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ORIGINAL ARTICLE

Inhalation Induction in Tracheostomized Patients: Comparison of Desflurane and Sevoflurane

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Abstract

Background: Inhalation induction (II) of anesthesia is a commonly used method in difficult airway management, pediatric anesthesia and also tracheostomized patients' surgical practices. Sevoflurane and desflurane are the most common inhalation agents for II in these procedures of patients. We demonstrated that II with sevoflurane or desflurane in tracheostomized patients who are not studied up until now and their outcomes. Cardiorespiratory changes in II should be the same in tracheostomized patients with desflurane compared to sevoflurane.

Methods: We studied 60 adult tracheostomized patients (ASA physical status 2 or 3), scheduled for elective surgery under general anesthesia. Patients were allocated randomly to receive either desflurane (Group D) or sevoflurane (Group S) for II. Following 1 mg midazolam and 1 μg/kg fentanyl, all patients were intubated via tracheostomy with a montandon tracheostomy tube. In the Group D, patients were firstly instructed to breath and then they immediately started using desflurane and 50% nitrous oxide in oxygen (3/3 L). Desflurane was introduced at an inspired concentration of 3% and increased by 1% every 4-6 breaths as tolerated, up to a maximum of 12%. In the Group S, patients were also instructed to breathe firstly and then they immediately started using sevoflurane and 50% nitrous oxide in oxygen (3/3 L). Sevoflurane was introduced at an inspired concentration of 1% and increased by 0.3% every 4-6 breaths as tolerated, up to a maximum of 6%. Hemodynamic values [(SpO_2, heart rate (HR) and arterial pressure (MAP)], respiratory complications (coughing, bronchospasm, desaturation, breath-holding), purposeful movement of limbs, secretions requiring removal by suction, time to loss of response to command and concentration of expired inhalation agent (desflurane or sevoflurane) were recorded for 10 minutes of II. Mean, standard deviation, frequency and percentage were used for descriptive statistics with SSPS 20.0.

Results: Couching, bronchospasm, desaturation, breath-holding and purposeful movements distributions did not show any differences in Group D and Group S. Requirement of secretion removal was higher in Group D. Hemodynamic values were more stable in Group S.

Conclusion: In tracheostomized patients' II; desflurane has similar airway irritation with sevoflurane but II is more stable with sevoflurane than desflurane.

Keywords

Inhalation induction, Sevoflurane, Desflurane, Tracheostomy

List of Abbreviations

II: Inhalation Induction; ENT: Ear, Nose and Throat; HR: Heart Rate; MAP: Mean Arterial Pressure; BCC: Basal Cell Carcinoma; ECG: Electrocardiography; NIBP: Noninvasive Blood Pressure; SpO_2: Oxygen Saturation by Pulse Oximetry

Background

Inhalation Induction (II) is frequently used in Ear, Nose and Throat (ENT) operations such as difficulty in airway and pediatric group [1]. Sevoflurane and desflurane are the most common inhalation agents for II in these procedures of patients [2]. They have similar low blood gas partition coefficients, therefore they provide rapid induction and early recovery [3]. II

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with desflurane is not popular than sevoflurane [4,5]. When desflurane is used II is associated with respiratory system irritation, hypertension, tachycardia [6-8].

Indications for tracheostomy are upper airway infection, trauma, tumor, obstructive sleep apnea, upper airway obstructions caused by stenosis foreign body, respiratory failure, management of secretions, promoting weaning and long term mechanical ventilation support, diaphragma weakness, aspiration, coma, and ineffective cough [9]. Tracheostomized patients may need surgery with general anesthesia in any time of their lives. In our anesthesia practice, the surgery types we commonly encounter in tracheostomized patients are a type of bladder cancer, neck dissection, Basal Cell Carcinom (BCC) Excision, mediastinoscopy, lung lobectomy, peripheral vascular and coronary bypass surgery.

We demonstrated that II with sevoflurane and/or desflurane in tracheostomized patients who are not studied up until now. We hypothesize that cardiorespiratory changes in II should be the same in tracheostomized patients with desflurane compared to sevoflurane.

Methods

After obtaining local ethics committee approval and written informed consent, we studied 60 adult tracheostomized patients (ASA physical status II or III), scheduled for elective surgery under general anesthesia at the Vakif Gureba Training Hospital, Istanbul.

Patients were unpremedicated. In the operating room, after cannulating a suitable vein, standard monitors [Heart Rate (HR) and rhythm by 5-lead Electrocardiography (ECG), Noninvasive Blood Pressure (NIBP), oxygen saturation by pulse oximetry (SpO_2)] were applied and the patients were allocated randomly to receive either desflurane (Group D) or sevoflurane (Group S) for inhalation induction. Following the intravenous administrations of 1 mg midazolam and 1 µg/kg fentanyl, all patients were intubated via tracheostomy with a montandon tracheostomy tube (Portex®, Smiths Medical, UK). By connecting montandon tube end to anesthesia circuit, preoxygenation with %100 O_2 by an oxygen flow of 4 liter/min for 3 minutes under spontaneous ventilation is enabled in patients.

In the Group D, patients were firstly instructed to breath and then they immediately started using desflurane and 50% nitrous oxide in oxygen (3/3 L). Desflurane was introduced at an inspired concentration of 3% and increased by 1% every 4-6 breaths as tolerated, up to a maximum of 12%. In the Group S, patients were also instructed to breathe firstly and then they immediately started using sevoflurane and 50% nitrous oxide in oxygen (3/3 L). Sevoflurane was introduced at an inspired concentration of 1% and increased by 0.3% every 4-6 breaths as tolerated, up to a maximum of 6%. Induction of anesthesia was considered complete when there was loss of response to command with the patient, loss of eyelash reflex, and the eyes were immobile and central.

Cardiovascular and respiratory changes were measured [10]. An observer recorded the hemodynamic values for 10 minutes, following (1) SpO_2 every 30 second and the lowest SpO_2 noted; (2) Heart rate (HR) and (3) Arterial pressure (MAP) every 1 minute; (4) Coughing: Each episode was recorded and graded: mild = 1-3 coughs, moderate = 4-7 coughs and severe ≥ 7 coughs; (5) Bronchospasm: The observer auscultated the chest at 1-minute intervals; (6) Desaturation: SpO_2 < 90%; (7) Breath-holding: Each episode was recorded and graded: mild ≤ 10 second, moderate = 10-20 second and severe ≥ 20 second; (8) Purposeful movement of limbs: Each episode was recorded and graded as mild, moderate and severe; (9) Secretions requiring removal by suction were recorded; (10) Time to loss of response to command; and (11) Concentration of expired inhalation agent (desflurane or sevoflurane) when anesthesia was induced.

All surgical operations were started after 10-minute-measures in order to avoid sympathetic response. Statistical methods: Mean, standard deviation, frequency and percentage were used for descriptive statistics. The distribution of variables was checked with Kolmogorov-Smirnov Test. Independent samples t test and Mann-Whitney U Test were used for the comparison of quantitative data. Paired samples t test and Wilcoxon Test were used for the repeated measurement analysis. Chi-Square Test was used for the comparison of the qualitative data. SSPS 20.0 was used for statistical analyses.

Results

No difference is detected in Group D and Group S patients' age, gender distribution, BMI values, tracheostomized life time and ASA rates ($p > 0.05$). Time to loss of response to command was shorter in Group D than Group S while concentration percentage of expired inhalation agent was higher in Group D than Group S ($p < 0.05$) (Table 1).

Couching, bronchospasm, desaturation, breath-holding and purposeful movements distributions did not show any differences in Group D and Group S ($p > 0.05$). Requirement of secretion removal was higher in Group D than Group S ($p < 0.05$) (Table 2).

Any differences were not detected in SpO_2 values in seconds of pre-op- 60- 90- 120- 150- 180- 210- 240- 270- 360- 420 neither in Group D nor in Group S ($p > 0.05$). SpO_2 values in seconds of 30- 300- 360 were lower in Group D than Group S ($p < 0.05$). SpO_2 values in seconds of 390- 450- 480- 510- 540- 570 were higher in Group D than Group S ($p < 0.05$). SpO_2 values in Group S were higher till the 360th second but after the 360th second SpO_2 values in Group D became higher (Table 3 and Figure 1).

Table 1: No difference is detected in Group D and Group S patients 'age, gender distribution, BMI values, tracheostomized life time and ASA rates ($p > 0.05$). Time to loss of response to command was shorter in Group D than Group S while concentration percentage of expired inhalation agent was higher in Group D than Group S ($p < 0.05$).

		Group D	**Group S**	**p**
		Mean ± s.d./n-%	**Mean ± s.d./n-%**	
Gender	Male	27 ± 90.0%	28 ± 93.3%	
	Female	3 ± 10.0%	2 ± 6.7%	0.640
Age (year)		64.6 ± 4.7	65.4 ± 6.4	0.582
BMI (kg/m^2)		20.0 ± 2.0	19.8 ± 1.8	0.416
Tracheostomized life time (week)		106.5 ± 77.6	134.3 ± 79.7	0.177
Time to loss of response to command (S)		166.7 ± 40.4	189.3 ± 41.0	**0.035**
Expired desflurane concentration (%)		6.9 ± 0.7	2.7 ± 0.5	**0.000**
ASA	II	20 ± 66.7%	19 ± 63.3%	0.787
	III	10 ± 33.3%	11 ± 36.7%	

Chi-square test/Independent Samples t test; BMI: Body Mass Index; ASA: American Society of Anesthesiologists.

Table 2: Coughing, bronchospasm, desaturation, breath-holding and purposeful movements distributions did not show any differences in Group D than Group S ($p < 0.05$). Requiring of secretions removal was higher in Group D than Group S ($p < 0.05$).

		Group D	**Group S**	**p**
		Mean ± s.d./n-%	**Mean ± s.d./n-%**	
Coughing	None	15 ± 50.0%	19 ± 63.3%	
	Mild	6 ± 20.0%	4 ± 13.3%	0.297
	Moderate	4 ± 13.3%	5 ± 16.7%	
	Severe	5 ± 16.7%	2 ± 6.7%	
Bronchospasm	No	27 ± 90.0%	28 ± 93.3%	0.640
	Yes	3 ± 10.0%	2 ± 6.7%	
Desaturation	No	23 ± 76.7%	24 ± 80.0%	0.750
	Yes	7 ± 23.3%	6 ± 20.0%	
Breath-Holding	None	18 ± 60.0%	24 ± 80.0%	
	Mild	5 ± 16.7%	2 ± 6.7%	0.091
	Moderate	6 ± 20.0%	3 ± 10.0%	
	Severe	1 ± 3.3%	1 ± 3.3%	
Purposeful Movements	None	19 ± 63.3%	24 ± 80.0%	
	Mild	5 ± 16.7%	3 ± 10.0%	0.152
	Moderate	4 ± 13.3%	3 ± 10.0%	
	Severe	2 ± 6.7%	0 ± 0.0%	
Requiring of Secretions Removal	No	14 ± 46.7%	22 ± 73.3%	**0.035**
	Yes	16 ± 53.3%	8 ± 26.7%	

Chi-square test.

Any differences were not detected in HR values in pre-op first and fourth minutes neither in Group D nor in Group S ($p > 0.05$). HR values in minutes of 2- 3- 5- 6- 7- 8- 9- 10 were higher in Group D than Group S ($p < 0.05$) (Table 4 and Figure 2).

Any differences were not detected in MAP values in pre-op and sixth minute neither in Group D nor in Group S ($p > 0.05$). MAP values in minutes of 1- 2- 3- 4- 5- 7- 8- 9- 10 were higher in Group D than Group S ($p < 0.05$) (Table 5 and Figure 3).

In group evaluation, SpO_2 value in Group D was not different from pre-op. value in minutes of 120- 150- 210- 240- 270 ($p > 0.05$). And in other times, SpO_2 value was higher compared to pre-op. measured value ($p < 0.05$). HR value was higher compared to pre-op. measured value at all times ($p < 0.05$). MAP value was higher compared to pre-op. measured value at all times ($p < 0.05$). SpO_2 value in Group S was not different from pre-op. value in minutes of 120- 150- 180- 210 ($p > 0.05$). And in other times, SpO_2 value was higher compared to

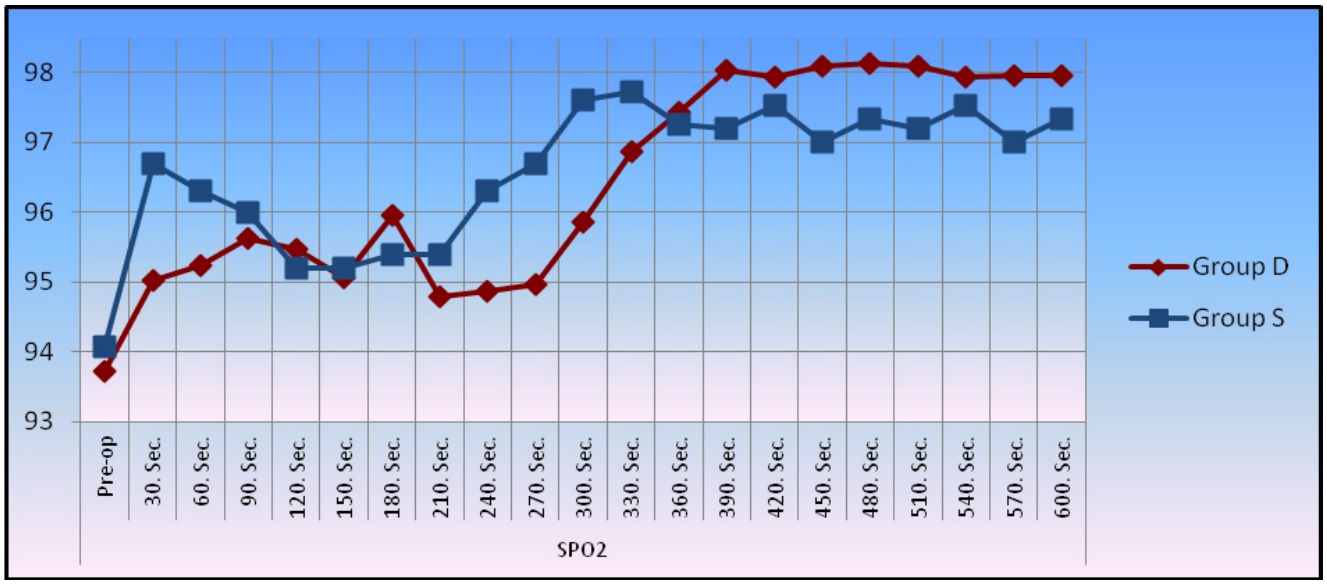

Figure 1: SpO_2 values in Group S and Group D.

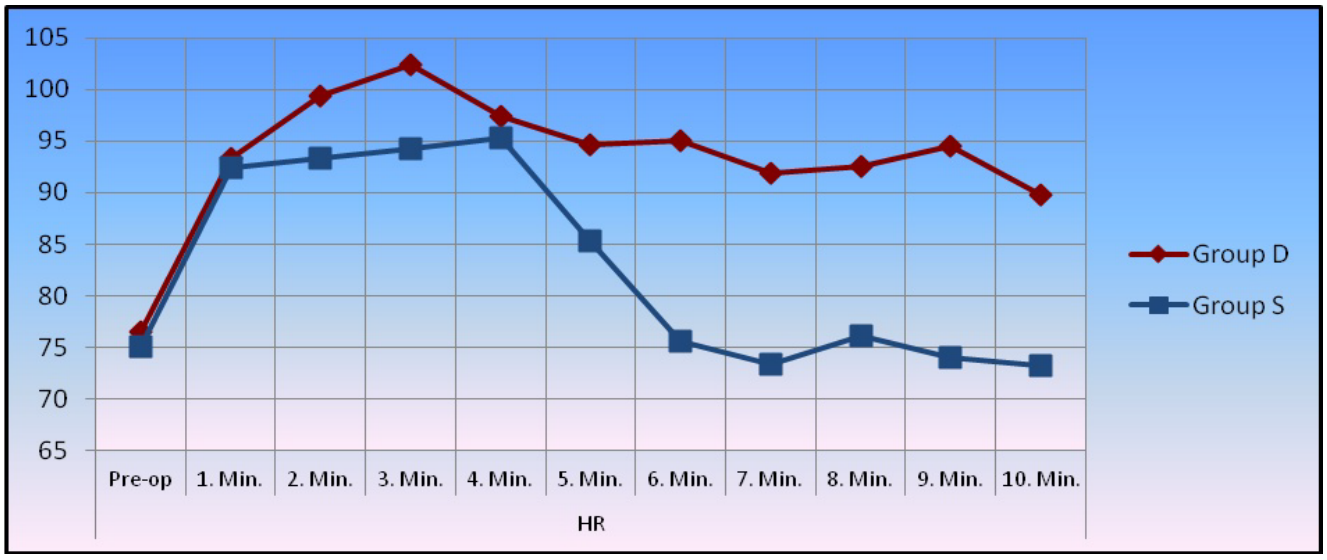

Figure 2: HR values in Group D and Group S.

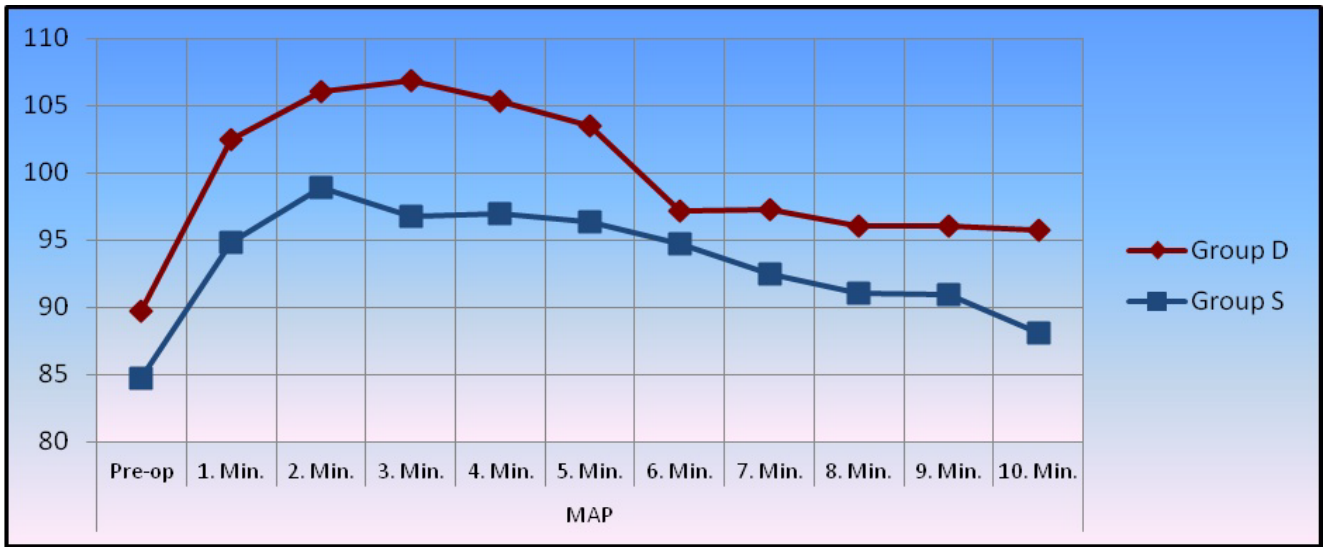

Figure 3: MAP values in Group D and Group S.

Table 3: Any differences were not detected in SpO_2 values in seconds of pre-op, 60, 90, 120, 150, 180, 210, 240, 270, 360, 420 neither in Group D nor in Group S ($p > 0.05$). SpO_2 values in seconds of 30, 300, 360 were lower in Group D than Group S ($p < 0.05$). SpO_2 values in seconds of 390, 450, 480, 510, 540, 570 were higher in Group D than Group S ($p < 0.05$). SpO_2 values in Group S were higher till the 360th second but after the 360th second SpO_2 values in Group D became higher. (SpO_2: Oxygen saturation).

	Group D	Group S	p
	Mean ± s.d.	Mean ± s.d.	
SPO_2-pre	93.7 ± 1.3	94.1 ± 1.2	0.304
SPO_2-30	95.0 ± 2.9	96.7 ± 2.0	**0.011**
SPO_2-60	95.2 ± 3.7	96.3 ± 3.4	0.246
SPO_2-90	95.6 ± 4.0	96.0 ± 3.6	0.711
SPO_2-120	95.5 ± 4.7	95.2 ± 4.2	0.817
SPO_2-150	95.1 ± 4.2	95.2 ± 3.9	0.898
SPO_2-180	96.0 ± 3.4	95.4 ± 4.6	0.592
SPO_2-210	94.8 ± 4.4	95.4 ± 3.7	0.568
SPO_2-240	94.9 ± 4.6	96.3 ± 2.7	0.143
SPO_2-270	95.0 ± 4.4	96.7 ± 2.0	0.054
SPO_2-300	95.9 ± 3.6	97.6 ± 1.0	**0.015**
SPO_2-330	96.9 ± 1.8	97.7 ± 0.7	**0.017**
SPO_2-360	97.4 ± 1.3	97.3 ± 1.2	0.601
SPO_2-390	98.0 ± 1.2	97.2 ± 1.2	**0.010**
SPO_2-420	97.9 ± 1.3	97.5 ± 0.7	0.137
SPO_2-450	98.1 ± 1.3	97.0 ± 1.4	**0.003**
SPO_2-480	98.1 ± 1.1	97.3 ± 1.0	**0.004**
SPO_2-510	98.1 ± 1.2	97.2 ± 1.2	**0.004**
SPO_2-540	97.9 ± 0.6	97.5 ± 0.7	**0.023**
SPO_2-570	98.0 ± 1.1	97.0 ± 1.4	**0.004**
SPO_2-600	98.0 ± 0.7	97.3 ± 1.0	**0.004**

Student t test.

Table 4: Any differences were not detected in HR values in pre-op first and fourth minutes neither in Group D nor in Group S ($p > 0.05$). HR values in minutes of 2-3-5-6-7-8-9-10 were higher in Group D than Group S ($p < 0.05$). (HR: Heart Rate).

	Group D	Group S	p
	Mean ± s.d.	Mean ± s.d.	
HRpre	76.5 ± 11.3	75.1 ± 10.1	0.801
HR1	93.3 ± 9.0	92.4 ± 11.9	0.485
HR2	99.4 ± 7.1	93.4 ± 11.9	**0.009**
HR3	102.4 ± 6.7	94.3 ± 11.9	**0.000**
HR4	97.4 ± 6.2	95.3 ± 11.9	0.185
HR5	94.7 ± 4.7	85.3 ± 11.9	**0.000**
HR6	95.0 ± 6.8	75.6 ± 11.1	**0.000**
HR7	91.8 ± 6.4	73.4 ± 12.0	**0.000**
HR8	92.5 ± 7.9	76.1 ± 11.1	**0.000**
HR9	94.5 ± 10.1	74.0 ± 11.7	**0.000**
HR10	89.8 ± 6.4	73.2 ± 10.5	**0.000**

Mann-whitney u test.

Table 5: Any differences were not detected in MAP values in pre-op and sixth minutes neither in Group D nor in Group S ($p > 0.05$). MAP values in minutes of 1-2-3-4-5-6-7-8-9-10 were higher in Group D than Group S ($p < 0.05$). (MAP: Mean Arterial Pressure).

	Group D	Group S	p
	Mean ± s.d.	Mean ± s.d.	
MAP pre	89.7 ± 10.7	84.7 ± 12.0	0.136
MAP1	102.5 ± 9.9	94.9 ± 11.1	**0.017**
MAP2	106.1 ± 11.6	98.9 ± 9.7	**0.012**
MAP3	106.9 ± 12.2	96.8 ± 8.1	**0.001**
MAP4	105.4 ± 11.5	97.0 ± 7.8	**0.004**
MAP5	103.5 ± 12.4	96.3 ± 8.3	**0.014**
MAP6	97.2 ± 10.1	94.8 ± 9.4	0.324
MAP7	97.3 ± 6.8	92.5 ± 9.3	**0.032**
MAP8	96.0 ± 7.2	91.1 ± 9.9	**0.030**
MAP9	96.1 ± 5.8	90.9 ± 8.5	**0.018**
MAP10	95.7 ± 3.5	88.1 ± 8.0	**0.000**

Mann-whitney u test.

pre-op. measured value ($p < 0.05$). HR value was higher compared to pre-op. measured value in minutes of 1- 2- 3- 4- 5 ($p < 0.05$). After the sixth minute, it was not different from pre-op. value ($p < 0.05$). MAP value was higher than pre-op. measured value in minutes of 1- 2- 3- 4- 5- 6- 7- 8- 9 ($p < 0.05$) while it was not different from pre-op measured value in tenth minute ($p > 0.05$) (Table 6).

Discussion

Tracheostomized patients' anesthesia induction is a simple technique. Although these patients generally have a co-morbid disease, enabling airway security is very easy. By means of an appropriate-sized endotracheal tube or tracheal cannula implemented to trachea from current tracheostomy, airway security is enabled easily. It will be beneficial to make sedoanalgesia before it. Whether induction shall be by intravenous or inhalation depends on anesthetists. Both of the methods are commonly used in our practice.

During ENT surgery, II is commonly used for infants and children. II is a comfortable, quick, physiological and minimally traumatic technique [11,12]. Moreover in adults, II is also used as an alternative since there is a risk of losing airway control due to intravenous induction [13]. In II, induction time may be long and especially due to smoking, upper respiratory tract infection and irritable airway diseases, there may be coughing, laryngospasm and bronchospasm [14-16]. We studied that II with sevoflurane and/or desflurane in tracheostomized patients.

Desflurane is an inhalation agent that may cause airway irritation compared to sevoflurane [17]. Many studies are being made in literature in order to lower effects of desflurane. Nebulized lidocaine, intravenous

Table 6: In group evaluation of HR, MAP, SPO_2 values (HR: Heart Rate, MAP: Mean Arterial Pressure, SPO_2: Oxygen Saturation).

	Group D	Group S		Group D	Group S
	p	p		p	p
HR1 - HR pre	0.000	0.000	**SPO_2 pre - SPO_2-30**	0.028	0.000
HR2 - HR pre	0.000	0.000	**SPO_2 pre - SPO_2-60**	0.049	0.002
HR3 - HR pre	0.000	0.000	**SPO_2 pre - SPO_2-90**	0.027	0.009
HR4 - HR pre	0.000	0.000	**SPO_2 pre - SPO_2-120**	0.077	0.165
HR5 - HR pre	0.000	0.000	**SPO_2 pre - SPO_2-150**	0.129	0.144
HR6 - HR pre	0.000	0.412	**SPO_2 pre - SPO_2-180**	0.005	0.139
HR7 - HR pre	0.000	0.191	**SPO_2 pre - SPO_2-210**	0.232	0.084
HR8 - HR pre	0.000	0.158	**SPO_2 pre - SPO_2-240**	0.223	0.000
HR9 - HR pre	0.000	0.413	**SPO_2 pre - SPO_2-270**	0.165	0.000
HR10 - HR pre	0.000	0.157	**SPO_2 pre - SPO_2-300**	0.006	0.000
			SPO_2 pre -SPO_2-330	0.000	0.000
MAP1 - MAP pre	0.000	0.000	**SPO_2 pre - SPO_2-360**	0.000	0.000
MAP2 - MAP pre	0.000	0.000	**SPO_2 pre - SPO_2-390**	0.000	0.000
MAP3 - MAP pre	0.000	0.000	**SPO_2 pre - SPO_2-420**	0.000	0.000
MAP4 - MAP pre	0.000	0.000	**SPO_2 pre - SPO_2-450**	0.000	0.000
MAP5 - MAP pre	0.000	0.000	**SPO_2 pre - SPO_2-480**	0.000	0.000
MAP6 - MAP pre	0.040	0.001	**SPO_2 pre - SPO_2-510**	0.000	0.000
MAP7 - MAP pre	0.004	0.011	**SPO_2 pre - SPO_2-540**	0.000	0.000
MAP8 - MAP pre	0.018	0.038	**SPO_2 pre - SPO_2-570**	0.000	0.000
MAP9 - MAP pre	0.012	0.031	**SPO_2 pre - SPO_2-600**	0.000	0.000
MAP10 - MAP pre	0.011	0.239			

morphine, fentanyl and remifentanil administration used for II [10,18-20]. Beginning region of airway reflexes affected by desflurane is not known and it is emphasized that there may be more vulnerable larynx and/or small airways [21,22]. Since larynx known to be vulnerable is bypassed in studied tracheostomized patients, we may not have detected differences in airway complications like coughing, breath-holding and desaturation in neither group; besides, we did not also observed any difference in complication belonging to small airway like bronchospasm. Garry, et al. [23] applied desflurane and II which, they think, are rapid and reliable for direct laryngoscopy to a 62-year-old male patient who have been treated in the neck by radiation due to laryngeal tumor and have 4th degree airway obstruction accompanied by stridor resulting from the formation of granulation tissue in subglottic and supraglottic regions; and II is evaluated as regular, sufficient and secure. Since then, in patients with similar pathology, desflurane has been used for inducing a fast and smooth anesthesia after anaesthetize airway topically [24,25]. It is possible to obtain fast and smooth anesthesia induction in patients having airway deficiency by benefitting from desflurane's low solubility in blood [26]. Rampil, et al. [27] induced anesthesia by desflurane until intubation became possible without using neuromuscular blockers in patients not administered sedative medication. The researchers observed small number of airway irritations with limited level during II and that 10-18 minutes is required for induction. Most common respiratory complications were increases in secretion (25-45%) and in coughing (38-56%). And the most important complication was laryngospasm by 2/44 rate. In our study, induction time was shorter; it may be due to our administration of midazolam and fentanyl before II. Incidences of respiratory effects during our study were similar. 16% coughing is observed in usage case of sevoflurane which is utilized for II both in infants and adults [28]. We detected 50% coughing incidence in tracheostomized patients when desflurane is used and 36% when sevoflurane is used; these incidences had been similar in patients not tracheostomized in former studies when desflurane is used but were in high incidence in those using sevoflurane.

It is widely accepted that II with desflurane is associated with respiratory system irritation as well as hypertension and tachycardia. The concentration of desflurane (much) bigger than 1.0 to 1.5 MAC results in sympathetic excitation, hypertension and tachycardia [29]. These symptoms can modulated with intravenous opioids, beta-blocking drugs, alpha-2 agonists [30]. In recent study, tracheostomized patients to who we administered desflurane and II in accordance with literature have higher MAP and faster HR values than sevoflurane-administered ones. The administration of midazolam sedation and fentanyl analgesia before administering II did not prevent this hemodynamic situation. Whether with desflurane or sevoflurane, no com-

plication occurred in our study to finish II in any patients or change the method.

It is known that larynx is a protective and defensive reflexogenic region in airway. Irritant receptors such as drive, pressure, and cold receptors have been clearly identified in larynx and tracheobronchial mucosa [31]. Laryngeal reflexes such as the cough reflex, expiration reflex, and laryngeal closure with apne protect the airways from aspiration. It is well-established knowledge that general anesthetics modify these reflexes, and the impairment of upper airway protective reflexes has been demonstrated [32,33]. It is possible that distal receptors in tracheobronchial mucosa is more adaptive or insensitive in tracheostomized patients [34].

As a result, in tracheostomized patients from whom larynx was bypassed, desflurane causes similar airway irritation with sevoflurane but as we known that II was more stable with sevoflurane than desflurane.

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