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The measurement of skin to epiglottis length for difficult airway prediction by ultrasonography in obese pregnant women: Prospective cohort study

Obez gebelerde zor havayolunu tahmin etmek için cilt-epiglot mesafesinin ultrasonografi ile ölçümü: Prospektif kohort çalışma

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Abstract

Aim: The risk of difficult airway is high in obstetric anesthesia, and weight gain above physiological limits further increases this risk. Ultrasonography (USG) has often been used recently in airway evaluation of all patient groups. The aim of this study was to investigate the effect of weight gain beyond physiological limits on the measurement of the distance of the skin-to epiglottis (DSE) with USG.

Methods: 50 pregnant women aged between 20-40 years, half of which had gained weight within physiological limits during pregnancy (<15kg) (Group 1) and the other half whose weight gain was equal to or greater than 15 kilograms (Group 2) were included in this study. The measurements were labelled as "a" and "b" for the first and third trimesters. Mallampati evaluation was made during ultrasonographic measurements in all pregnant patients by an anesthesiologist blinded to the study.

Results: No statistically significant difference was determined between the Group 1 and Group 2 pregnant patients with respect to age, BMI, and distance of skin to epiglottis (DSE) values (P=0.293, P=0.281, P=0.515). A statistically significant increase in BMI and DSE was detected in Group 2b when compared to Group 1b (both: P<0.001).

Conclusion: Ultrasonographic DSE measurement in pregnant women with weight gain above the physiological limit during pregnancy may be used to predict difficult airways when utilized together with Mallampati scoring, especially during the third trimester.

Keywords: Obesity, Pregnancy, Difficult airway, Ultrasonography

Öz

Amaç: Obstetrik anestezide zor havayolu riski yüksektir. Fizyolojik sınırların üzerinde kilo artışı ile bu risk daha da artmaktadır. Son yıllarda bütün hasta gruplarında havayolu değerlendirilmesinde ultrasonografi sıklıkla kullanılmaktadır. Bu çalışmada gebelerde fizyolojik sınırların üzerindeki kilo artışının ultrasonografi ile cilt epiglot mesafesi ölçümüne etkisinin araştırılması amaçlanmıştır.

Yöntemler: 20-40 yaş arası gebeliği boyunca beklenen fizyolojik sınırda kilo artışı gösteren Grup 1 olarak isimlendirilen (n:25) ve aynı yaş grubunda gebeliği boyunca beklenenden daha fazla (fizyolojik sınır olan 15kg ve üstü) kilo artışı gösteren ve Grup 2 olarak isimlendirilen (n:25) toplam 50 gebe çalışmaya alınmıştır. Radyoloji kliniğine gebelikle ilgili rutin USG kontrolü için başvuran gebelere birinci ve üçüncü trimesterde eş zamanlı olarak boyun USG yapılarak cilt-epiglot mesafesi ölçülmüştür. 1. trimester ölçümler 'a', 3. trimester ölçümler 'b' harfi ile isimlendirilmiştir. Ultrasografik ölçümler sırasında tüm gebelerin mallampati değerlendirmesi çalışmayı bilmeyen bir anestezi uzmanı tarafından yapılmıştır.

Bulgular: Grup 1 ve 2'de bulunan gebelerin yaş, beden kitle indeksi ve ölçülen cilt-epiglot mesafesi yönünden istatistiksel olarak anlamlı bir fark olmadığı bulunmuştur (P=0,293, P=0,281, P=0,515). Grup 1b ve 2b değerlendirildiğinde beden kitle indeksi ve ölçülen cilt-epiglot mesafesi değerlerinde istatistiksel olarak anlamlı bir artış tespit edildi (P<0,001).

Sonuç: Üçüncü trimesterde preoperatif havayolu değerlendirilmesinde, özellikle fizyolojik sınırların üstünde kilo alımı olan gebelerde non-invaziv bir teknik olan ultrasonografi ile cilt epiglot mesafesi ölçümü ve mallampatinin birlikte değerlendirilmesi zor havayolu tahmininde güvenilir bir belirteçtir.

Anahtar kelimeler: Obezite, Gebelik, Zor havayolu, Ultrasonografi

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Introduction

The risk of difficult airway is high in obstetric anesthesia [1]. The most important cause of maternal morbidity and mortality related to anesthesia is difficulty in intubation. The oxygen reserves in pregnant patients are reduced, which makes it necessary to take precautions by estimating difficult airway preoperatively [1]. The recent Obstetric Anesthetists' Association/Difficult Airway Society Guidelines emphasize that an airway assessment should be performed before induction of general anesthesia [2]. This evaluation should be made not only to decrease difficult intubation, but also to evaluate the possibility of difficult mask ventilation and the difficulty of placement of the supraglottic airway device [2].

The dramatically increasing rate of obesity in the general population also extends to women of reproductive age. The anesthesiologist must be prepared to customize a perioperative plan to take care of these patients in the operating rooms [3]. Obesity increases the risk for cesarean delivery significantly and anesthesiologists are increasingly faced with morbidly obese patients. Several studies have reported that obesity was a major risk factor for maternal mortality. Obesity and its associated comorbidities, including obstructive sleep apnea, right ventricular failure, cardiomyopathy, diabetes mellitus, hypertension, and thromboembolic disease pose anesthetic challenges with failed intubation and aspiration representing the cause of death in most cases [4,5].

Airway ultrasonography (USG) is a simple, safe and noninvasive technique that can provide images of the concealed upper airway from the uvula to the glottis [6,7]. The engorgement of the oropharyngeal mucosa leads to an increase in Mallampati score, which this causes difficulties in intubation [8]. In addition to these factors, weight gain above the physiological limits may cause differences in airway evaluation with USG. Pinto et al. [9] reported that measuring the distance of the skin-to epiglottis (DSE) was a bedside test that could be used to estimate difficult laryngoscopy, and a cutoff value of 27.5mm provided an accuracy, sensitivity and specificity of 74.3%, 64.7% and 77.1%, respectively.

The aim of this study was to investigate the effect of weight gain above the physiological limits on the measurement of the skin to epiglottis distance with USG, a non-invasive technique which can be used daily to evaluate the obese pregnant individuals' airways.

Materials and methods

Approval for the study was granted by the Institutional Ethics Committee (Decision number: 2017-KAEK-189_2018.02.27_08).

50 pregnant women aged between 20-40 years, half of which had gained weight within physiological limits during pregnancy (<15kg) (Group 1) and the other half whose weight gain was equal to or greater than 15 kilograms (Group 2) were included in this study [10].

The patients were selected from those who were referred to the Radiology Clinic for routine antenatal ultrasonographic examination during the first and third trimesters and whose DSE were measured with neck ultrasonography. The measurements were labelled as "a" and "b" for the first and third trimesters. Mallampati evaluation was made during ultrasonographic measurements in all pregnant patients by an anesthesiologist blinded to the study.

Sonographic evaluation

DSE measurements were performed by the same radiologist blinded to the study, using a Ge-Health Care Logiq S7 device with a 10-13-MHz linear transducer. Patients were placed supine with their head and neck in a neutral position. Until the epiglottis was visible through the thyrohyoid membrane as a curvilinear hypoechoic structure, the airway was systematically imaged along its course using the linear transducer oriented transversely across the anterior surface of the neck. Swallowing facilitated identification of the epiglottis as a discrete mobile structure. The borders of the epiglottis were delineated by the brighter linear air-mucosa (A-M) interface (posterior) and pre-epiglottic space (anterior). DSE values were calculated with three measurements (central axis and the left - right extremities of the epiglottis) obtained from each patient and the mean value was used in the analysis [9].

Statistical analysis

Data obtained in the study were analyzed with SPSS v25.0 software. Conformity of the data to normal distribution was assessed with the Kolmogorov-Smirnov test, which showed that the data were non-normally distributed. Mann Whitney U-test was used for comparisons between the groups, and Wilcoxon Signed Ranks test was used for repeated measurements. Relationships between variables were evaluated with Spearman's rho correlation test. $P<0.05$ was considered statistically significant.

Power analysis was performed with G*Power 3.1.9.2 software. The power of this data was calculated as $1-\beta=0.82$ with $n_1=25$, $n_2=25$, $\alpha=0.05$ and an effect size of $d=0.85$.

Results

No statistically significant difference was determined between Group 1a and Group 2a with respect to age, body mass index (BMI), and DSE values ($P=0.293$, $P=0.281$, $P=0.515$, respectively) (Table 1). A significant increase was detected in BMI and DSE increases in each group (both: $P<0.001$) and between Groups 1b and 2b (both: $P<0.001$) (Table 2).

Table 1: Comparisons of age, BMI, and DSE values between Groups 1a and 2a

	Group 1a (n=25)	Group 2a (n=25)	Z	P-value
Age (years)	27 (18 - 35)	29 (18 - 37)	-1.052	0.293
BMI (kg/m2)	23.3 (20.8-34.2)	24.5 (20.1-31.3)	-1.078	0.281
DSE (mm)	24.2 (20.3-31.3)	24.9 (20-29)	-0.650	0.515

*: Mann-Whitney U Test (median [minimum-maximum])

Table 2: Comparisons of BMI, and DSE values between Group 1b and Group 2b

	Group 1b (n=25)	Group 2b (n=25)	Z	P-value
BMI (kg/m2)	23.3 (20.8-34.2)	25.6 (21-33.2)	-4.377	<0.001
DSE (mm)	24.2 (20.3-31.3)	26.2 (20.5-31)	-4.375	<0.001

*: Wilcoxon Signed Ranks Test (median [minimum-maximum])

A significantly positive correlation was determined between BMI and DSE in Group 1 in both trimesters (r=0.856, $P<0.05$) (Figure 1). The correlation coefficients of the first and third trimesters in Group 1 were 0.697 and 0.689, respectively. The overall correlation coefficient between BMI and DSE was 0.764.

No statistically significant difference was determined between Group 1a and Group 2a with respect to Mallampati

scores (*P*=0.249). The Mallampati scores of Group 2b were significantly higher than those of Group 1b and Group 2a (both: *P*<0.001) (Table 3). Mallampati scores and DSE values of the groups were not significantly correlated (*P*>0.05).

Table 3: Comparisons of Mallampati values between Group 1b and Group 2a

	Group 1b (n=25)	Group 2a (n=25)	Group 2b (n=25)	*P*-value
Mallampati	2 (1 - 3)	2 (1 - 3)	3 (2 - 4)[a]	<0.001

a: Group 2b values were significantly higher than Group 1b and Group 2a (z values -5.139, -4.796 respectively), *: Mann-Whitney U Test (median [minimum-maximum])
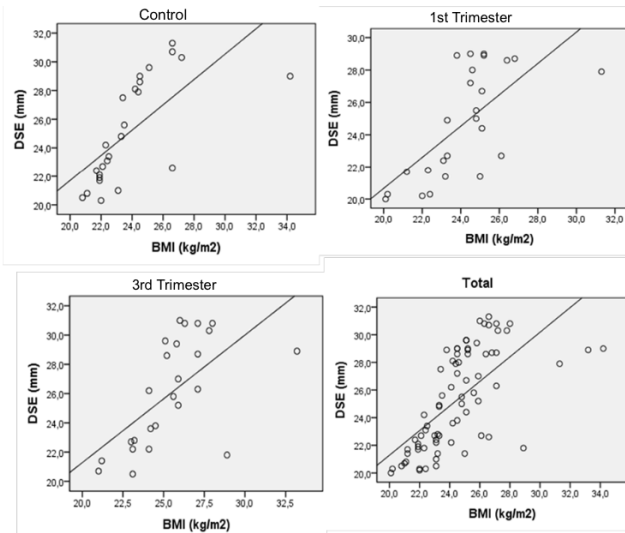

Figure 1: The correlations of DSE with BMI in Group 2

Discussion

Airway ultrasonography is a simple, safe, noninvasive technique that can provide images of the concealed upper airway from the uvula to the glottis. Hui et al. [11] used ultrasonography to image the sublingual space in a non-pregnant population. Sublingual USG has been shown to be well tolerated, and it has been reported that this technique may be relevant in pregnant women [12].

In another study of airway evaluation with USG in non-pregnant, morbidly obese patients, the distance between the midline skin and the larynx, the tracheal anterior wall at the level of the vocal cords and suprasternal notch, was found high in patients with difficult laryngoscopic findings [13]. Specific predictors for USG assessments of airway have not yet been established and there is a need for standardized USG scan measures for preoperative airway assessments. The cut off value of 27.5mm for difficult laryngoscopy was considered as the reference value for the current study in which soft tissue thickness was measured with USG between the skin and the epiglottis at the level of the thyroid membrane in elective patients [9]. In this study, no difficulties were encountered in any of the pregnant patients during DSE measurements.

Obesity is currently the most frequently seen global epidemic eating disorder with increasing incidence. Increased BMI is correlated with an increase in morbidity and mortality. In pregnancy, the growing fetus, placental and amniotic components, and increases in adipose tissue and fluid cause changes in the body. Generally, the increase in body weight during pregnancy is difficult to differentiate from obesity in obstetric patients. The incidence of unsuccessful intubation in the general population is approximately 1:2500 and this rate increases to 1:280 in obstetric cases. The addition of obesity to pregnancy not only increases the frequency of unsuccessful intubation but also complicates mask ventilation. The incidence of failed intubation in the morbidly obese pregnant women was reported as high as 33% [14]. The results of our study showed a positive correlation between increased BMI and DSE measurement. Therefore, a high DSE measurement on USG suggests that meticulous preoperative preparations should be made for difficult airway in obese pregnant patients.

Although the Mallampati score is widely used in preoperative airway evaluation, this scoring system has low sensitivity (50%) and specificity (89%) [11]. In a study examining the changes in Mallampati classification during pregnancy, birth, and the postpartum period, the incidence of Mallampati 3 and 4 reportedly increased from the 8th month of pregnancy until birth and these changes reversed within 48 hours after delivery [15]. In other studies in literature, Pilkington et al. [16] observed an increase in Mallampati scores during the course of pregnancy, and Abe et al. [4] confirmed these observations and reported that the engorgement of the oropharyngeal mucosa leads to an increase in Mallampati scores during labor and delivery. In accordance with those findings, Mallampati scores in our study were observed to increase in association with pregnancy and weight gain beyond the physiological limits, but no correlation was determined between Mallampati scores and DSE. This result may have been affected by the low number of patients. Nevertheless, both parameters are important in the evaluation of difficult airway, and when either is elevated, great care is required with respect to preparation for a difficult airway.

Limitation

An important limitation of this study is that as none of the pregnant patients underwent caesarean section under general anesthesia, hence, there was no actual evaluation of whether the airways were difficult. In our hospital, the rates of normal spontaneous vaginal delivery with epidural analgesia are extremely high. When indications for caesarean delivery arise, surgery is performed under epidural analgesia, which decreases the number of pregnant patients who received general anesthesia.

Conclusion

Weight gain in pregnancy over the expected physiological limit, especially during the 3rd trimester, increases DSE values measured ultrasonographically. Although no correlation was found between Mallampati scores and DSE, ultrasonographic DSE measurement, a non-invasive and easily performable technique, may be considered a more reliable warning of a difficult intubation than expected.

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