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The effects of endotracheal intubation via McGRATH Videolaryngoscope on intraocular pressure: A randomized clinical trial

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Abstract
In this study; we aimed to compare the effects of endotracheal intubation via direct laryngoscope and McGRATH videolaryngoscope (VL) on intraocular pressure. Total of 50 ASA (American Society of Anesthesiologist) Grade 1-2, Mallampati score 1 or 2, age between 18 to 65 patients planned to undergo nonophthalmic surgery were included to study. Patients were divided randomly into 2 groups as direct laryngoscopic (Macintosh)(n=25) and videolaryngoscopic (McGRATH)(n=25) intubation group. The mean arterial blood pressure (MAP) and heart rate (HR) recorded by anesthesiologist and intraocular pressure (IOP) measured by ophthalmologist with tonopen device were recorded pre-induction (basal), pre-intubation, 1th,3rd,5th minutes of intubation, respectively. Study terminated after 5th minute values taken. There were no statistically significant differences in distirubiton of sex, weight, age, height, and ASA between groups. Duration of intubation in McGRATH group was 32 ± 2 s and statistically significantly longer than Macintosh group (23.8 ± 2.9 s)($p<0.05$). Statistically significant increase was found in IOP after 1st minute of intubation in Macintosh group (16.1 ± 2.4 mmHg) compared with McGRATH group (12.1 ± 2.5 mmHg) ($p<0.001$). There were no significant differences between groups in terms of MAP and HR values ($p>0.05$). We concluded that endotracheal intubation via McGRATH VL provide a lower IOP level compared with Macintosh laryngoscope in patients when performed by experienced anesthesiologists. There is a need for further studies related to the effects of patients with high intraocular pressures.

Keywords: Anesthesia, macintosh laryngoscope, McGRATH videolaryngoscope, intraocular pressure

Introduction

The management of airway during general anesthesia is one of the main responsibility of the anesthetists. Direct laryngoscopy via Macintosh laryngoscope is routine practice for most anesthetists. In recent years, VL are now being used more common in the management of normal and difficult airway. For endotracheal intubation, there are many airway devices used for indirect laryngoscopy that require varying degrees of airway manipulation without need to apply upward and forward force on the imaging of the glottis and advancing the endotracheal tube [1,2]. The McGRATH is one of the VL that require minimal strength and display enhanced glottis imaging.

The McGRATH VL (Aircraft Medical Ltd., Edingburgh, UK) has a curve and thin blade, contains a small camera and a light source at the end of the blade. Its advantage is to provide a better image of the larynx via indirect view of the glottis during VL-assisted intubation [3]. Also, VL requires less upward lifting force and neck movement during laryngoscopy compared with direct laryngoscopy and potentially less stimulating of larynx [4]. The McGRATH VL has been proposed most frequently in patients with difficult airway [5]. It is used with Macintosh blade and intubation with McGRATH VL was reported to be faster and enable a higher first-attempt intubation success rate [6]. In addition, VL-assisted intubation success rates are higher than direct laryngoscope-assisted intubation [7].

It was shown that IOP, HR and MAP increases undesirably during direct laryngoscopy and endotracheal intubation [8]. The sympathetic-adrenal activity caused by the stimulation of the laryngeal and endotracheal tissues is responsible for these undesirable changes [9, 10]. Especially, it must be careful for increasing of IOP in patients with glaucoma and open globe injury.

Many studies have compared different VLs in terms of hemodynamic responses and changes in the IOP for standard endotracheal intubation. Ahmad et al. [11] noticed that Glidescope videoassisted endotracheal intubation, shown lesser rise in IOP at 1 minute after intubation in study of comprasion with Macintosh laryngoscope and Glidescope was preffered.

We primarily aimed to compare the McGRATH VL and Macintosh laryngoscope with regard to alterations of intraocular pressure, hemodynamics and time of intubation. Our hypothesis was that the

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increase of IOP during laryngoscopy would be decreased with the use of McGRATH VL. In addition, duration of intubation would be faster with the use of McGRATH VL than direct laryngoscope.

Materials and methods

This study was carried out at the Department of Anesthesiology and Reanimation Clinic of our University with the approval of Institutional Research and Ethical Board (No. 2015/134). It was registered with ClinicalTrials.gov (NCT03003598). Patients were informed and written consent form was obtained prior to the start of the study. This was a prospective, randomized study in non-ophthalmic surgery requiring endotracheal intubation.

Fifty cases, aged 18-65 yr, who underwent elective surgery for nonophthalmic surgery, ASA (American Society of Anesthesiologist) 1-2, Mallampati Score 1-2 were included in the study. Patients with glaucoma, diabetes mellitus, cardiovascular and pulmonary disease, ASA III-IV, body mass index (BMI) more than 35 kg/m2, obstetric and laparoscopic surgery, Mallampati score 3-4, thyromental distance less than 6 cm, maximum mouth opening less than 3 cm, preanesthetic IOP greater than 20 mmHg, anticipated/history of difficult intubation and mask ventilation, and contraindications to propofol, fentanyl and rocuronium were excluded from the study. Also, patients requiring more than 60 s for intubation were excluded.

Randomly allocated patients were placed into two groups of 25 people each: McGRATH group and Macintosh group. Age, height, weight, sex, ASA score, BMI and Mallampati scores were recorded in the preoperative evaluation of the patients. Mallampati grading, thyromental and sternomental distance, neck extension examination were performed to expect the difficult airways in the airway evaluation.

All patients were fasted overnight and were restricted from oral intake of clear fluid for 2-3 h. They were premedicated with midazolam (0.03 mg/kg IV) 30 min before induction of anesthesia. After taking the patients into the operative room, standard anesthesia monitoring was performed such as MAP and HR (Datex-Ohmeda F-CU8; Datex Instrumentarium, Helsinki, Finland). In the operating room, all patients was laid supine position and all measurement was recorded at this position. After preoxygenation for 3 min with 100% O_2, propofol 2 mg / kg IV and fentanyl 1 mcg / kg IV were administered to both groups in induction of anesthesia until the eyelash reflex was lost. Rocuronium 0.5 mg / kg IV was applied for muscular relaxation. TOF-Watch SX (Organon Ltd, Drynam Road, Swords, Co, Dublin, Ireland) was used to show the effect of neuromuscular agent by measuring train of four (TOF). Orotracheal intubation was applied after the complete supression of TOF. Patients were intubated with 7-7,5 numbered tube for male and female patients in 2 minutes after injection of rocuronium. After successful intubation, the cuff of the tube was inflated with air to a pressure of 20 mmHg and lungs were ventilated for 5 min after intubation with mixture of 2% sevoflurane in 50% oxygen air mixture. Tidal volüme (6-8 ml / kg) and respiratory rate (8-12 f /min) were edited to keep end-tidal CO_2 between 30-35 mmHg. No other medication was administered during the period of measurements.

IOP, HR and mean arterial pressure (MAP) were measured at pre-induction, pre-intubation, 1st, 3rd and 5th min of intubation. The period from termination of manual ventilation with facemask and the instrument entered the patient's oral cavity until observation of end-tidal CO_2 tracing was accepted and recorded as duration of intubation. In both groups, size 3 blade was used for endotracheal intubation using with McGRATH VL and Macintosh laryngoscope. All endotracheal tubes were pre-loaded on the specific rigid stylet, but only in McGRATH group, stylet was angulated 60 degree. Oral endotracheal intubation with McGRATH VL and Macintosh laryngoscope was performed by the same anesthesiologist who experienced more than 90% success rate at first attempt.

IOP evaluation was performed with TonoPen-AVIA tonometer (Reichert Technologies, USA) by same ophthalmologist who was blinded to the airway device used and patients. Before measurement of IOP, 0.5% ophthalmic solution of proparacaine hydrochloride was applied. The preoperative baseline IOP was measured in the operating room without any drug administration.

Statistical analysis

In power analysis, it was determined that 25 patients in each group to show difference of 30% in the IOP with 80% power and alpha error was set to 0.050 two-sided. Data for the quantitative variables were given as mean ± standard deviation (SD) and data for qualitative variables as number (n) and percentage (%). Normal distribution fitness was done by Shapiro-Wilk test. In statistical analyzes, t-test in independent samples, one-way analysis of variance in repeated measures, Bonferroni test in multiple comparisons, Yates's corrected chi-square test was used where appropriate. The results were accepted as 95% confidence interval, $p<0.05$ was considered statistically significant. Data were analyzed using IBM SPSS 22.0 for Windows (Statistical Package of Social Science, IBM Corporation, Armonk, New York, USA).

Results

There were no significant differences among both groups in terms of patients characteristics data such as gender, height, weight, age and ASA/Mallampati classifications (Table 1). All endotracheal intubations were done successfully at first attempt within 60 s. Duration of intubation in McGRATH group was 32 ± 2 s and statistically significantly longer than Macintosh group (23.8 ± 2.9 s) ($p<0.001$) (Table 1).

No significant differences were found between the groups in the HR values (P = 0.412, 0.469, 0.665, 0.505 respectively) and MAP values (P = 0.267, 0.729, 0.182, 0.38 respectively) at all measurements. Pre-induction values of MAP and HR decreased significantly compared to pre-intubation values when the groups are assessed within themselves ($p>0.05$) (Table 2, Figure 1,2).

Pre-intubation values of IOP decreased compared with the pre-induction values in both groups, but this decrease was not significant when compared with each other ($p>0.05$). There was a significant decrease in IOP compared with pre-induction and pre-intubation value in both groups when the groups are assessed within themselves ($p<0.001$). There was only significant difference in the increase of IOP at 1 min after intubation in Macintosh group compared with McGRATH group (Figure 3)($p<0.001$). No patients were excluded from the study.

Table 1. Patient characteristics data

Groups	McGRATH (n=25)	Macintosh (n=25)	p
Gender (male/female)	12/13	11/14	
ASA (I/II)	16/9	17/8	
Height (cm)	169,6 ± 8,2	167,7 ± 8,6	0,443
Weight (kg)	69,1 ± 9,1	59,8 ± 12,2	0,179
Age (yr)	36,4 ± 8,5	32,7 ± 3,9	0,132
Intubation times (s) **	32 ± 2 (range 19-29 s) *	23,8 ± 2,9 (range 10-36 s)	< 0,001

Values are means ± SD except for gender and ASA data. ASA: American Society of Anesthesiologist.
* significant difference at intubation time between groups. (p<0,001) ** The period from termination of manuel ventilation with facemask and the instrument entered the patient's oral cavity until observation of end-tidal CO2 tracing

Table 2. Values of MAP, IOP and HR of the McGRATH group (n=25) and the Macintosh group (n=25

Variables	Groups	Pre-induction values	Pre-intubation values	After intubatoin 1 min	After intubation 3 min	After intubation 5 min
MAP (mmHg)	McGRATH	95,1 ± 10,1	75,8 ± 9,3	89,5 ± 12,6	80,8 ± 9,8	77,8 ± 10,5
	Macintosh	92 ± 9,2	66 ± 8,8	97,8 ± 12,4	79,8 ± 12,4	74,2 ± 8,1
IOP (mmHg)	McGRATH	16 ± 2,6	10,2 ± 2,4	12,1 ± 2,5	11 ± 2	10,2 ± 1,8
	Macintosh	17,3 ± 2,5	10 ± 2	**16,1 ± 2,4***	12,1 ± 2	11,2 ± 1,8
HR (bpm)	McGRATH	78,4 ± 11,4	72,3 ± 10	80,2 ± 9,8	77,3 ± 8,3	74,7 ± 9,1
	Macintosh	81,7 ± 16,2	70 ± 11,9	81,7 ± 13,8	78,8 ± 16,3	76,6 ±16,9

Values are means ± SD. *p < 0.05, compared with pre-intubation values

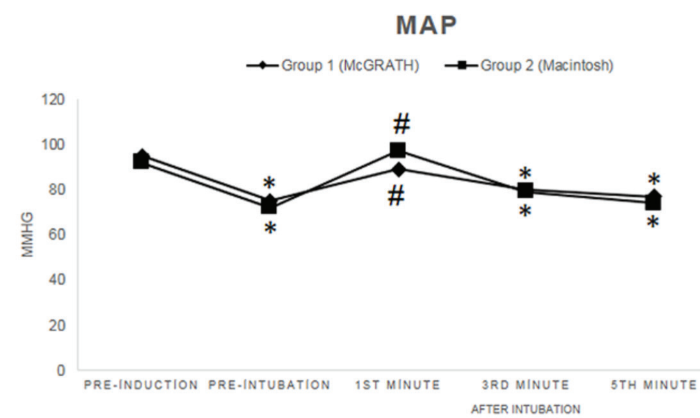

Figure 1. MAP values after McGRATH VL assisted endotracheal intubation versus Macintosh laryngoscope
* p<0,05 compared to pre-induction value; # p<0,05 compared to pre-intubation values

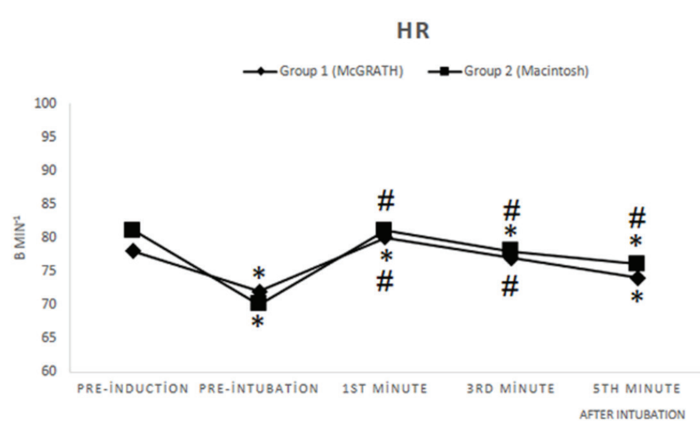

Figure 2. HR in after McGRATH VL assisted endotracheal intubation versus Macintosh laryngoscope
* p<0,05 compared to pre-induction value; # p<0,05 compared to pre-intubation values

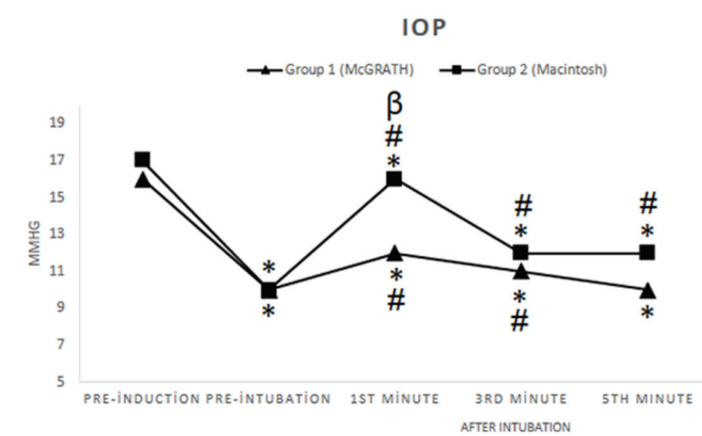

Figure 3. IOP after McGRATH assisted endotracheal intubation versus Macintosh laryngoscope
* p<0,05 compared to pre-induction value; # p<0,05 compared to pre-intubation values; β p<0,05 compared groups each other

Discussion

In this study, we compared the effects of laryngoscopy with McGRATH VL and Macintosh laryngoscope on IOP and hemodynamic response under general anesthesia in total of 50 cases who were undergoing nonophthalmic elective surgery. We chosed McGRATH VL which has a blade designed similar with Macintosh laryngoscope. Our study demonstrated that IOP increased during intubation using McGRATH VL were less than using Macintosh laryngoscope after 1st minute of intubation.

Laryngoscopy and endotracheal intubation may cause undesirable changes in the IOP, HR and MAP. Sympathetic-adrenal activity due to the stimulation of the laryngeal and endotracheal tissues is responsible for these undesirable changes [12, 13]. Hassan et al. [14] reported that direct laryngoscopy caused hypertension, tachycardia, and increased catecholamine levels via proprioceptive stimulation with pressure of blade to tongue root. They showed that endotracheal intubation stimulated hemodynamic and epinephrine response by stimulating receptors in the larynx and trachea. Although hemodynamic and IOP changes may be accepted in patients who may not undergo ophthalmic surgery, it is extremely important for surgical outcomes especially in patients undergoing ophthalmic surgery in the presence of increased IOP. It has been reported that IOP increases or accompanying pathologies in patients with glaucoma may be much more exaggerated and claimed that IOP increase in patients with glaucoma or penetrating eye injury may lead to permanent visual loss [12, 15].

In recent times, VL is used because of the benefits of hemodynamic changes in patients without difficult airways. VL is preferred especially for patients with less manipulation and better laryngeal image quality. Ng et al. [16] reported that the McGRATH VL provided significantly more grade 1 laryngoscopic views than C-MAC VL in patients with poor Mallampati scores. Gómez-Ríos et al. [17] reported that McGRATH VL were associated with better views during laryngoscopy. Implementation by experienced users of intubation with VL also increases the chances of success.

Many studies related to the relationship between VL and hemodynamic changes have been made. Malik et al. [18] emphasized that there were significant differences of degree of hemodynamic stimulation between Truview EVO2, Glidescope and Airwayscope VL. In addition, Nishikawa at al. [19] reported that Pentax airwayscope reduced changes of hemodynamic responses compared with the Macintosh laryngoscope. But in rare study, it was reported that there were no statistical differences between the McGRATH VL and Macintosh laryngoscope in hemodynamics. Ozturk et al. [20] noticed that the use of the McGRATH VL for transesophageal echocardiography insertion causes similar hemodynamic changes as in the conventional blind insertion technique. Jakusenko et al. [21] reported that there was a similar hemodynamic response in all groups and no statistically significant difference between the groups in a study of 60 adult patients who planned elective abdominal surgery and compared the stress response of endotracheal intubation with direct laryngoscopy, fiberoptic bronchoscopy and Glidescope videolaryngoscopy under general anesthesia. Xue et al. [22] reported that Glidescope VL did not make difference in hemodynamic responses compared with Macintosh laryngoscope. This result had been attributed to the fact that the broad structure of the blade of Glidescope VL and use of endotracheal tube style. Liu et al. [23] demonstrated that systolic arterial pressure increased after intubation via direct laryngoscopy by inexperienced anesthesiologists compared to McGRATH VL.

Xue et al. [24] showed that hemodynamic responses of orotracheal intubation performed using Glidescope VL and fiberoptic bronchoscope were similar and not statistically significant, although fiberoptic bronchoscopy had the ability to prevent mechanical stimulation of oropharyngolaryngeal tissues applied by Glidescope VL. Yokose et al. [26] demonstrated that the incidence of hypertension after endotracheal intubation using the McGRATH VL was less than using Macintosh laryngoscope in a retrospective study. Unlike other studies, Wallace et al. [25] noticed that there was no statistical difference in the performances of the McGRATH VL and the Macintosh laryngoscope. In this study, after the induction of general anesthesia, HR and MAP values decreased significantly in both groups compared with the pre-induction values ($p < 0.001$). However, this decrease was not statistically significant among the groups ($p > 0.05$).

Various studies related to IOP effects of intubation with VL and supraglottic airway devices have been noticed. Agrawal et al. [10] reported that 59% of patients who underwent elective ophthalmic surgery under general anesthesia had an increase in IOP after direct laryngoscopic intubation and this increase of IOP was significantly higher than measured after insertion of Proseal laryngeal mask airway (PLMA). Madan et al. [27] reported that endotracheal intubation via direct laryngoscopy caused a statistically significant increase in IOP compared to LMA, and these pressure increase were more exaggerated in the glaucoma eye than the normal eye. Ahmad et al [11] noticed that Glidescope VL incresed IOP lesser than Macintosh laryngoscope during endotracheal intubation at 1 min after intubation. Karaman et al. [28] indicated that IOP increased after intubation and 5th and 10th minutes of intubation compared McGRATH VL and Macintosh laryngoscope. In their study, they measured IOP immediately after intubation. However, we measured IOP at first, third and fifth minutes. Unlike Karaman's study, there was a significant difference between pre-intubation groups and post-intubation groups in only 1 minute. But in their study, they indicated that IOP values were higher in direct laryngoscopy group compared with McGRATH VL group at 5th and 10th minutes after intubation.

Some studies have reported that the use of VL during orotracheal intubation prolongs significantly the duration of intubation compared to direct laryngoscopy [29, 30]. Conversely, some studies have reported that the use of videolaryngoscopy shortens the duration of intubation compared to direct laryngoscopy [31, 32]. Jakusenko et al. [21] noticed that intubation times were 120 ± 65 sec in the FOB group, 29 ± 5 sec in the direct laryngoscope group and 26 ± 9 sec in the Glidescope VL group. Ng et al. [16] informed that intubation time using C-MAC VL is significantly less than using McGRATH VL. However, similarly to our study, they showed that there were no significant differences between groups in terms of hemodynamic. In addition, most anesthetists accept C-MAC as an easier device to use than McGRATH VL. Jeon et al. [26] showed that Glidescope VL reduced the intubation time when compared with McGRATH VL in patients with normal airways (40.5 sec and 53.3 sec, respectively). In their study, they accepted the intubation time between picking up the endotracheal tube and verification of the endotracheal intubation with the visualization of three expiratory carbon dioxide waveforms. In our next study, we plan to study the effects of C-MAC VL and Glidescope VL on IOP for this beneficial effect in non-ophthalmic patients.

Limitations

There are few limitations to this study. Firstly, unexpected increases on IOP may occur due to increased intubation time and difficult manipulation in patients with difficult airways. Patients with difficult airways should also be studied. Secondly, we constituted the study in patients with no comorbidities such as glaucoma. Thirdly, researchers who applied intubation could not be blinded, only the ophthalmologist was blinded.

Conclusions

Consequently, we induced that orotracheal intubation using direct laryngoscope and McGRATH VL might cause the similar hemodynamic responses. But, it was seen in our study that IOP increased in intubation using Macintosh laryngoscope compared with using McGRATH VL, significantly at 1st min of intubation. We concluded that McGRATH VL may be preferable for use in ophthalmic patients in whom a rise in IOP is unwanted. However, further clinical trials are required to support our results in patients with glaucoma.

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Competing interests
The authors declare that they have no competing interest.
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