INTRODUCTION

Anesthesia causes deaths directly effect maternal mortality and its airway-related factors. Airway management in obstetrics remains an important problem for several reasons. In the United States of America anesthesia is the seventh most common cause of maternal death. Changes in airway anatomy and physiology during pregnancy can lead to airway management problems. During pregnancy, the diameter of the laryngopharyngeal tract can...
tighten, and the modified Mallampati score could worsen. Thus, hypoxia may occur faster. Additional morbidities such as obesity and preeclampsia can cause problems in airway management. The incidence rate of difficult intubation in pregnancy is 1 per 30 births, according to the literature. The incidence rate of failed intubation in pregnancy is 1 per 280 births, which is 8 times more than that of the normal population. It is better to evaluate several criteria in understanding difficult intubation.

Although the role of ultrasonography (USG) in anesthesia-related airway evaluation and procedural inventions is not clear, its use should be supported. Anatomical structures in supraglottic, glottic, and subglottic areas can be monitored using USG. In airway management, USG can be useful in confirming endotracheal tube placement, in suggesting post-extubation stridor, in the evaluation of soft mass tissues before intubation, and in the determination of pediatric endotracheal tube size. Airway monitoring via USG has several advantages, including the fact that it is reliable, fast, repeatable and transportable.

Changes in the respiratory system during pregnancy are manifest as alterations in the upper airway, also minute ventilation, lung volumes and arterial oxygenation. The pre-operative anaesthesia evaluation should include an assessment of airway. It has been reported that difficult intubation increases with increasing Body Mass Index (BMI). The tracheas of obese patients are believed to be more difficult to intubate than those of normal weight patients. There are lots of factors associated with difficult laryngoscopy which include short sternomental distance, short thyromental distance, large neck circumference, limited head, neck and jaw movement, receding mandible and prominent teeth. But, there are a few simple pre-operative bedside determinations that can be performed quickly to evaluate the airway in a pregnant patient. These include mouth opening, Mallampati classification, thyromental distance and atlanto-occipital extension. It is recommended that the airway be reassessed before induction of general anesthesia. Soft tissue changes such as airway edema are an invariable association of pregnancy, and this may contribute to difficult intubation. The underlying cause for this change is attributed to fluid retention that occurs with pregnancy. Upper airway volume has two components: an oral component and a pharyngeal component. The oral component is the one normally assessed using Mallampati classification.

The pharyngeal volume is concealed and not evaluated in clinical practice. The aim of this study was to compare the ultrasonic measurements of the transverse diameter of the upper airway and clinical scanning tests for difficult intubation in pregnant women with a BMI higher and lower than 30 kg m$^{-2}$. Is USG useful or not to evaluate the subglottic area volume changes in pregnant patients according to BMI?

METHODS

This study was a prospective observational trial and conducted in Bagcilar Training and Research Hospital. Permission was granted by the hospital’s ethics committee, and written consent was obtained from patients. Forty pregnant women of American Society of Anesthesiologists (ASA) I-2 scheduled for general anesthesia for cesarian operation were included in the study, which took 4 months to be completed. Patients with airway malformation and pathology causing limitations in head-neck movements were excluded. Diabetes mellitus and chronic hypertension were evaluated as comorbid diseases.

The degree of obesity was calculated according to the classification of the BMI of the World Health Organization, which is adopted by the American College of Obstetrics for pregnant patients. Body Mass Index was determined with BMI=weight (kg) height$^{-2}$ (cm) formula. Patients were assigned into Group 1 (n=20) and Group 2 (n=20), according to BMI being lower and higher than 30 kg m$^{-2}$, respectively.

Every patient taken to the operation room was monitored non-invasively for arterial pressure (mmHg), heart rate (HR per minute), and peripheral oxygen saturation (SpO2). Patients were informed about the operation, and all patients had USG by the same practitioner. All ultrasonographic investigations were performed with USG (SDU-450 XL, Kyoto, Japan).

Each patient’s head was placed into mild extension in the supine position. The patient was ordered to breathe slowly in order to avoid airway changes due to breathing. Ultrasonographic measurement was performed from the mid-front part of the neck using a linear probe (5-10 MHz). Ultrasonographic procedure started from the level of true vocal cords, and tracheal arc was monitored by moving the probe slowly towards the caudal direction in order to avoid disorder between the tracheal cartilage and tracheal ring. The diameter of the tracheal transverse air shadow in the subglottic...
area was measured three times and mean value was calculated. Besides patients’ demographic data, and modified Mallampati score (Table-I) were evaluated. Thyromental distance and sternomental distance measurements were made and recorded. Patients were preoxygenated with 100% oxygen for 3 minutes. Anesthesia was standardized in all patients using a rapid-sequence induction protocol. Patients were given propofol 2 mg/kg, and succinylcholine 1.5 mg/kg, or rocuronium 0.6 mg/kg. After cricoid pressure was applied and the trachea was intubated anesthesia was maintained with sevoflurane in a mixture of nitrous oxide 2 L/min and oxygen 2 L/min, and the lungs of all patients were mechanically ventilated to maintain an ETCO2 concentration of 32–37 mmHg. Patients underwent laryngoscopy by the same advanced specialist anesthesiologist after general anesthesia application and Cormack-Lehane score (Table-II) was recorded. After delivery, midazolam 2 mg and fentanyl 100 µg were given intravenously.

The sample sizes were calculated with the assumption of a possible in ultrasonic measurements at least of 20% between any two groups. Therefore 20 patients were assigned into each group in order to obtain an alpha error of 5% and statistical power of 80%.

Statistical Analysis: Statistical analysis in this study were made using NCSS (Number Cruncher Statistical System) 2007 Statistical software (Utah, USA). In addition to definitive statistical methods (mean standard value, median, interquartile range), the Mann-Whitney U test was used to compare groups, and the chi-square test was used to compare qualitative data. A p<0.05 was accepted as statistically significant.

RESULTS

There were no statistically significant differences between groups regarding mean age range (p=0.694) and mean number of pregnancy range (p=0.628). Group 2 had statistically significant higher mean values in terms of body weight (p=0.0001), pre-pregnancy body weight (p=0.0001), and BMI (p=0.0001) compared to Group 1 (Table-III). There were no statistically significant differences between groups regarding ASA scores (p=0.292), co-morbid disease presence range (p=0.376) (Table-IV). There were no statistically significant differences between groups regarding mean values of the modified Mallampati scores (p=0.068) and Cormack-Lehane scores (p=0.365) (Table-V). There were no statistically significant differences between groups regarding the measurements of thyromental distance (p=0.539), sternomental distance (p=0.535), and ultrasonic measurement values (p=0.160) (Table-VI).

DISCUSSION

Obesity is defined as having a BMI higher than 30 kg m\(^{-2}\). Due to massive adipose tissue presence, oral opening and jaw movement limitations and tightening in pharyngeal distance are seen in obese patients. Endotracheal intubation is more difficult in obese patients and pregnant women in comparison to patients with normal body weight. It is reported that difficult intubation risk increases with a rise in BMI, particularly in those with a BMI higher than 30 kg m\(^{-2}\).
than 35 kg m\(^{-2}\), where in the incidence of difficult intubation is as high as 15%.\(^\text{8,18}\) Difficult or failed intubation in pregnant women causes an increase in maternal morbidity and mortality by increasing the risk for hypoxic cardiac arrest and/or pulmonary aspiration. Therefore, careful examination must be carried out prior to anesthesia to determine the predictive factors for difficult intubation.\(^\text{3}\) There are no specific tests to evaluate the airway in obstetric and obese patients, and classical tests are used for these populations. However, none of these methods are adequate for predicting difficulty in endotracheal intubation.\(^\text{19}\) Short sternomental distance and thyromental distance, limitations in head-neck and jaw movements, and modified Mallampati scores higher than 3 indicate a high possibility of difficult intubation.\(^\text{8}\) Although difficult intubation risk is reported to be 34% after a positive Mallampati test, this finding cannot be used as a predictive parameter by itself.\(^\text{17}\) Our study showed no statistically significant difference between groups in the clinical tests. None of our patients had a modified Mallampati score or Cormack-Lehane score of 4. Two patients in the group with BMI>30 kg m\(^{-2}\) had difficult intubation. Both of these patients had a modified Mallampati score of 2 and a Cormack-Lehane score of 3. While the first patient was intubated on second attempt with blind intubation technique, the latter was intubated on the third attempt without usage of any alternative device. We have not expected any ventilation difficulty in our patients.

Although using USG findings in suggesting difficult intubation can be useful, the data is limited.\(^\text{6}\) In various clinical trials, USG-related difficult intubation criteria were investigated but results are controversial.\(^\text{6,17,20-22}\) Kundra et al\(^\text{6}\) reported pretracheal soft tissue thickness via USG at vocal cord level in obese patients as a good predictor for difficult intubation. However, Komatsu et al\(^\text{17}\) reported that pretracheal soft tissue thickness is not an indicator of difficult laryngoscopy in morbidly obese patients. Adhikari et al\(^\text{20}\) measured the soft tissue of the neck and tongue thickness via USG in normal patients, and found no statistically significant difference between measurements and clinical scan tests. Another study found that pretracheal soft tissue thickness is not a good indicator for difficult intubation in morbidly obese patients.\(^\text{21}\) Wojtczak’s study\(^\text{22}\) showed that hyomental space measurements using USG can be useful in predicting difficult intubation. One of the anatomical changes pregnancy causes is pharyngolaryngeal tightening, which is worsened by obesity. Ultrasonography is defined as a reliable tool for determining the narrowest diameter in the cricoid lumene. In their study, Prasad et al\(^\text{23}\) compared USG and anatomic airway parameters using USG and computerized tomography (CT). Results showed that all structures able to be evaluated via CT can be monitored using USG. Lakhal et al\(^\text{12}\) compared the diameter of the cricoid lumene measurements using USG and magnetic resonance imaging in healthy, young adults, and concluded that diameter of the upper airway can be reliably measured using USG. Our study concluded that ultrasonic measurements of the subglottic area does not change according to BMI. We did not find any differences between conventional preoperative airway evaluation tests and USG findings in obese pregnant patients.

In conclusion, ultrasonographic evaluation of the upper airway may provide anatomic information, but it is not useful alone. We thought that ultrasonic measurement could not give us valuable information in obese or non-obese pregnant women. We suggest that obesity in pregnant women does not cause a significant change in thyromental distance, sternomental distance, modified Mallampati score, or Cormack-Lehane score in ultrasonographic measurements although USG is a reliable, non-

| Table-V: Modified Mallampati Score and Cormack-Lehane Score in groups. | Group 1 (n=20) | Group 2 (n=20) | P     |
|--------------------------|----------------|----------------|-------|
| ASA Score 1              | 19             | 17             | 0.292 |
| Modified Mallampati Score 1 | 13             | 6              | 0.068 |
| Score 2                  | 7              | 13             | 0.365 |
| Cormack-Lehane Score 3   | 1              | 9              | 0.000 |
| Score 4                  | 0              | 1              | 0.000 |

*p<0.05

| Table-VI: Thyromental distance, sternomental distance and ultrasonographic measurement in groups. | Group 1 (n=20) | Group 2 (n=20) | p     |
|-------------------------------------------|----------------|----------------|-------|
| Thyromental distance (cm)                 | 7.28±1.28      | 7.58±0.75      | 0.539 |
| Sternomental distance (cm)                | 11.25±1.73     | 11.55±1.77     | 0.535 |
| Ultrasonographic measurement (mm)         | 16.78±2.13     | 17.69±1.91     | 0.160 |

*p<0.05 (Mean±SD)
invasive airway measurement, and it is safe to use during pregnancy. However, further clinical experience and studies are required to assess this conclusion in greater depth.

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**REFERENCES**

1. Balki M, Cooke ME, Dunington S, Salman A, Goldszmidt E. Unanticipated difficult airway in obstetric patients: development of a new algorithm for formative assessment in high-fidelity simulation. Anesthesiology. 2012;117(4):883-897.
2. Boutonnet M, Faitot V, Keita H. Airway management in obstetrics. Ann Fr Anesth Reanim. 2011;30:651-664. doi: 10.1016/j.janfar.2011.03.024
3. Munurar U, de Boisblanc B, Suresh MS. Airway problems in pregnancy. Crit Care Med. 2005;33:259-268.
4. Kodali BS, Chandrasekhar S, Bulich LN, Topulos GP, Datta S. Airway changes during labor and delivery. Anesthesiology. 2008;108(3):357-362. doi: 10.1097/ALN.0b013e31811452d3
5. Singh M, Chim KJ, Chan VW, Wong DT, Prasad GA, Yu E. Use of sonography for airway assessment: an observational study. J Ultrasound Med. 2010;29(1):79-85.
6. Kundra P, Mishra SK, Ramesh A. Ultrasound of the airway. Indian J Anaesth. 2011;55:456-462. doi: 10.4103/0019-5049.988687
7. Kristensen MS. Ultrasonography in the management of the airway. Acta Anaesthesiol Scand. 2011;55:1155-1173. doi: 10.1111/j.1399-6576.2011.02518
8. Rao DP, Rao VA. Morbidly obese parturient: Challenges for the anaesthesiologist, including managing the difficult airway in obstetrics. What is new? Indian J Anaesth. 2010;54:508-521. doi: 10.4103/0019-5049.72639
9. Voyagis GS, Kyriakis KP, Dimitriou V, Vrettou I. Value of oropharyngeal Mallampati classification in predicting difficult laryngoscopy among obese patients. Eur J Anaesthesiol. 1998;15:330-334.
10. Benumof JL. Obstructive sleep apnoea in the adult obese patient: implications for airway management. J Clin Anesth. 2001;13:144–156.
11. Farcon EL, Kim MH, Marx GF. Changing Mallampati score during labour. Can J Anaesth. 1994;41:50–51.
12. Lakhal K, Delplace X, Cottier JP, Tranguer F, Sauvagnac X, Mercier C, et al. The feasibility of ultrasound to assess subglottic diameter. Anesth Analg. 2007;104:611-614.
13. Safavi M, Honarmand A, Zare N. A comparison of the ratio of patient’s height to thyromental distance with the modified Mallampati and the upper lip bite test in predicting difficult laryngoscopy. Saudi J Anaesth. 2011;5:258-263. doi: 10.4103/1658-354X.84098
14. Cormack RS, Lehane J. Difficult tracheal intubation in obstetrics. Anaesthesia. 1984;39:1105-1111.
15. Juvin PH, Lavaut E, Dupont H, Lefevre P, Demetriou M, Dumoulin JL, et al. Difficult tracheal intubation is more common in obese than in lean patients. Anesth Analg. 2003;97:595-600.