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Comparison of Ramped and Sniffing Positions in Video-Laryngoscopy-Guided Tracheal Intubation For Elective Cesarean Section: A Prospective Randomized Study

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ABSTRACT

The physiological and anatomic changes in pregnancy create a series of difficulties in intubation for general anesthesia. Therefore, the aim of this study was to investigate the effects on the duration of intubation of the ramped and sniffing positions in the videolaryngoscopy guidelines in the cesarean section.

A total of 60 patients undergoing elective cesarean section with general anaesthesia were randomly separated into 2 groups. Both groups were intubated with videolaryngoscopy; one group in the sniffing position with a pillow 7cm in height placed below the occiput, and the other group in the ramped position with specially designed pillows providing horizontal alignment of the external auditory meatus and sternal notch. The intubation times were compared between the groups.

The total intubation time was determined to be statistically significantly shorter in the ramped position (11.80 ± 2.30 s) than in the sniffing position (14.06 ± 1.86 s) ($p<0.001$). The laryngoscopy time was significantly shorter in the ramped position group (5.61±1.22 s) than in the sniffing position group (7.37±1.48 s) ($p<0.001$), and the tube insertion time was similar in both groups ($p>0.117$)

To be able to prevent desaturation which can develop rapidly in rapid intubation because of the reduced functional residual capacity and increased oxygen consumption in pregnancy, the ramped position may be a better option than the sniffing position in pregnant patients applied with tracheal intubation with videolaryngoscopy in cesarean section surgery.

Keywords: Airway management; Cesarean Section; Positioning; Tracheal intubation; Videolaryngoscopy

Introduction

Cesarean section (CS) is one of the most frequently performed surgical interventions throughout the world (1). In some countries, the rate of CS exceeds 50% (2), and in 2020, with 573 CS per 1000 live births, Türkiye had the highest rate of CS births in Europe (3). Regional anesthesia and general anesthesia are the anesthesia methods used for CS surgery. Studies of obstetric mortality have shown that regional anesthesia is 2-16-fold safer than general anesthesia (4). Despite the advantages of regional anesthesia, general anesthesia is applied to some patients for CS for reasons such as emergency situations, patient refusal of regional anesthesia, or when there are contraindications for regional anesthesia. Patients applied with general anesthesia constitute 5-6% of all CS operations (5).

The physiological and anatomic changes in pregnancy create a series of intubation difficulties for general anesthesia. Even if a pregnant patient prefers general anesthesia as the anesthesia plan, the significant physiological and anatomic changes of pregnancy must be taken into consideration. The changes involving the respiratory, cardiovascular, and gastrointestinal systems are the most important for the anesthetist.

The Mallampati classification worsens during pregnancy and more so during the birth (6). Just as edematous swelling of the oral and laryngeal mucosa in pregnancy, especially in the third trimester, makes glottic visualisation more difficult, it can also prevent the passage of the tracheal tube. Changes in the upper respiratory tract, expanded breasts, and obesity can make intubation difficult during pregnancy. As a result of the pregnant uterus elevating the diaphragm, a 10-25% decrease in functional residual capacity (FRC) and a 20-33% increase in oxygen consumption compared to baseline, can lead to rapid desaturation during apnea despite sufficient pre-oxygenation (7-9). In most pregnancies, the

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intra-abdominal part of the oesophagus moves to within the thorax, and the lower oesophageal sphincter loosens with the effect of progesterone. These anatomic and hormonal effects cause gastro-oesophageal reflux, which is a known condition of pregnancy (10). The risk of aspiration of gastric content increases during intubation of pregnant patients due to increased intra-abdominal pressure and decreased lower oesophageal sphincter tonus.

Failure of intubation is 8-fold higher in pregnant patients than in the general population (11). In a recent multicentre study including approximately 14,000 cases of general anesthesia for CS, the rate of difficult intubation was reported to be 1:49 and failed intubation as 1:808 (12).

In all CS operations, difficult and high-risk airway must be predicted and precautions must be taken accordingly. International airway groups now recommend that videolaryngoscopy can be used first in the difficult airway management guidelines (13,14). Videolaryngoscopes are now almost universally available in obstetric units in England and it is even recommended as the first stage tool for routine intubation (15).

In women with enlarged breasts because of pregnancy, the routine use of the elevated head position is recommended during general anesthesia induction to improve airway manipulation and laryngoscopy (13). In order to achieve horizontal alignment between the sternal notch and the external auditory meatus, the ramped position is achieved by positioning blankets beneath the upper trunk and head. The ramped position can provide alignment compatible with the three axes of intubation (oral, pharyngeal, laryngeal) in pregnant patients who show similar anatomic and physiological characteristics to obese patients. To be able to perform intubation more easily and to obtain better glottic visualisation in intubation with videolaryngoscopy, alignment of the three axes of intubation at the level of the eye is not necessary (16). Although videolaryngoscopy seems to facilitate and accelerate intubation because of this characteristic, in the videolaryngoscopy guidelines it is not known whether or not the ramped position provides benefit for CS in pregnant patients. Therefore, the aim of this study was to compare the intubation times in the ramped and sniffing positions in CS in the videolaryngoscopy guidelines. The ramped position would need less intubation time than the sniffing position, according to the study hypothesis. The primary outcome of the study was the total intubation time, and the secondary outcomes were difficulties in intubation and mask ventilation, laryngoscopy time, tube insertion time, and complications related to intubation.

Materials and Methods

This prospective, randomised, controlled study with parallel groups evaluating the intubation times in CS operations was performed in Karaman Training and Research Hospital between 28 October 2023 and 30 November 3023. Approval for the study was granted by the Research Ethics Committee of Karamanoğlu Mehmetbey University School of Medicine (decision no: 05-2023/14, date: 31 July 2023, chairperson: Ahmet Aslan). In line with the Helsinki Declaration, the study was registered at http://www.clinicaltrials.gov with number NCT06107751 prior to patient enrollment. Every patient enrolled in the study gave written informed consent.

The patients included in the study were aged 18-40 years, of American Society of Anesthesiologists physical status classification (ASA) II-III, were planned to undergo elective cesarean section delivery, and selected general anesthesia. Patients were excluded from the study if they did not wish to participate, had any orientation or co-operation disorder, had a cervical spine defect, a history of head and neck surgery, a history of difficult intubation, or were at risk of pulmonary aspiration.

The patients were randomly separated into two groups as the sniffing position group (Group S) and the ramped position group (Group R) by a clinician not involved in the study using a computerised randomisation method. The study could not be blinded because of the nature of the interventions to be made and as the researchers kept the records. However, the observers who evaluated the patients and complications after 4 hours were blinded to the groups.

The airway measurements including the Mallampati score, inter-incisor distance, neck circumference, thyromental distance, and sternomental distance were recorded in the preoperative preparation room. Standard monitorisation including non-invasive blood pressure, electrocardiography, end-tidal carbon dioxide ($EtCO_2$) and pulse oximetry was applied preoperatively in the operating room. Preoxygenation was achieved in all the patients with 100% oxygen for 3 minutes. Anesthesia induction was applied with 2mg/kg propofol and 0.6mg/kg rocuronium. Following anesthesia induction, repetitive train-of-four (TOF)

stimulation was started and all the patients were ventilated manually with 100% oxygen until neuromuscular blockage was obtained.

In all the patients, a McGrath® Series 5 videolaryngoscope (Aircraft Medical Ltd, Edinburgh, UK) with number 3 blade and a tracheal tube of 7.0 mm internal diameter was used. The tracheal tubes were shaped according to the videolaryngoscope blade before intubation. Following intubation, the cuff pressure was set to be 25cm H_2O with the analog pressure indicator device (VBM Cuff Pressure Controller, Germany). A senior anesthetist with at least 50 intubations using videolaryngoscopy performed each intubation.

The Group S patients were placed in the supine position with a pillow 7 cm in height placed below the occiput. For the Group R patients, pillows specially designed to provide horizontal alignment of the external auditory meatus and the sternal notch were placed below the head and upper body. For ventilation and intubation of the patients in both groups, the height of the operating table was adjusted so that the head of the patient was between the umbilicus and xyphoid process of the anesthetist.

Difficulty in mask ventilation was evaluated with the Warters scale (Table 1). This a grading scale in which points are assigned in the intervention applied to reach 5mL/kg tidal volume according to ideal body weight (17). When the target tidal volume of 5mL/kg cannot be reached, the Warters scale points show an increase using a nasal and airway device with gradually increasing inspiratory pressure and two-person ventilation. A Warters scale score of ≥4 points is accepted as difficult ventilation. The Intubation Difficulty Scale (IDS) was used to assess the difficulty of tracheal intubation (18). The IDS score is obtained from the 7 variables of number of alternative intubation techniques, number of operators, number of intubation attempts, Cormack grade, external laryngeal pressure, use of increased lifting force during laryngoscopy and position of the vocal cord. According to the IDS score, the intubation difficulty was classified as easy (IDS =0), slightly difficult (IDS = 1-5), moderate to severe difficulty (IDS >5), or impossible (IDS = infinity).

To be able to differentiate the degree of difficulty of the laryngoscope duration and tube insertion time as the two components of intubation time, were evaluated separately. The laryngoscopy duration was defined as the time from the tip of the laryngoscope blade first passing betweeen the teeth of the patient to the time when the best glottic visualisation was obtained. The tube insertion time was measured as the time from the tip of the endotracheal tube first passing between the teeth of the patient to the tube passing the glottis. The sum of the laryngoscopy and tube insertion times was used to calculate the total intubation time.

At 4 hours postoperatively, complications related to intubation (sore throat, any changes in voice, trauma to the tongue, palate, or teeth) were questioned by an evaluator blinded to the study groups.

Priori Power Analysis For Sample Size Estimation: Based on the projected mean intubation duration from a pilot research (n = 10 for each group), the sample size was calculated. The means of the groups were 11.59±3.07 and 13.65±1.27. Power analyses indicated that sample size of 56 patients (28 for each group) would provide a statistical power of .90 with two sided level of .05 to detect significant diffferences. Consedering possible drop outs a total sample size of 60 patients was calculated.

Statistical Analysis: The Kolmogorov–Smirnov test measured the distribution of the variables. The results indicated that the distribution was normal. For this reason the independent samples *t*-test was used to compare normally distributed continuous data. Categorical variables were compared using the chi-square test or Fisher exact test. Data are presented as number of patients, mean ± SD, or median (Q1, Q3). Statistical significance was determined as $p < 0.05$. In this study, data were analyzed using SPSS 25 (IBM Corp. Released 2017.IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.).

Results

A total of 65 patients who selected general anesthesia for elective C/S were screened for suitability for the study. Of these, 5 were excluded for the reasons shown in Figure 1. The study was completed without problems with a total of 60 patients, randomly assigned as 30 patients in the sniffing position and 30 patients in the ramped position. Both groups' demographic information and airway characteristics were similar (Table 2).

The total intubation time, which was the primary outcome of this study, was determined to be significantly shorter in the ramped position group (11.80±2.30 s) than in the sniffing position group (14.06±1.86 s) ($p<0.001$) (Table 3). The laryngoscopy time was determined to be significantly shorter in the ramped position group

Table 1: The Warters Grading Scale for Mask Ventilation

Description/definition	Points
Oral or nasal airway	1
PIP 20–25 cmH2O	1
PIP 26–30 cmH2O	2
PIP > 30 cmH2O	3
Unable to generate PIP > 30 cmH2O	3
Two-person ventilation	2
Tidal volume 2–5 mL/kg	2
Unable to ventilate	4

Reaching a goal volume of 5 mL/kg (ideal body weight) is the basis for the point system. PIP: Peak inspiratory pressure.

Table 2: Demographic Data and Airway Parameters

Variable	Ramped group (n = 30)	Sniffing group (n = 30)	P value
Age (yr)	28.87±4.90	30.10±4.23	0.301
Height (cm)	161.37±5.60	162.73±4.99	0.322
Weight (kg)	74.20±7.67	76.27±13.37	0.466
BMI (kg/m2)	28.51±3.65	29.09±4.02	0.560
ASA physical status (II/III)	28/2	29/1	0.554
Airway parameters			
Mallampati score (I/II/III)	10/13/7	12/12/6	0.861
Neck circumference (cm)	33.20±1.13	33.67±1.40	0.160
Sternomental distance (cm)	15.41±1.01	15.93±1.51	0.127
Thyromental distance (cm)	9.38±1.18	9.66±1.33	0.393
Inter-incisor distance (cm)	3.91±0.21	3.91±3.89	0.967

Values are presented as number of patients or mean ± SD. Independent samples *t* tests was conducted to compare the means of the groups and Chi-square analysis was performed to compare the distribution rates of the groups. BMI: Body mass index, ASA: American Society of Anesthesiologists, yr: year, cm: centimeter, kg: kilogram

Table 3: Comparison of laryngoscopy time, tube insertion time and the total intubation time

Variables	Group	n	Mean	S	t	P value
Laryngoscopy Time	Ramped Group	30	5.61	1.22	-5.015	<0 .001
(s)	Sniffing Group	30	7.37	1.48		
Tube Insertion Time	Ramped Group	30	6.18	1.49	-1.592	0.117
(s)	Sniffing Group	30	6.69	0.91		
Total Intubation Time	Ramped Group	30	11.80	2.30	-4.188	<0 .001
(s)	Sniffing Group	30	14.06	1.86		

Values are presented as the mean and standart deviation of the variables. Independent samples *t* tests was conducted to compare the means of the groups. s: second

(5.61±1.22 s) than in the sniffing position group (7.37±1.48 s) ($p<0.001$). Regarding the duration of tube insertion, no statistically significant difference was found between the groups ($p=0.117$) (Table 3).

No difficulty in mask ventilation (Waters scale score ≥4) was determined in either group. The Warters scale score was 1 in all the patients in the ramped position group, and was 2 in 5 patients in the sniffing position group, with a statistically

Table 4: Difficulty in Mask Ventilation and Tracheal Intubation

Variable	Ramped Group (n = 30)	Sniffing Group (n = 30)	P value
Difficulty of mask ventilation			
Warters scale			
1	30 (100)	25 (83.3)	0.007
2	0 (0)	5 (16.7)	
Difficulty of Intubation			
IDS score	0 (0-1)	1 (0-1.25)	0.006
A. No. of attempts (n-1)			
1	30 (100)	28 (93.3)	0.150
2	0 (0)	2 (6.7)	
B. No. of operators (n-1)			
0	30 (100)	30 (100)	1.000
C. No. of alternative techniques (n)			
0	30 (100)	30 (100)	1.000
D. Cormack grade			
1	21 (70.0)	14 (46.7)	0.067
2	9 (30.0)	16 (53.3)	
E. Lifting force required (increased = 1)	0 (0)	3 (10)	0.038
F. External laryngeal pressure (applied = 1)	0 (0)	1 (3.3)	0.236
G. Vocal cord mobility (adduction = 1)	0 (0)	0 (0)	1.000
Ease of Intubation			
Easy (IDS = 0)	21 (70.0)	12 (40)	0.020
Slight difficulty (0 < IDS ≤ 5)	9 (30.0)	18 (60)	
Moderate to Major Difficulty (IDS > 5)	0 (0)	0 (0)	

Values are presented as the number of patients (%) or median (Q1, Q3). Chi-square analysis was performed to compare the distribution rates of the groups. IDS score = sum of score of seven variables (A–G). IDS: Intubation Difficulty Scale

significant difference determined between the groups (p=0.007) (Table 4).

The ramped position group had a greater percentage of easy intubation than the sniffing position group, according the IDS (70% vs.40%) (p=0.020). The Cormack grade rates were similar in both groups (p=0.067). Extra lifting force was required in 3 patients in the sniffing position group and in none of the ramped position group (p=0.038). External laryngeal pressure was applied to 1 patient in the sniffing position group and to none of the ramped position group (p=0.236) (Table 4).

The hemodynamic parameters at baseline, before intubation and after intubation were similar in both groups (Table 5). There was no significant difference seen between the groups in terms of intubation-related complications (Table 6).

Discussion

In this study, the intubation times were compared in patients in the ramped and sniffing positions using videolaryngoscopy in CS operations. The results showed that the intubations in both positions were successfully completed without any problems. No difficult intubation was seen in either group. However, compared to the sniffing position group, the ramped position group's total intubation time was noticeably less. While the laryngoscopy time was shorter in the ramped position group, the tube insertion time was similar in both groups. Although there was no significant difference between the groups in respect of mask

Table 5: Peroperative Hemodynamic Parameters

Variables	Group	n	Mean	S	t	P value
SO2 Baseline	Ramped Group	30	97.93	1.08	-0.822	0.414
	Sniffing Group	30	98.17	1.12		
SO2 Before Intubation	Ramped Group	30	99.43	0.50	0.000	1.000
	Sniffing Group	30	99.43	0.63		
SO2 After Intubation	Ramped Group	30	99.37	0.67	-1.762	0.083
	Sniffing Group	30	99.63	0.49		
HR Baseline	Ramped Group	30	89.40	10.25	-0.520	0.605
	Sniffing Group	30	90.67	8.56		
HR Before Intubation	Ramped Group	30	92.20	12.43	0.732	0.467
	Sniffing Group	30	90.13	9.21		
HR After Intubation	Ramped Group	30	103.97	16.53	-0.035	0.972
	Sniffing Group	30	104.10	12.81		
MAP Baseline	Ramped Group	30	93.13	16.32	0.365	0.716
	Sniffing Group	30	91.87	9.72		
MAP Before Intubation	Ramped Group	30	84.27	16.34	-0.337	0.738
	Sniffing Group	30	85.40	8.57		
MAP After Intubation	Ramped Group	30	101.07	24.86	-0.071	0.944
	Sniffing Group	30	101.43	13.50		

Values are presented as the mean and standart deviation of the variables. Independent samples *t* tests was conducted to compare the means of the groups. SO2: Oxygen saturation, HR: Heart rate, MAP: Mean arterial pressure

Table 6: Complications Related To Intubation

	Ramped group (n = 30)	Sniffing group (n = 30)	P value
Hoarseness			
Yes	3 (10)	6 (20)	0.274
No	27 (90)	24 (80)	
Sore Throat			
Yes	3 (10)	6 (20)	0.274
No	27 (90)	24 (80)	
Teeth Trauma			
No	30 (100)	30 (100)	1.000
Palate Trauma			
No	30 (100)	30 (100)	1.000
Tongue Trauma			
No	30 (100)	30 (100)	1.000

Values are presented as the number of patients (%). Chi-square analysis was performed to compare the distribution rates of the groups

ventilation, the rate of easy intubation was higher in the ramped position group. These results support the view that in addition to contributing to the speed of videolaryngoscopy and facilitating intubation, the ramped position increased the speed of intubation in CS surgery.

The longer laryngoscopy time in the patients in the sniffing position can be attributed to pregnancy-related large breasts obstructing the handle of the videolaryngoscope during the manoeuvre of moving the videolaryngoscope towards the mouth of the patient during intubation. Although the anatomic and physiological changes in pregnancy represent a problem for intubation, this has led to the development of a short laryngoscope handle to improve the ease of intubation (19). However, the McGrath® Series 5 videolaryngoscope used in the current study does not have a short handle. As there is an insufficient area for the laryngoscope in

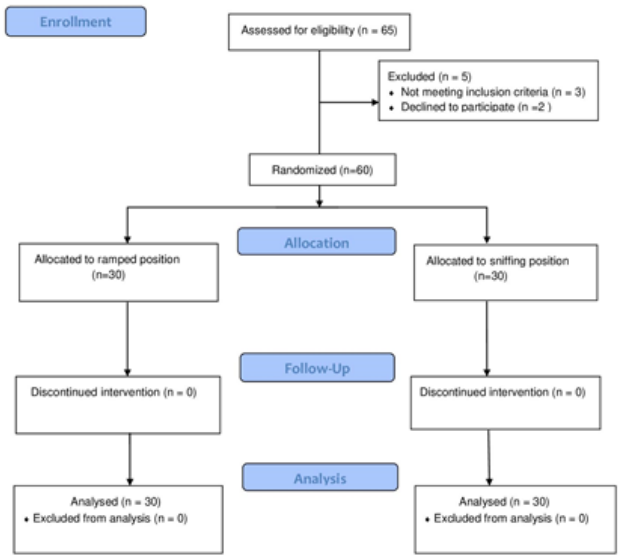

Fig. 1. CONSORT Flow Diagram of Study

patients in the sniffing position, additional manoeuvres can be required such as placement by rotating the videolaryngoscope handle 90° to the right to be able to place the hyperangulated blade of the videolaryngoscope in the mouth. In contrast, there is more room for traditional use of the laryngoscope in the ramped position. This could explain the longer laryngoscopy time in the sniffing position.

Tube insertion time was measured as similar in the two groups of the current study. Lee et al. compared intubation times in morbidly obese patients in the ramped and sniffing positions, and unlike the current study results, reported that tube insertion time was longer in obese patients (20). Edema forming because of increased levels of progesterone in pregnancy can cause narrowing in the upper airways (21). However, this edema that has formed is not of as great an amount as in the upper airways of obese patients together with the accumulated fat mass in the neck and back, and because of the different fat distribution the tube insertion time may not be affected. Another reason may be that there was similar glottic exposure (Cormack grade 1 and 2) in both positions, and the tracheal tube that had been previously shaped according to the videolaryngoscope blade could be advanced to the glottic space and trachea with an equal degree of difficulty.

Despite the similar tube insertion times in the two groups using videolaryngoscopy in CS, the laryngoscopy time and total intubation time were determined to be shorter in the ramped position in the current study. It has been reported that desaturation develops rapidly because of reduced FRC and increased oxygen consumption in pregnancy (9,22). So that both the mother and infant are not left hypoxic, rapid desaturation should be met with rapid intubation in CS. Therefore, the shorter total intubation time in the ramped position has the advantage of being able to prevent desaturation, which can develop rapidly.

Pregnancy is not a risk factor for difficult mask ventilation. No difficult mask ventilation was observed in either group of the current study. This showed that the airway opening was similar in both groups and the airway opening was in parallel with the similar tube insertion times. In a similar study of morbidly obese patients by Lee et al., difficult mask ventilation was seen at a higher rate in the sniffing position, and the intubation time was reported to be longer (20). Successful mask ventilation gives the anesthetist confidence for successful intubation. The current study results showed successful and similar mask ventilation and similar tube insertion time, while Lee et al. reported that the sniffing position resulted in a higher rate of difficult mask ventilation and longer tube insertion time in morbidly obese patients (20).

As a result of the evaluation of complications following intubation in both positions, that no intubation-related complications were observed in this study can be attributed to the similar numbers of interventions and that there were no unsuccessful or lengthy intubations.

There were some limitations to this study. First of all, crossover design was not preferred in this study due to the avoidance of position injuries that may arise from position changes, concerns about airway safety and the risk of hypoxia. A second limitation was that a single type of videolaryngoscope with a hyperangulated blade was used. Therefore care must be taken in the generalisation of the results to other types of videolaryngoscope. Although the evaluations of complications were made blinded to the groups, that the evaluators in the operating room could not be blinded because of the nature of the study could constitute a further limitation. Finally, the study was performed in a single centre and all the intubations by a single senior anesthetist, which could limit the applicability of the study to other institutions or inexperienced anesthetists.

In conclusion, the results of this study demonstrated that total intubation time and laryngoscopy time were shorter in the ramped position than in the sniffing position in CS operations using videolaryngoscopy. The ramped position in intubation with videolaryngoscopy

seems to be a good option for rapid intubation to be able to prevent desaturation and associated complications, which can develop rapidly because of decreased FRC and increased oxygen consumption in pregnancy.

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Declarations: Conflict of interest

All the authors declare that they have no conflicts of interest.

References

1. Souza JP, Betran AP, Dumont A, de Mucio B, Gibbs Pickens CM, Deneux-Tharaux C, et al. A global reference for caesarean section rates (C-Model): a multicountry cross-sectional study. BJOG. 2016;123(3):427-36.
2. Chien P. Global rising rates of caesarean sections. BJOG. 2021;128(5):781-782.
3. OECD (2023), Caesarean sections (indicator). doi: 10.1787/adc3c39f-en (Accessed on 10 October 2023)
4. Hawkins JL, Koonin LM, Palmer SK, Gibbs CP. Anesthesia-related deaths during obstetric delivery in the United States, 1979-1990. Anesthesiology. 1997; 86(2):277-84
5. Cobb BT, Lane-Fall MB, Month RC, Onuoha OC, Srinivas SK, Neuman MD. Anesthesiologist Specialization and Use of General Anesthesia for Cesarean Delivery. Anesthesiology. 2019; 130(2):237-246.
6. Kodali BS, Chandrasekhar S, Bulich LN, Topulos GP, Datta S. Airway changes during labor and delivery. Anesthesiology. 2008; 108(3):357-62.
7. Lapinsky SE. Acute respiratory failure in pregnancy. Obstet Med. 2015; 8(3):126-32.
8. Bhatia P, Chhabra S. Physiological and anatomical changes of pregnancy: Implications for anaesthesia. Indian J Anaesth. 2018; 62(9):651-657.
9. McClelland SH, Bogod DG, Hardman JG. Apnoea in pregnancy: an investigation using physiological modelling. Anaesthesia. 2008; 63(3):264-9.
10. Shah S, Nathan L, Singh R, Fu YS, Chaudhuri G. E2 and not P4 increases NO release from NANC nerves of the gastrointestinal tract: implications in pregnancy. Am J Physiol Regul Integr Comp Physiol. 2001; 280(5): R1546-54.
11. Biro P. Difficult intubation in pregnancy. Curr Opin Anaesthesiol. 2011; 24(3):249-54.
12. Reale SC, Bauer ME, Klumpner TT, Aziz MF, Fields KG, Hurwitz R, et al. Multicenter Perioperative Outcomes Group Collaborators. Frequency and Risk Factors for Difficult Intubation in Women Undergoing General Anesthesia for Cesarean Delivery: A Multicenter Retrospective Cohort Analysis. Anesthesiology. 2022; 136(5):697-708.
13. Mushambi MC, Kinsella SM, Popat M, Swales H, Ramaswamy KK, Winton AL, Quinn AC; Obstetric Anaesthetists' Association; Difficult Airway Society. Obstetric Anaesthetists' Association and Difficult Airway Society guidelines for the management of difficult and failed tracheal intubation in obstetrics. Anaesthesia. 2015; 70(11):1286-306.
14. Apfelbaum JL, Hagberg CA, Caplan RA, Blitt CD, Connis RT, Nickinovich DG, et al. American Society of Anesthesiologists Task Force on Management of the Difficult Airway. Practice guidelines for management of the difficult airway: an updated report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. Anesthesiology. 2013; 118(2):251-70
15. Zaouter C, Calderon J, Hemmerling TM. Videolaryngoscopy as a new standard of care. Br J Anaesth. 2015; 114(2):181-3.
16. Liao CC, Liu FC, Li AH, Yu HP. Video laryngoscopy-assisted tracheal intubation in airway management. Expert Rev Med Devices. 2018; 15(4):265-275.
17. Warters RD, Szabo TA, Spinale FG, DeSantis SM, Reves JG. The effect of neuromuscular blockade on mask ventilation. Anaesthesia. 201; 66(3):163-7.
18. Adnet F, Borron SW, Racine SX, Clemessy JL, Fournier JL, Plaisance P, Lapandry C. The intubation difficulty scale (IDS): proposal and evaluation of a new score characterizing the complexity of endotracheal intubation. Anesthesiology. 1997; 87(6):1290-7.
19. Chang LY, Tsen LC. The development and historical context of the Datta short laryngoscope handle. Anesth Analg. 2013; 117(6):1480-4.
20. Lee S, Jang EA, Hong M, Bae HB, Kim J. Ramped versus sniffing position in the videolaryngoscopy-guided tracheal intubation of morbidly obese patients: a prospective randomized study. Korean J Anesthesiol. 2023; 76(1):47-55.
21. Ede G., Unal R. N. Physiological and Pharmacokinetic Alterations and Drug-Nutrient Interactions During

Pregnancy. Istanbul Med J. 2017;18(3), 120-127.

22. Baraka AS, Hanna MT, Jabbour SI, Nawfal MF, Sibai AA, Yazbeck VG, et al. Preoxygenation of pregnant and nonpregnant women in the head-up versus supine position. Anesth Analg. 1992; 75(5):757-9.