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Fiberoptik entübasyonun ardından solunum ve hemodinamik parametrelerin değişimi: 50 hasta ile tecrübemiz

Alteration of respiratory and hemodynamic parameters following fiberoptic intubation: our experience with 50 patients

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ÖZ

GİRİŞ ve AMAÇ: *Zor entübasyon öncesinde algoritmalar dikkatlice gözden geçirilmeli ve entübasyon ve ekstübasyon ile bağlantılı morbidite ve komplikasyonları en aza indirmek için gerekli hazırlıklar yapılmalıdır. Tecrübeli bir anestezi uzmanı tarafından yapılan fiberoptik entübasyon, acil havayolu kurulmasını gerektiren durumlarda iyi bir alternatif oluşturabilir. Çalışmada, öğrenme eğrisinin erken dönemlerinde fiberoptik bronkoskop kullanılarak entübe edilen hastalarda hemodinamik ve solunumsal parametrelerdeki değişimleri saptamak amaçlandı.*

YÖNTEM ve GEREÇLER: *Bu retrospektif çalışmada, çeşitli cerrahi işlemlerden önce esnek bronkoskop yardımıyla entübe edilen toplam 50 hastanın tıbbi dosyalarından elde edilen veriler analiz edildi. Temel tanımlayıcı istatistikler, antropometrik ölçümler ve anesteziyolojik veriler kaydedildi.İndüksiyon öncesi ve sonrası ve fiberoptik entübasyon sonrası bu parametrelerdeki değişiklikler karşılaştırıldı.*

BULGULAR: *Ortalama sistolik arter basıncı (SAP), diyastolik arter basıncı (DAP), ortalama arter basıncı (MAP) ve kalp atış hızının indüksiyon sonrası anlamlı şekilde azaldığı, ancak entübasyon sonrası arttığı gözlemlendi. Arteriyel oksijen satürasyonu (saO2) seviyesinde anlamlı değişiklik olmadı ve indüksiyondan sonrası ile entübasyon sonrası değerler arasında anlamlı fark tespit edilmedi. Entübasyon sonra end-tidal karbon dioksit (etCO2) değerlerinde istatistiksel olarak anlamlı artış kaydedildi.*

TARTIŞMA ve SONUÇ: *Sonuçlarımız fiberoptik entübasyonun işlem süresini uzatmadığını ve istenmeyen solunumsal veya kardiyovasküler sonuçlara yol açmadığını göstermektedir. Fiberoptik entübasyonun için öğrenme eğrilerinin başında olan hekimler, zorlu havayolu vakalarından önce normal hastalarda bu güvenli ve pratik prosedürü uygulayabilirler.*

Anahtar Kelimeler: *fiberoptik entübasyon, oksijen satürasyonu, hemodinamik parametreler, zor entübasyon, entübasyon başarısızlığı*

ABSTRACT

INTRODUCTION: *The algorithm for difficult intubation must be reviewed carefully and necessary instruments must be prepared in order to minimize morbidity and complications linked with intubation and extubation. Fiberoptic intubation by an experienced anesthesiologist can constitute a good alternative in cases necessitating urgent establishment of airway.To compare the changes in hemodynamic and respiratory parameters following endotracheal intubation with the use of flexible bronchoscope in the early stages of learning curve*

METHODS: *In this retrospective study data extracted from the medical files of a total of 50 patients who were intubated with the aid of flexible bronchoscope prior to various surgical procedures was analyzed. Baseline descriptive, anthropometric measurements, anesthesiological data were noted. Alterations in these parameters before and after induction as well as subsequent to intubation were investigated.*

RESULTS: *We observed that mean systolic arterial pressure (SAP), diastolic arterial pressure (DAP), mean arterial pressure (MAP) and heart rate decreased significantly after induction, but it increased after intubation. Arterial oxygen saturation (saO2) level remain unchanged, and there was no significant difference between after induction and after intubation. There was a statistically significant increase in end tidal carbon dioxide (etCO2) after intubation.*

DISCUSSION AND CONCLUSION: *Our results indicate that fiberoptic intubation does not prolong the duration of procedure and does not lead to adverse respiratory or cardiovascular outcomes. Trainees who are in the beginning of their learning curve for FOI can perform this safe and practical procedure in normal patients before difficult airway cases.*

Keywords: *fiberoptic intubation, oxygen saturation, hemodynamic parameters, difficult intubation, intubation failure*

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INTRODUCTION

Difficult intubation is defined as three unsuccessful laryngoscopic attempts, inability to perform direct laryngoscopy, need for use of additional instrument during intubation and failure to partially or totally visualize glottis despite application of external pressure (1). Methods that can be used to determine difficult intubation involve Mallampati test and Cormack Lehane grading system (1). Severe difficulty in intubation is encountered in 2-3% of patients and this difficulty may be linked with anatomical reasons, congenital anomalies, inflammatory and degenerative disorders, tumors, endocrine reasons, trauma and foreign bodies (2).

Difficult airway is a multifactorial condition which is influenced by anatomical features of patients, clinical conditions and experience or skills of anesthesiology team (2). Difficult airway is more likely to occur in patients with distorted morphology associated with previous surgery, trauma, rheumatological disease, structural malformations such as micrognathia or retrognathia as well as obese and senile cases (3). Flow charts were defined for management of difficult airway by American Society of Anesthesiologists (ASA) in 2003 and by Difficult Airway Society (DAS) in 2004. The components that contribute to difficult airway are difficult mask ventilation, difficult laryngoscopy and unsuccessful intubation (4). Prediction of difficult airway can be attempted by measures such as Mallampati score, inter incisor distance (mouth opening), thyromental and sternomental distances as well as evaluation of cervical mobility. Awake fiberoptic intubation (FOI) is a frequently used method in patients presumably evaluated as difficult airway (3).

Fiberoptic intubation is an effective technique for providing access to airway in patients with both anticipated and unanticipated difficult airways. It was first described in the late 1960s, and this approach was beneficial for facilitation of airway management in various circumstances. In FOI, the mechanical stimulus on oropharyngeal structures is diminished and it is likely to reduce the hemodynamic and stress responses which may become evident during orotracheal intubation (4).

The purpose of the present study was to evaluate the alterations in hemodynamic and respiratory parameters in patients who underwent FOI due to difficult airway.

MATERIALS AND METHODS

Study design

This retrospective study was performed in the anesthesiology and reanimation department of a tertiary care center subsequent to the approval of the local Institutional Review Board. Data was extracted from the medical charts of 50 patients who underwent various general surgical and urological procedures between 2012 and 2017 as shown in Table 1. Airway of patients was assessed and all patients were intubated with flexible bronchoscope due to difficult airway.

Exclusion criteria consisted of ASA physical status III or IV, age less than 18 or more than 70, uncontrolled diabetics (blood glucose < 100 mg/dl or > 180 mg/dl), patients with hyperactive airway disease, upper airway abnormalities, gastro-esophageal reflux and ejection fraction <45%. Patients were fasted for at least 6 hours before surgery.

Midazolam was administered intravenously at a dose of 0.02 mg/kg. No atropine was given prior to induction. Noninvasive monitoring of heart rate, systolic and diastolic blood pressures was performed at baseline, post-induction and after intubation. Oxygen saturation was continuously monitored. Electrocardiogram recording was initiated before induction of anesthesia and was conducted on 5-leads.

Subsequent to pre-oxygenation for 3 minutes, anesthesia was induced using fentanyl (2 µg/kg), propofol (2 mg/kg) and atracurium (0.5 mg/kg). Isotonic saline infusion was maintained during induction. After complete neuromuscular blockade was accomplished, FOI was implemented following 2 unsuccessful attempts for tracheal intubation.

In the sniffing position, intubation was performed with fiberoptic bronchoscope having an outer diameter of 5.1 mm. The insertion cord and the outer surface of endotracheal tube with an internal diameter of 6 mm to 8 mm were lubricated with lidocaine gel 2%. The light source and suction were controlled. The endotracheal tube was placed in hot water for malleability. The bronchoscope together with the tube over it was passed through specialized oral airway. No jaw thrust maneuver was used.

Statistical analysis

Data was analyzed using IBM Statistical Package for Social Sciences 21 program. Descriptive data was expressed as mean and standard deviation for quantitative variables, whereas number and percent was used to demonstrate categorical variables. Two way repeated measures ANOVA was used to evaluate the variability of parameters under investigation over time. In case of detection of significant difference over time, Bonferroni corrected post hoc tests were administered to determine time intervals that cause difference. For variables that display significant difference for more than 2 categories, Tukey HSD post hoc test was employed. Level of statistically significant difference was set at $p < 0.05$.

RESULTS

Our series (n=50) consisted of 34 women and 16 men with an average age of 48.9±13.1 (range: 21 to 75). The average body-mass index (BMI) was 29.8±11.0. The duration of intubation procedure was 34.8±4.5 minutes (range: 27 to 50). The thyromental distance and distance between mandibula ramus and mentum were 6.7±0.8 cm and 10.6±1.8 cm, respectively. Majority of our patients (n=41, 92%) had additional diseases such as hypertension, diabetes mellitus, chronic obstructive pulmonary disease, anemia and asthma. Twenty-seven patients (54%) had a previous history of general anesthesia and mouth opening was poor (inter incisor distance<3 cm) in 16 cases (32%). Postoperative throat pain and dysphagia were detected in 25 (50%) and 9 (18%) patients, respectively. Number of patients with Mallampati score of I was 10 (20%), whereas 24 cases (48%) had Mallampati score of II, and 16 patients (32%) were found to have Mallampati score of III.

Analysis of alteration of systolic arterial pressure (SAP) demonstrated that the interaction of variable with time was insignificant. Age, gender, thyromental distance, mallampati score, neck mobility and duration of intubation yielded statistically significant differences. All 3 time intervals (before induction, after induction and after intubation) were different from each other in terms of SAP (Figure 1). Age, gender, mallampati score, neck mobility and endoscopy score seemed to affect SAP significantly. Patients with Mallampati score of 3 had higher values of SAP (Table 1).

For diastolic arterial pressure (DAP), variability of parameters over time was insignificant. The time variable was found to be statistically significant in the model established by assessment of age, gender, mallampati score and neck mobility. The interval after the induction of anesthesia was different from others in terms of DAP with respect to these parameters (Figure 2). The DAP values were significantly higher in patients with Mallampati score of 3 and in patients with restricted neck mobility (Table 2).

The variability of parameters over time was insignificant for mean arterial pressure (MAP). The time variable was found to be statistically significant in the model established by assessment of age, gender, thyromental distance, mallampati score, neck mobility and duration of intubation. The interval after the induction of anesthesia was different from others in terms of MAP with respect to these parameters (Figure 3). Age, mallampati score and endoscopy score were found to be important confounders for MAP. The MAP values were significantly higher in patients with Mallampati score of 3 compared to those with Mallampati score of 1 (Table 3).

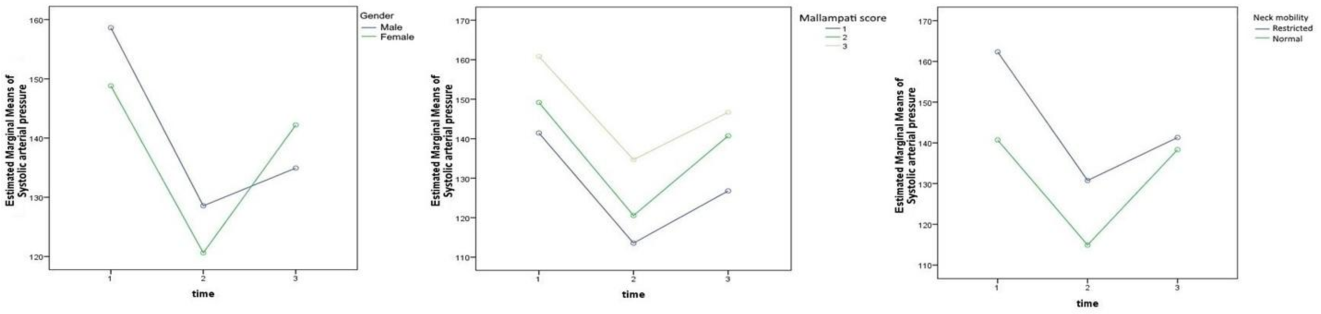

Figure 1. The change in systolic arterial pressure throughout the procedure according to gender, Mallampati score and the neck mobility (Time intervals 1: before induction; 2: after induction; 3: after intubation)

Table 1. Descriptive statistics for systolic arterial pressure

Variables			Time interval 1	2	3	P value
SAP, mmHg	Total		151.9 ± 24.6^{a}	123.2 ±23.2^{b}	139.9±21.6^{c}	< 0.001
	Gender	Male (n=16)	158.6 ± 22.9^{a}	128.6 ± 26.9^{b}	134.9 ± 25.0^{b}	< 0.001
		Female (n=34)	148.8 ± 25.2^{a}	120.6 ± 21.1^{b}	142.2 ± 19.7^{a}	< 0.001
	Mallampati Score	1 (n=10)	141.4±18.6^{a}	113.6±9.5^{b}	126.8±20.8^{c}	< 0.001
		2 (n=24)	149.2±26.7^{a}	120.5±22.6^{b}	140.7±21.4^{a}	< 0.001
		3 (n=16)	160.8±22.9^{a}	134.7±25.2^{b}	146.7±20.7^{c}	< 0.001
	Neck Mobility	Restricted (n=26)	162.4±24.0^{a}	130.8±21.4^{b}	141.3±30.4^{c}	< 0.001
		Normal (n=24)	140.7±20.4^{a}	114.9±22.6^{b}	138.3±23.2^{a}	< 0.001

(SAP: systolic arterial pressure; Time intervals 1: before induction; 2: after induction; 3: after intubation)
^{a,b,c} = The same letter denotes lack of the statistical significance

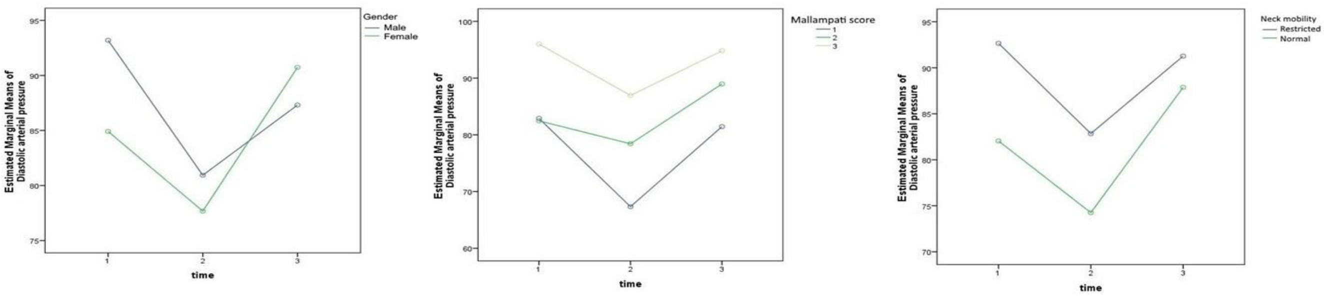

Figure 2. The change in diastolic arterial pressure throughout the procedure according to gender, Mallampati score and the neck mobility (Time intervals 1: before induction; 2: after induction; 3: after intubation)

Table 2. Descriptive statistics for diastolic arterial pressure

			Time interval 1	2	3	P value
DAP, mmHg	Total		87.6 ± 16.1	78.7 ±13.5	89.6±17.2	0.060
	Gender	Male (n=16)	93.2 ± 11.9^{a}	80.9 ± 14.9^{b}	87.8 ± 22.8^{a}	0.036
		Female (n=34)	84.9 ± 17.2^{a}	77.7 ± 12.9^{b}	90.7 ± 14.0^{a}	0.042
	Mallampati Score	1 (n=10)	82.9±9.6^{a}	67.3±7.3^{b}	81.4±16.5^{a}	0.024
		2 (n=24)	82.5±18.5	78.4±11.3	88.9±15.9	0.073
		3 (n=16)	96±9.3	86.9±13.9	94.8±18.8	0.096
	Neck Mobility	Restricted (n=26)	92.6±10.9	82.8±131.3	91.3±18.2	0.068
		Normal (n=24)	82.04±18.9^{a}	74.3±12.5^{b}	87.9±16.2^{a}	0.044

(DAP: diastolic arterial pressure; Time intervals 1: before induction; 2: after induction; 3: after intubation)
^{a,b,c} = The same letter denotes lack of the statistical significance

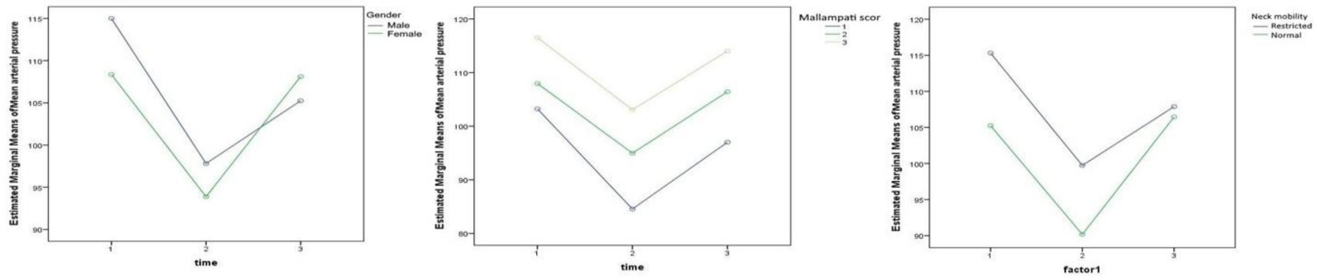

Figure 3. The change in mean arterial pressure throughout the procedure according to gender, Mallampati score and the neck mobility (Time intervals 1: before induction; 2: after induction; 3: after intubation)

Table 3. Descriptive statistics for mean arterial pressure

			Time interval			P value
			1	2	3	
MAP, mmHg	Total		110.5 ± 15.6 [a]	95.1 ±15.9 [b]	107.2±18.6 [a]	< 0.001
	Gender	Male (n=16)	115.0 ± 13.5 [a]	97.8 ± 17.9 [b]	105.2 ± 23.8 [a]	< 0.001
		Female (n=34)	108.3 ± 16.2 [a]	93.9 ± 14.9 [b]	108.1 ± 15.9 [a]	< 0.001
	Mallampati Score	1 (n=10)	103.2±14.2 [a]	84.6±6.6 [b]	97±19.1 [a]	< 0.001
		2 (n=24)	107.9±15.5 [a]	94.6±13.9 [b]	106.4±17.6 [a]	0.032
		3 (n=16)	116.5±116.5 [a]	103.1±17.9 [b]	114±18.7 [a]	0.028
	Neck mobility	Restricted (n=26)	115.3±13.6 [a]	99.7±14.4 [b]	107.9±17.3 [a]	0.011
		Normal (n=24)	105.2±16.1 [a]	90.2±16.2 [b]	106.5±20.2 [a]	< 0.001

(MAP: mean arterial pressure; Time intervals 1: before induction; 2: after induction; 3: after intubation)
[a,b,c] = The same letter denotes lack of the statistical significance

The impacts of age, body-mass index, gender, mallampati score, neck mobility and the duration of intubation on heart rate were significant in time-related model. Time interval before induction of anesthesia was responsible for the difference in terms of heart rate (Figure 4). Body weight, thyromental distance and the distance between mandibula ramus and mentum seemed to significantly affect heart rate (Table 4).

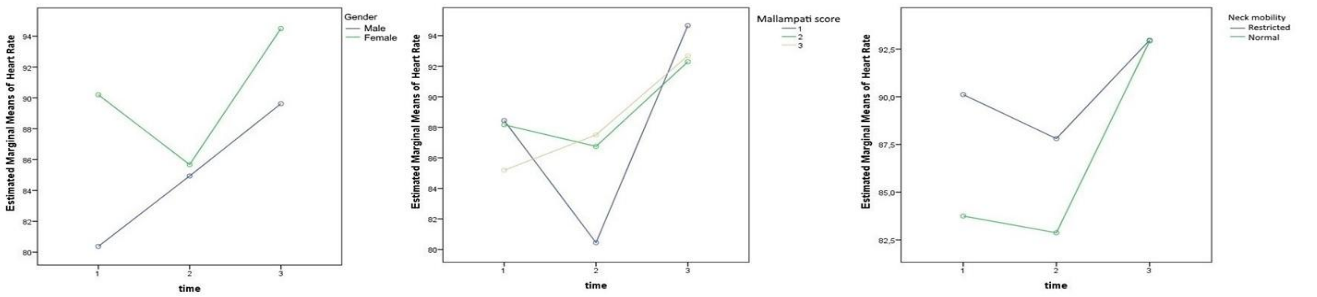

Figure 4. The change in heart rate throughout the procedure according to gender, Mallampati score and the neck mobility (Time intervals 1: before induction; 2: after induction; 3: after intubation)

Table 4. Descriptive statistics for heart rate

			Time interval			P value
			1	2	3	
Heart rate, beats/min	Total		87.1 ± 17.7 ^{a}	85.4 ±15.7 ^{a}	92.9±15.1 ^{c}	<0.001
	Gender	Male (n=16)	80.4 ± 15.6 ^{a}	84.9 ± 16.9 ^{a}	89.6 ± 13.5 ^{c}	<0.001
		Female (n=34)	90.2 ± 17.9 ^{a}	85.7 ± 15.4 ^{b}	94.5 ± 15.7 ^{a}	<0.001
	Mallampati Score	1 (n=10)	88.4 ± 15.9 ^{a}	80.4 ±13.9 ^{b}	94.7±20.4 ^{c}	<0.001
		2 (n=24)	88.2 ± 20.6 ^{a}	86.8± 18.7 ^{a}	92.3 ± 15.3 ^{a}	0.024
		3 (n=16)	85.2 ± 14.9 ^{a}	87.5 ± 12.5 ^{a}	92.7 ± 12.5 ^{c}	<0.001
	Neck Mobility	Restricted (n=26)	90.1 ± 14.7 ^{a,b}	87.8 ±14.8 ^{b}	92.9±12.8 ^{a}	0.042
		Normal (n=24)	83.7 ± 20.2 ^{a}	82.9± 16.6 ^{a}	92.9 ± 17.5	<0.001

(Time intervals 1: before induction; 2: after induction; 3: after intubation)
^{a,b,c} = The same letter denotes lack of the statistical significance

The interaction of end-tidal CO_2 (et-CO_2) concentration and time were significant with respect to thyromental distance and after intubation. The et-CO_2 concentrations in accordance to these variables display variability over time **(Figure 5)**. Time interval seems to be statistically significant for variables age, body-mass index, gender, mallampati score, neck mobility, endoscopy score and duration of intubation. The et-CO2 values after induction are higher than et-CO2 values before induction. Body weight and endoscopy score seem to significantly affect et-CO2 (Table 5).

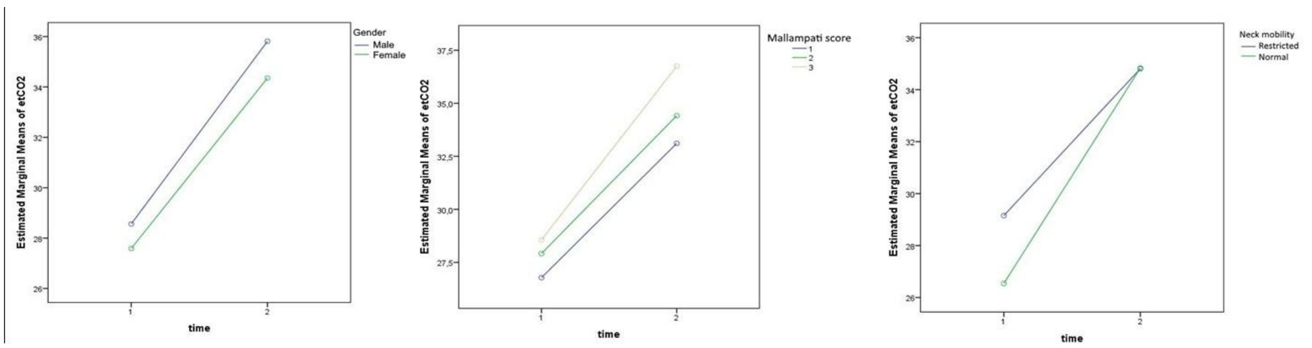

Figure 5. The change in end tidal carbon dioxide (etCO2) throughout the procedure according to gender, Mallampati score and the neck mobility (Time intervals 1: before induction; 2: after induction; 3: after intubation)

Table 5. Descriptive statistics for end-tidal CO_2

			Time interval		P value
			1	2	
$etCO_2$, mmHg	Total		27.9±4.9	34.8±4.5	<0.001
	Gender	Male (n=16)	28.6±6.4	35.8±4.1	<0.001
		Female (n=34)	27.6±4.1	34.3±4.7	<0.001
	Mallampati Score	1 (n=10)	26.8±4.3	33.1±3.4	<0.001
		2 (n=24)	27.9±4.2	34.4±4.7	<0.001
		3 (n=16)	28.6±6.4	36.7± 4.2	<0.001
	Neck mobility	Restricted (n=26)	29.1±5.1	34.8±4.5	<0.001
		Normal (n=24)	26.5±4.3	34.8±4.6	<0.001

Time intervals 1: before induction; 2: after induction

DISCUSSION

Difficult intubation cannot be always predicted and it constitutes a common cause of anesthesia related morbidity (5). The prevalence of difficult airway has been reported as 0.05-18% and 2-3% of these cases present with serious problems (6). Possible options that can be used to manage difficult airway include intubation with oral or nasal fiberoptic bronchoscope, blind intubation through oral or nasal route, intubation laryngeal mask (ILMA) and laryngeal mask (LMA) (5,6). It must be recognized that there is not a gold standard method which yields excellent outcomes under all conditions. Even though intubation with fiberoptic bronchoscope is accepted as gold standard in the management of difficult airway, a possibility of failure must be always kept in mind (7). Difficult intubation is not always a predictable clinical entity, but an anesthesiologist must be ready to manage this condition. In this purpose, implementation of a consecutive therapeutic algorithm that involves different strategies can be necessary.An anesthesiologist must be able to perform the most appropriate alternative to avoid irreversible hypoxic lesions (6,7).

The algorithm for management of difficult airway is comprised of ILMA after failure of initial attempt of intubation. However, intubation with nasotracheal fiberoptic bronchoscope without endeavoring LMA cannot be assigned as inappropriate especially when oxygenation and ventilation can be maintained sufficiently (8). During preoperative evaluation, a detailed anesthetic history may remind a previous history of difficult endevaours by means of direct laryngoscopy. Thus, past records of anesthetic procedures must be reviewed if possible. The term "difficult intubation" has been utilized to define a restricted view on direct laryngoscopy, the requirement for more than one attempt or utilization of different airway aids. Interestingly, the prevalence of difficult intubation is higher than expected in patients without airway anatomic abnormalities (9).

Fiberoptic bronchoscope is readily available, and its use recently became more popular attributed to less stimulation to the pharyngeal structures and less stress response. These favorable responses are associated with less haemodynamic changes and induction of stress hormone release (4). Comparison of blood pressure and heart rate measurements between patients undergoing endotracheal intubation during general anesthesia, and who had an awake fibreoptic intubation under local anesthesia indicated that awake FOI diminishes the resistance to endotracheal intubation (10). Therefore, FOI seems to be appropriate for use in patients under risk due to the pressor response and our results are consistent with this data.

In contrast, another publication suggested that both orotracheal intubation by either fiberoptic bronchoscope or direct laryngoscope techniques cause similar increases in blood pressure and heart rate (11). This difference was attributed to the relatively longer intubation time with fiberoptic that leads to hypercapnia which may subsequently cause hypertension and tachycardia (11).

Comparison of heart rate, blood pressure and catecholamine levels between direct laryngoscopy and fiberoptic groups of patients after intubation yielded that there was no significant difference between these groups (12). They stated that general anesthesia of sufficient depth could inhibit the hemodynamic response elicited by intubation and this factor might have contributed to the similarity of the results in both groups. These results may also ensource from the prolonged time for FOI (12). Newly developed devices which integrate the characteristics of fiberoptic bronchoscope and avoid the need for direct laryngoscopy resulted in an attenuated hemodynamic respons. This may offer an advantage especially for patients with comorbidities such as ischemic heart disease. Moreover, the incidence of sore throat can be decreased due to elimination of direct laryngoscopy (4).

Awake intubation is a technically reliable method; however, it is more difficult to perform. Prior to the procedure, blockade with local anesthesia must be performed. Cooperation with the patient must be maintained during the intervention. Fiberoptic intubation is the method of choice to establish a safe airway in case of failure of intubation with direct laryngoscopy. Its success rate had been reported as high as 90% (9). Potential complications linked with FOI include laryngeal trauma, aspiration of saliva and gastric contents, activation of sympathetic system, laryngospasm and increased intraocular and intracranial pressure. In current literature, data on risks and complications of FOI is scarce and further studies must be conducted to investigate this issue. Difficult airway management is a critical point in anesthesiology practice, and the role of FOI in difficult airway situations is well established. Achievement of skills in FOI must therefore be a crucial part of training in anesthesiology (9).

This study possesses certain restrictions which must be taken into account before extrapolation of our results to larger populations. These limitations involve relatively small sample size, lack of a control group, data derived from a single center and possible impacts of social, ethnic and environmental factors. Therefore, our results must be interpreted cautiously.

Results of the present study indicate that algorithm for difficult intubation must be reviewed carefully and necessary instruments must be prepared in order to minimize morbidity and complications linked with intubation and extubation. Fiberoptic intubation by an experienced anesthesiologist can constitute a good alternative in circumstances with need for urgent establishment of airway. To conclude, we suggest that FOI may provide beneficial effects by diminution of adverse hemodynamic and respiratory responses associated with intubation.

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Conflict of interest statement

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