Ann Med Res

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Comparison of the effects of direct laryngoscopy and fiberoptic oral endotracheal intubation on the intraocular pressures of non-ophthalmic patients: A prospective, randomised, clinical trial

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ARTICLE INFO

Keywords:
Direct laryngoscope
Fiberoptic bronchoscope
Intraocular pressure
Hemodynamics

Received: Dec 28, 2021
Accepted: Mar 09, 2022
Available Online: 25.07.2022

DOI:
10.5455/annalsmedres.2021.12.669

Abstract

Aim: In this prospective, randomised, clinical study; we aimed to compare the effects of endotracheal intubation (ETI) via direct laryngoscope (DLS) and fiberoptic bronchoscope (FOB) on intraocular pressure (IOP) and hemodynamic data of non-ophthalmic patients.

Materials and Methods: Fifty-four adult patients undergoing non-ophthalmic surgeries performed in the supine position under general anesthesia requiring orotracheal intubation were included into the study. The patients were randomly and prospectively divided into 2 groups: Group DLS (n=27) and Group FOB (n=27). Mean arterial pressure (MAP), Heart rate (HR), IOP were measured at before induction (basal), post-induction and 1st, 2nd, 3rd, and 5th minutes of intubation.

Results: There was no statistically significant difference in distribution of patient characteristics. Duration of intubation was significantly longer in Group FOB ($p<0.001$). There was no statistically significant difference in MAP and HR when groups compared each other. Statistically significant increase was found in IOP at 1st minute of intubation in Group DLS when compared with Group FOB ($p<0.001$). No significant difference was found in terms of IOP in other time periods.

Conclusion: We thought that endotracheal intubation by FOB could be more useful with respect to endotracheal intubation by DLS in patients with high IOP due to significantly less rise caused in IOP when performed by experienced anesthesiologists.

Introduction

Endotracheal intubation (ETI) via direct laryngoscope (DLS) and fiberoptic bronchoscope (FOB) which are implemented for airway maneuver and maintenance may cause intraocular pressure (IOP), heart rate (HR) and undesirable changes in blood pressure – particularly high blood pressures. The sympatho-adrenal activity arising from stimulation of laryngeal and tracheal tissues are typical results of these undesirable changes [1,2]. There are airway tools used for indirect laryngoscopy which do not require the application of upward and forward force for imaging glottis for endotracheal intubation [3,4]. The flexible FOB is one of the tools requiring minimum force for imaging glottis and providing improved imaging [5]. ETI with FOB is an alternative method applied for airway method. IOP is the tension created by filling the front and back camera and pushing aqueous humor against cornea and sclera, and its normal values are between 10-21.7 mm Hg [1]. While the hemodynamic and IOP changes occurring on individuals who will not undergo ophthalmic surgery may be tolerated; it is very important for patients who will undergo ophthalmic surgeries to keep IOP from increasing. It was informed that IOP increments in patients with accompanying pathologies (glaucoma, etc.) will be much exaggerative and IOP increment for patients with penetrant eye injuries [1,6]. The method to be applied and tools to be utilized for ETI may contribute to decrease such response. In this study, we aimed to compare the effects of direct laryngoscopy and fiberoptic oral ETI on IOP in non-ophthalmic patients.

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Materials and Methods

Protocol

This study was approved by the local ethic committee of Inonu University Medical Faculty, Malatya, Turkey, (09 September 2015, protocol no: 2015/134) and registered at the US National Institutes of Health (ClinicalTrials.gov)(#NCT03003585). We conducted a prospective, randomized, placebo-controlled clinical study with 54 cases scheduled for nonophthalmic surgery from October 2015 to April 2016 at our university hospital.

Study participants

Total of 54 cases, between the ages of 18 and 65, with American Society of Anesthesiologist (ASA) score 1-2 and Mallampati score (MPS) 1-2 were included into the study to receive elective nonophthalmic surgery after the approval taken from local ethical board and written contents of the patients. The cases with patients having body mass index (BMI) higher than 35, glaucoma, diabetes mellitus, cardiovascular and pulmonary diseases, ASA III-IV, difficult intubation, obstetric surgery, propofol, fentanyl and rocuronium contraindication were excluded. IOP evaluation was conducted with tonopen-AVIA (Reichert Technologies, USA), non-invasive device which measures the intraocular pressure in a non-invasive way method with high accuracy.

Randomization

This study was planned as a randomized prospective trial. Randomization was conducted by an independent researcher with the Med Calc for Windows (medcalc.com.tr.), version 16 statistical software. The patients were divided into two groups; such as Groups DLS and Groups FOB.

Preoperative procedures

The age, height, weight, gender, ASA score, BMI, and MPS of the patients were recorded during pre-operative examinations. Electrocardiography (ECG) on standard DII derivation, mean arterial pressure (MAP) and HR (Masimo SET® Rainbow, Masimo corp., Irvine, CA) were measured after they were taken into operating room.

Study design and outcome measures

The patients were divided into two groups (Group DLS, n = 27 and Group FOB, n=27). In both groups, at anesthesia induction, propofol 2mg/kg intravenously (IV), fentanyl 1 mcg/kg IV and rocuronium 0.5 mg/kg IV were applied after 3 minutes preoxygenation with 100% oxygen via face mask. The patients were intubated with spiral tube numbered 7-7,5 for females and 8-8.5 for males 2 minutes after the muscle relaxant was administered, respectively. The anesthesia maintenance was ensured with 1-2% sevoflurane and 50% O_2/50% air (flow rate: 2 L/min) for each group. The patient's MAP, HR and IOP values were recorded at before induction (basal), post-induction and 1st, 2nd, 3rd and 5th minutes of intubation. All IOP measurements were made by the same ophthalmologist who blinded which device was used. Before measuring IOP, 0.4% topical proparacaine HCL was applied. When 20% decrement of MAP measured, 10 mg ephedrine IV was applied and when HR was lower than 40 pulses/min, 0.5 mg atropine IV was applied. The application time of intubation was accepted starting from completion of ventilation of patient with face mask to the measuring of end-tidal CO2 value more than 15 mmHg and seen end-tidal CO2 wave at least 3 waves. The study was terminated after the measurement values were taken at 5th minute of intubation.

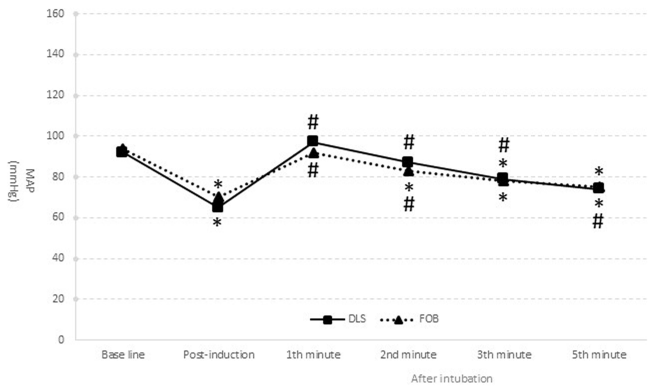

Figure 1. MAP

MAP: Mean arterial pressure; DLS: Direct laryngoscope; FOB: fiberoptic bronchoscope * $p < 0.05$ compared with baseline values # $p < 0.05$ compared with post-induction values.

Statistical analysis

IBM SPSS Statistics 22,0 software program was implemented for analyses. The number of patients recruited was determined 27 for each group in accordance with the power of the study analysis (a power of 95%). The data regarding quantitative variables was given as mean ± standard deviation (SD); and for qualitative variables it was given as number (n) and percentage (%). The conformity to normal distribution was tested with Shapiro-Wilk Test. In the statistical analyses, t test was used for independent samples, one-way analysis of variation was used for repeated measurements, Bonferroni test was used for multiple comparisons and Yates's corrective chi square test was used in suitable points. The results were statistically significant when $p<0.05$ with 95% confidence interval.

Results

A total of 54 cases that had already received elective surgeries and that were planned to receive non-ophthalmic surgeries were included into the study. The distribution of demographical characteristics was given in Table 1. No statistically significant difference was found between the groups regarding gender, weight, age, height, BMI, MPS and ASA Score ($p>0.05$). The intubation time was found to be significantly longer in Group FOB according to Group DLS ($p<0.001$). No statistically significant difference was found regarding MAP values at all measuring times when groups were compared to each other ($p>0.05$). MAP values significantly decreased at the

Table 1. Demographic data and duration of intubation (mean ± SD or number).

	DLS	FOB	p
n	27	27	
M/F	11(40.7%)/16(59.3%)	14(51.9%)/12(48.1%)	0.413
Age (year)	22.81 ± 4.76	24.18 ± 6.46	0.572
Weight (kg)	65.25 ± 12.03	67.29 ± 11.71	0.084
Height (cm)	168.37 ± 8.57	168.18 ± 9.01	0.939
BMI (kg/m2)	22.11 ± 2.91	23.72 ± 3.29	0.104
MPS 1/2	14(51.9%)/13(48.1%)	13(48.1%)/14(51.9%)	0.785
ASA Score 1/2	19(70.4%)/8(29.6%)	17(63.0%)/10(37.0%)	0.564
Intubation time a (sec)	30.59 ± 3.34 (21-45)**	51.18 ± 7.71* (42-64)**	<0.001

DLS: direct laryngoscope; FOB: fiberoptic bronchoscope; M:male; F:female; BMI: body mass index; MPS: mallapathy score; ASA: American Society of Anesthesia; *p<0.05, compared with other group **Intubation time range aTime from manual ventilation with face mask to termination of ventilation with tracheal tube

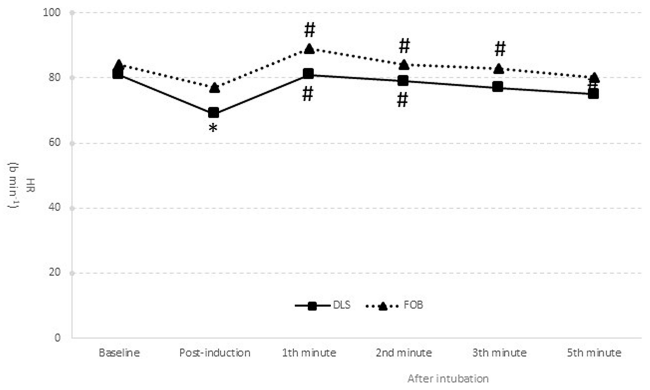

Figure 2. HR

HR: Heart rate; DLS: Direct laryngoscope; FOB: fiberoptic bronchoscope * $p < 0.05$ compared with baseline values.

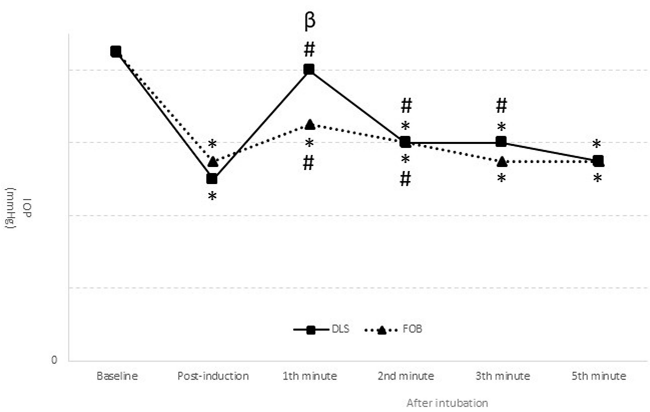

Figure 3. IOP

IOP: Intraocular pressure; DLS: Direct laryngoscope; FOB: fiberoptic bronchoscope * $p < 0.05$ compared with baseline values # $p < 0.05$ compared with post-induction values β $p < 0.05$ compared with Group FOB.

post-induction and 3rd, 5th minutes of intubation when compared with baseline values in Group DLS (p<0.001). MAP values significantly decreased at post-induction, 2nd, 3rd, 5th minutes of intubation when compared to baseline values in Group FOB (p<0.001). MAP values significantly increased at the first, 2nd, 3rd and 5th minutes of intubation when compared with post-induction values in Group DLS (p<0.001). MAP values significantly increased at the first, first and 2nd minutes of intubation when compared with post-induction values in Group FOB (p<0.001)(Figure 1). No statistically significant difference was found regarding MAP and HR values at all measuring times when groups were compared to each other (p>0.05). The post-induction HR values significantly decreased when compared to baseline values in Group DLS (p<0.001). HR values significantly increased at the 1st and 2nd min when compared to post-induction values in Group DLS (p<0.001). HR values significantly increased at the 1st, 2nd and 3rd min when compared to post-induction values in Group FOB (p<0.001) (Figure 2). IOP value significantly increased in Group DLS against Group FOB at 1st min of intubation when groups were compared to each other (p<0.001). IOP values decreased with statistical significance at post-induction, 2nd, 3rd, and 5th minutes after intubation when compared to baseline values in Group DLS (p<0.001). IOP values increased with statistical significance at 1st, 2nd and 3rd minutes of intubation when compared to post-induction values in Group FOB (p<0.001) (Figure 3). ETI via FOB and DLS was performed by the same experienced anesthesiologist with a success rate over 90% in the first attempt.

Discussion

There was no significant difference between the groups in terms of demographic data in this study. In our study, it was found significant increases in IOP at first min of intubation in Group DLS when compared with Group FOB (p<0.001). No significant increases were seen in other time periods. There was no significant difference between the groups in terms of HR and MAP values. The intubation time was found to be significantly longer in Group FOB according to Group DLS. The laryngoscopy and tracheal intubation applied under general anesthesia and airway control techniques ensured with laryngeal mask airway (LMA) causes different hemodynamic response, IOP and catecholamine levels [7]. Agrawal et al. [7] compared the impacts of ETI via direct laryngoscopy and proseal laryngeal mask airway (PLMA) in point of hemodynamic response and IOP. Average IOP measured after placement of PLMA and intubation via DLS was obtained as 14.8 mmHg and 17.08 mmHg in their study, respectively. Fifty-nine cases who were younger than 14 years undergoing elective ophthalmic surgery under general anesthesia was included in this study, unlike our work. They stated that the increment of IOP value after intubation via DLS is higher than according to after the placement of PLMA. In our study, we found that the average IOP value measured at 1st minute after the intubation was 16.22 mmHg in Group DLS and the average IOP value measured at same time in Group FOB was 13.51 mmHg. And also, we found that this increment of IOP value at first minute of intubation in Group DLS was statistically higher than Group FOB. Madan et al. [8] researched the impacts of ETI and LMA over IOP for adults and children with or without glaucoma. They notified that after the ETI, it was a statistically significant increment of IOP compared to LMA and this increment was much higher in eye with glaucoma compared to normal eye in their study.

Bhardwaj et al. [9] notified that IOP is minimally affected in in glaucomatous children who was applied LMA. Ismail et al. [10] compared the effects of I-gel, endotracheal tube and LMA on IOP and notified that insertion of the i-gel device provides better stability of IOP and the hemodynamic system compared with insertion of an endotracheal tube or LMA in patients undergoing elective nonophthalmic surgery. On the contrary, Akhtar et al. [11] compared IOP measured after placement of LMA against after tracheal intubation and they stated that there were no statistical significance differences in terms of IOP. The effects of endotracheal intubation and supraglottic airway devices on hemodynamic values were investigated in many studies. In our study, the significant decrements in MAP values were prominent in both groups (Group DLS and FOB) in post-induction period compared to baseline values ($p<0.001$). Yet, this decrement was not statistically significant when groups were compared with each other ($p>0.05$). There was no significant differences between groups in terms of HR ($p>0.05$). Jakusenko et al. [12] compared DLS, FOB and Glidescope videolaryngoscopy in terms of effects of MAP and HR and they notified that a similar (no statistically significant difference) hemodynamic response occurred in all groups that included 60 patients whose average age was 54 ± 18 years. Barak et al. [13] found that the catecholamine levels and pressure responses of ETI conducted with orotracheal intubation via DLS and FOB were found to be similar in their study. The average age of the patients included in their study was 36.1±10.6 years and 35.5±14.7 years for Group DLS and FOB, respectively. Finfer et al. [14] indicated that maximum increment in MAP and HR occurred after laryngoscopy and endotracheal intubation in the study comparing the direct laryngoscopy and tracheal intubation with intubation via FOB in regard to cardiovascular response. Xue et al. [15] indicated that the hemodynamic responses of orotracheal intubation with FOB and Glidescope videolaryngoscope were similar and statistically not significant even though they had the ability to prevent the mechanical stimulation of oropharingolaryngeal tissues applied by FOB in their study. It is thought that fiberoptic orotracheal intubation invalidates the benefits of avoiding orofaringolaryngeal stimulation and causes other nociceptive stimulations in the airway. As an example, the invasive or stressful actions such as blind advancement and rotation of tracheal tube during the FOB application, lifting the chin and adjusting the head-neck position of the patient may cause this. However, the experience of the practitioner who intubates with FOB is also an important factor here. A lower hemodynamic response in a fiberoptic intubation that can be achieved with minimal contact with the surrounding tissues may also be an expected result. In fact, although ETI via DLS can be performed faster, similar to the results in our study, it is thought that it may provide less hemodynamic response and IOP by minimizing the head-neck position and not placing the guide wire in the tube. Videoryngoscopes have been shown to be effective in preventing elevation of IOP after intubation according to DLS, unlike FOB. Ozkan at al [16] concluded that the C-MAC videolaryngoscope may be preferable when compared to the Macintosh and McGRATH MAC laryngoscopes for use in ophthalmic patients in whom a rise in the IOP is undesirable. In many studies, it has been reported that intubation times vary according to the equipment used in intubation. Although Xue at al. [15] reported that intubation time with FOB was longer than intubation with Glidescope videoryngoscopy, they also emphasized that there was no significant hemodynamic difference between these two groups. Barak et al. [13]compared the intubation times of DLS and FOB and found that the intubation period was significantly higher in Group FOB. Barak et al. [13] compared the intubation times of DLS and FOB and found that the intubation period was significantly higher in Group FOB. Furthermore, they notified that successful endotracheal intubation was realized in 16.9±7.0 seconds in DLS group (8-40) and 55±22.5 seconds in Group FOB (29-120). Jakusenko et al. [12] compared the intubation times of DLS, FOB and Glidescope laryngoscope and notified that the intubation time was longer with statistical significance with FOB. Similarly, Xue FS et al. [15] found that the intubation time was longer with statistical significance with FOB in their study. Our study also found that the intubation time was longer with statistical significance with FOB similar to these studies ($p<0,05$). In our study, successful endotracheal intubation was realized in 30.59 ± 3.34 seconds (range 21-45 sec) in Group DLS and 51.18 ± 7.71 seconds (range 42-64 sec) in Group FOB. In many studies, it has been reported that there are significant differences in hemodynamic responses after intubation via FOB, DLS and videolaryngoscope, as well as similar responses. Further studies are needed to determine the reasons for these differences.

Conclusion

As a result, we consider that endotracheal intubation with FOB will be beneficial for patients with high IOP when conducted with experienced anesthesiologists as it is shown that endotracheal intubation via DLS causes a higher increment in IOP compared to endotracheal intubation via

FOB in our study. Similar studies required for patients with high IOP to better demonstrate this benefit.

Ethics approval

This study was performed at Inonu University Hospital with the approval of Local Clinical Research Ethics Committee of Inonu University [2015-134].

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