoperatively (ECG, SpO2, heart rate, and noninvasive blood pressure). Preoxygenation was performed by oxygen mask at a flow of 5 l/min. General anesthesia was induced with midazolam 0.05 mg/kg IV, fentanyl 3μg/kg IV, and propofol 2 mg/kg IV. After checking mask ventilation, rocuronium-bromide was given at a dose of 0.6 mg/kg IV, and after achieving muscle relaxation, intubation was performed using either the Macintosh laryngoscope or the McGrath videolaryngoscope. After performing laryngoscopy anesthesiologist graded the glottis view according to Cormack–Lehane grade (CL) (12).An anti-fog solution was used for the camera before intubation with the McGrath. The choice of the size of ETT was at the discretion of the anesthesiologist. The malleable ETT stylet was used during intubation in both groups. Duration of laryngoscopy was defined as the time from inserting the blade between the teeth until optimal glottis visualization. Duration of intubation was defined as the time from inserting the blade between the teeth until confirmation of the correct ETT placement by two capnographic curves and chest auscultation. First attempt intubation success was defined as correct placement of ETT the on first attempt, but without removing the laryngoscope from oral cavity. Each removal of the blade out of oral cavity was considered as another attempt of intubation. In case of two consecutive unsuccessful intubation attempts, the patient was ventilated by mask, and further, it was proceeded according to the protocol of the University Clinical Center, Clinical of Anesthesiology Reanimatology and Intersive Therapy. Time was measured by stopwatch and was recorded by the resident who was blinded to the study protocol. If intubation couldn't be performed after the second attempt, it was considered a failed intubation. Additional maneuvers during intubation, such as applying Backward, Upward, Rightward Pressure (BURP) manuver on the larynx and the use of a bougie were recorded. Also, adverse events including desaturation (SpO2 < 90%), mucosal trauma, bleeding, dental damage, and esophageal intubation were recorded.

The primary objective of our study was to compare the duration of intubation and laryngeal view by Cormack–Lehane grade. Secondary outcomes included first-attempt intubation success rate, duration of laryngoscopy, number of intubation attempts, adverse events (mucosal trauma, desaturation SpO2 < 90%, dental damage), number of failed attempts, BURP maneuver, and the use of bougie.

Statistical analysis of data was conducted using the Statistical Package for the Social Sciences version 16 program (SPSS Inc., Chicago, IL, USA). Data are presented as arithmetic mean ± SD, as well as absolute and relative numbers. Comparison of variables was performed using the t-test or Mann–Whitney test, depending on data distribution normality. Categorical variables comparison was performed using the Chi-Square test and Fisher's Exoct test. A statistical difference was considered significant at $p < 0.05$.

Results

The study included 60 patients divided into two groups, each consisting of 30 patients. There was no statistically significant difference in age, gender, ASA classification, BMI, and Mallampati score between the groups (Table 1).

Duration of laryngoscopy was significantly shorter in the MG group compared with the MAC group (7.87 ± 1.70 vs. 6.00 ± 0.95, p < 0.001). During laryngoscopy, CL grade I was significantly more frequent in the MG group compared to the MAC group (80% vs. 40%, p = 0.004) (Figure 1).

Table 1. Patients' characteristics

Characteristics	MAC group (n = 30)	MG group (n = 30)	p-value
Age (mean ± SD) years	54.93 ± 11.60	53.80 ± 10.68	0.695[2]
Male n (%) Female n (%)	14 (46.7) 16 (53.3)	15 (50) 15 (50)	1.000[1]
ASA n (%) I II III	 9 (30.0) 20 (71.4) 3 (10.7)	 7 (23.3) 16 (53.3) 8 (26.7)	0.254[1]
BMI (Mean ± SD kg/m²)	25.29 ± 2.89	25.46 ± 3.12	0.555[2]
Mallampati (n %) I II	 9 (30.0) 21 (70)	 7 (23.3) 23 (76.6)	0.559[1]

ASA—American Society of Anesthesiologists, BMI—body mass index

p < 0.05 statistically significant, [1]Chi-Square test, [2]t-test

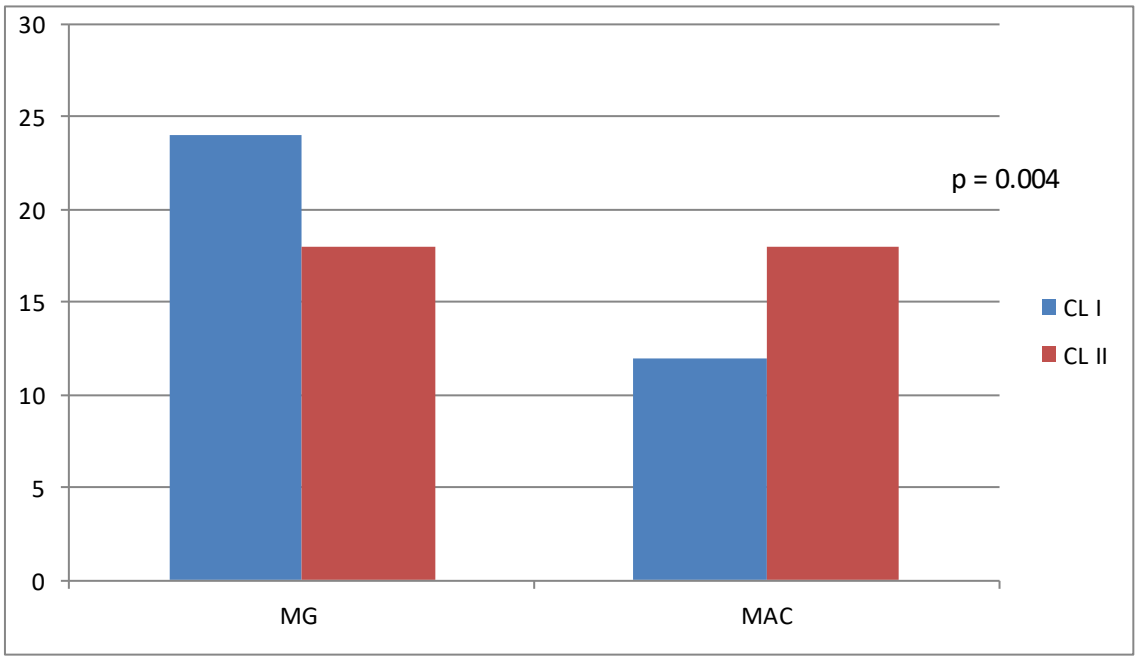

Figure 1. Comparison of Cormack–Lehane grade between the McGrath and Macintosh groups

Although the mean duration of intubation was shorter in the MG group compared to the MAC group, the difference between the groups was not statistically significant (26.03 ± 1.32 s vs. 28.30 ± 5.66 s; p = 0.057). The maximal intubation time with McGrath was 29 s, and with Macintosh 47 s.

In comparison with the Macintosh, the McGrath videolaryngoscope was associated with a higher rate of successful intubations on first attempt: 96.7% (29/30) vs. 86.7% (26/30), respectively. However, the difference was statistically comparable between the groups (p = 0.350). Both groups experienced no more than two intubation attempts. However, the MG group had fewer second attempts compared to the MAC group (1 vs. 4). There were no failed intubations in either group. Backward, Upward, Rightward maneuver was more frequent in the MAC group compared to the MG group (20% vs. 0%, p = 0.024). Bougie was not used in either group. Desaturation (SpO2 < 90%) was not observed in either group of patients (Table 2).

With the exception of mucosal trauma no other complications were observed in either group. Mucosal trauma was present in 2 patients in the MAC group, while in the MG group no patient underwent mucosal injury. There was no significant difference in complication rates between the two devices (Table 2). There were no esophageal intubations in either group.

Table 2. Comparison of outcome parameters

Parameters	MAC group (n = 30)	MG group (n = 30)	p-value
T laryngoscopy mean ± SD	7.87 ± 1.70	6.00 ± 0.95	< 0.001[2*]
T intubation mean ± SD	28.30 ± 5.66	26.03 ± 1.32	0.057[2]
CL grade CL I CL II	 12 (40%) 18 (60%)	 24 (80%) 6 (20%)	0.004[1*]
First attempt intubation	26 (86.7%)	29 (96.7%)	0.350[1]
Second attempt intubation	4 (13.3%)	1 (3.3%)	0.605[3]
Failed intubation	0 (0.0%)	0 (0%)	NA
ELM	6 (20%)	0 (0%)	0.024[*]
Bougie	0 (0.0%)	0 (0%)	NA
Desaturation (SpO2 < 100%)	0 (0.0%)	0 (0.0%)	NA
Esophageal intubation	0 (0%)	0 (0%)	NA
Dental damage	0 (0%)	0 (0%)	NA
Mucosal trauma	2 (6.7%)	0 (0.0%)	0.492[1]
Bleeding	0 (0%)	0 (0%)	NA

[*]p < 0.05 statistically significant, [1]Chi-Square test, [2]T-test, [3]Fisher's test, NA/not applicable,

Discussion

Our study showed that the duration of laryngoscopy was significantly shorter in the MG group compared with the MAC group (p < 0.001). McGrath was associated with a significantly higher rate of CL I grade. The explanation is in the design of McGrath. The camera on the distal tip of the blade enables better glottis view and therefore shortens laryngoscopy time. Our results are supported by previous researches (13, 14).

However, despite the fact that McGrath improved the glottis view, the duration of intubation between the MG and MAC groups was comparable (p = 0.057). The results of our study suggest that improved CL grade does not necessarily mean faster intubation, even though CL grade I is considered one of the predictors of "easy" intubation. There are several reasons for this. First of all, indirect laryngoscopy requires hand–eye coordination. Second, intubation using McGrath might take more time because it requires maneuvering of the ETT that should pass a steep angle to enter the glottis (15). To improve intubation and facilitate the placement of ETT through the glottis in our study, we used a malleable stylet, which might be the reason for shorter mean intubation time with McGrath compared with Macintosh (26.03 vs. 28.30, respectively), but still without statistical significance. Our results are in line with the results obtained by Kaur et al. They reported shorter mean intubation time with McGrath compared to Macintosh, but the difference was not statistically significant although McGrath improved CL grade. Also, there was no difference in the first attempt success intubation rate (16).

Data regarding intubation time for Macintosh and McGrath are conflicting. In a study that

compared Macintosh, McGrath, and C-MAC, Abhaynkar et al. reported superior glottis view with McGrath, but significantly longer time of both laryngoscopy and intubation with McGrath ($p < 0.0001$), which is opposite to our results. The authors reported fogging of the camera as one of the main reasons for prolonged intubation (17). In our study anti-fog solution was used prior to videolaryngoscopy, and fogging was present in 1 out of 30 cases.

Walker et al. compared Macintosh with the McGrath in patients with normal airways and reported significantly longer intubation time in McGrath group (18). The results of our study are not consistent with those of Walker et al., given that intubations in their study were performed by inexperienced anesthetists. Contrary to our results, are results of Hoshijima et al. They reported significantly longer intubation time with McGrath (19). Similar results were reported by Sansone et al. (20), who compared McGrath with Macintosh and found that intubation time with McGrath was longer, but without statistical significance. However, most of the providers in these studies had more clinical experience with the Macintosh than with McGrath videolaryngoscope, which could be an explanation for longer intubation time during videolaryngoscopy. Bakshi et al. concluded that expertise with direct laryngoscopy does not necessarily mean expertise with VLs (10). Different skills are necessary to efficiently perform both videolaryngoscopy and direct laryngoscopy. All this emphasize the importance of clinicians' experience and skills in using VLs and Macintosh as well as its impact on intubation success, complications, and duration of the procedure.

In our study, 96.7% of patients (29/30) were successfully intubated on the first attempt using McGrath and 86.7% (26/30) using Macintosh. Although the difference was not statistically significant, its clinical significance should not be ignored. The results of our study are in line with the results of previous studies (17, 18, 21). However, in a recent study with a large number of patients with normal airway Kriege et al. have reported significantly higher first-pass intubation success rate with McGrath compared to Macintosh (22). The difference between our results and those obtained in their study can be explained by the small sample size of our study.

Regarding the use of optimization maneuvers, the BURP maneuver was not performed during videolaryngoscopy, but it was significantly more frequent in the Macintosh group, which is supported by the fact that during direct laryngoscopy, manipulation is needed to align all three axes to visualize the glottis. Our results suggest that McGrath improves intubation conditions by superior glottis view, shortens laryngoscopy time, and lessens the requirement for BURP. All this should contribute to fewer intubation attempts and therefore lead to fewer complications.

The importance of limiting the number of intubation attempts was highlighted in the recent ASA guideline (23). Multiple attempts of intubation are associated with tissue trauma and desaturation. In the present study, most patients were intubated on the first attempt, and a few on the second. There was no desaturation in either group. We did not find significant differences in adverse events between the groups. It has been shown that “during direct laryngoscopy in difficult airway, complications are 45 times more common than in those with predicted easy airways” (24). Given that the current study included patients with predicted non-difficult airways, the only reported trauma was oral mucosal injury that happened in 2 patients intubated with a Macintosh, whereas in the MG group, none of the patients underwent any trauma. The injuries occurred as a result of the pressure of the blade on the gingiva. Regarding trauma, current research did not find statistically significant differences between Macintosh and McGrath, which is in line with previous research (15, 16). There is a report about palatal perforation with McGrath, probably due to “blind period of intubation” (25). In the present study, no serious trauma occurred.

Our study had some limitations. First of all, the anesthesiologists who performed intubations were not blinded to the devices they used. Furthermore, this was a small sample study.

Conclusion

In patients without predictors of difficult airway, McGrath significantly improves glottis view, reduces the duration of laryngoscopy, and lessens the requirement for optimization maneuvers such as BURP. Regarding intubation time, rate of successful intubation on first attempt and complications Macintosh and McGrath are comparable.

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POREĐENJE McGRATH VIDEO-LARINGOSKOPA I MACINTOSH LARINGOSKOPA U ENDOTRAHEALNOJ INTUBACIJI HIRURŠKIH PACIJENATA BEZ PREDIKTORA OTEŽANOG DISAJNOG PUTA

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U ovom istraživanju smo analizirali i upoređivali efikasnost upotrebe McGrath video-laringoskopa i Macintosh laringoskopa u endotrahealnoj intubaciji pacijenata bez prediktora otežanog disajnog puta koji se podvrgavaju elektivnim hirurškim procedurama.

Istraživanje je obuhvatilo šezdeset pacijenata, koji su podeljeni u dve grupe sačinjene od trideset pacijenata: McGrath (MC) grupu i Macintosh (MAC) grupu. Glavni cilj istraživanja bilo je poređenje trajanja intubacije i vizuelizacije glotisa na osnovu Cormack–Lehane (CL) skale. Sporedni cilj bilo je poređenje trajanja laringoskopije, procenta uspešnih intubacija iz prvog pokušaja, broja pokušaja intubacije, neželjenih događaja (trauma tkiva, desaturacija < 90%, lomljenje zuba), broja neuspešnih intubacija, BURP (engl. *Backward, Upward, Rightward Pressure* – BURP) manevara i upotreba bužija.

Rezultati su pokazali značajno češći CL gradus I u MG grupi nego u MAC grupi (80% prema 40%; p = 0,004). Trajanje laringoskopije bilo je značajno kraće u MG grupi nego u MAC grupi (7,87 ± 1,70 prema 6,00 ± 0,95; p < 0,001). Međutim, nije bilo statistički značajne razlike u trajanju intubacije između grupa (26,03 s ± 1,32 s prema 28,30 s ± 5,66 s u MG grupi i MAC grupi; p = 0,057). Iz prvog pokušaja uspešno je intubirano 96,7% pacijenata u MG grupi i 86,7% pacijenata u MAC grupi (p = 0,350). BURP manevar bilo je značajno češće u MAC grupi (p = 0,024) u toku laringoskopije. Nisu zabeležene značajna razlike među grupama kada je reč o komplikacijama.

Kod pacijenta bez prediktora otežanog disajnog puta koji se podvrgavaju elektivnim hirurškim procedurama McGrath video-laringoskop značajno poboljšava vizuelizaciju glotisa, skraćuje trajanje laringoskopije i smanjuje potrebu za izvođenje BURP manevre. Ne postoji značajna razlika u trajanju intubacije, stopi uspešnih intubacija iz prvog pokušaja i komplikacija prilikom korišćenja McGrath video-laringoskopa i Macintosh laringoskopa.

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***Ključne reči**: McGrath, Macintosh, video-laringoskopija, elektivna hirurgija*