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ORIGINAL ARTICLE
ORİJİNAL ARAŞTIRMA

The Effect of Sonographic Head Circumference on Delivery Mode and Perineal Laceration

Ultrasonografik Baş Çevresinin Doğum Şekli ve Perine Yırtığı Üzerine Etkisi

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ABSTRACT

Aim: The present study aimed to determine the role of head circumference for delivery mode and perineal laceration both in primiparous and multiparous patients and compare this role with estimated fetal weight.

Material and Method: A total of 866 patients, who delivered in our clinic were divided into two groups: vaginal delivery (n=604) and cesarean section (n=262). Demographic characteristics, sonographic head circumference, estimated fetal weight, birth week and weight, presence of severe perineal laceration, gender, neoatal head circumference, Apgar scores were compared between groups.

Results: The median head circumference was 339 (302-384) milimeter in vaginal delivery and 347 (314-384) milimeter in cesarean section (p<0.001). Sonographic head circumference was positively correlated with estimated fetal weight (r=0.561,p<0.001), birth weight (r=0.446,p<0.001) and neonatal head circumference (r=0.396,p<0.001). Head circumference >35.4 predicted cesarean section with 36.3% sensitivity and 84.8% specificity (AUC=0.637,p<0.001) and >35.2 predicted perineal laceration with 78.6% sensitivity and 85.4% specificity (AUC=0.853,p<0.001). Head circumference was superior for cesarean section as compared to estimated fetal weight (p=0.003) whereas no difference was found for perineal laceration (p=0.64).Head circumference >34.9 predicted cesarean section with 60% sensitivity and 73.8% specificity (AUC=0.692,p<0.001) in primiparous while >35.4 predicted cesarean section with 34.3% sensitivity and 84.5% specificity in multiparous women (AUC=0.624,p<0.001).

Conclusion: Considering large head circumference was more strongly associated with cesarean delivery and perineal lacerations than estimated fetal weight, we suggest that measuring head circumference would be an appropriate approach for determining delivery mode and complications.

Keywords: Cesarean section, estimated fetal weight, head circumference, perineal tear, vaginal delivery

ÖZ

Amaç: Bu çalışmanın amacı, hem primipar hem de multipar hastalarda baş çevresinin doğum şekli ve perine yırtığı üzerindeki rolünü belirlemek ve bu rolü tahmini fetal ağırlıkla karşılaştırmaktır.

Gereç ve Yöntem: Kliniğimizde doğum yapan toplam 866 hasta iki gruba ayrıldı: vajinal doğum (n=604) ve sezaryen (n=262). Demografik özellikler, ultrasonografik baş çevresi, tahmini fetal ağırlık, doğum haftası ve ağırlığı, şiddetli perine yırtığı varlığı, cinsiyet, neonatal baş çevresi, Apgar skorları gruplar arasında karşılaştırıldı.

Sonuçlar: Ortanca Baş çevresi vajinal doğum grubunda 339 (302-384) milimetre ve sezaryen doğumda 347 (314-384) milimetre idi (p<0,001). Ultrasonografik baş çevresi, tahmini fetal ağırlık (r=0,561, p<0,001), doğum ağırlığı (r=0,446, p<0,001) ve yenidoğan baş çevresi (r=0,396, p<0,001) ile pozitif korelasyon gösterdi. Baş çevresinin >35,4 olması sezaryen doğumu %36,3 duyarlılık ve %84,8 özgüllükle (AUC=0,637, p<0,001) ve >35,2 olması perine yırtığı %78,6 duyarlılık ve %85,4 özgüllükle (AUC=0,853, p<0,001) öngördü. Baş çevresi sezaryen için tahmini fetal ağırlığa göre daha üstündü (p=0,003) ancak perineal laserasyon için fark bulunamadı (p=0,64). Baş çevresi >34,9 primipar kadınlarda %60 duyarlılık ve %73,8 özgüllükle sezaryen doğumu tahmin ederken (AUC=0,692, p<0,001) >35,4 multipar kadınlarda %34,3 duyarlılık ve %84,5 özgüllükle sezaryen doğumu tahmin etti (AUC=0,624, p<0,001).

Sonuç: Büyük baş çevresinin sezaryen doğum ve perineal laserasyonlarla tahmini fetal ağırlığa göre daha güçlü bir şekilde ilişkili olduğu düşünüldüğünde, baş çevresinin ölçülmesinin doğum şeklini ve komplikasyonları belirlemek için uygun bir yaklaşım olabilir

Anahtar Kelimeler: Sezaryen, tahmini fetal ağırlık, baş çevresi, perine yırtığı, vajinal doğum

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INTRODUCTION

Cesarean section is the most common surgical procedure performed in obstetric practice. Although it is life-saving in some circumstances, like other surgeries, it has some complications. Perioperative complications such as aspiration, adjacent organ injury, hemorrhage, wound infections and future complications such as placenta accreata spectrum and pelvic adhesions are some of associated perinatal morbidities (1,2). There is an increasing trend to find preventive strategies all around the world to reduce cesarean section rates. On the other hand, pelvic lacerations, operative births, shoulder dystosia and asphyxia are some of the complications of vaginal birth (3,4). Thus, obstetricians are torn between the pressure to reduce the cesarean section rate on the one hand, and the desire to ensure perinatal well-being on the other. Therefore, it is crucial to give appropriate caesarean section decision is of vital importance.

Considering that the harmony between the passage and the passenger has a critical role for vaginal birth, the role of anthropometric measurements were started to be investigated (5). Fetal weight estimation has shown to be a gold standard approach to decide delivery mode for many years (6). Recent studies have focused especially on the fetal head (7). These studies claimed that head circumference has been a good predictor for operative deliveries, cesarean section, perineal laceration and is better than the birth weight for adverse obstetric outcomes (6,8-10). Other studies defined an equal role for head circumference and estimated fetal weight (5,8,11). Similar to the confliction in the comparative role of two parameters, there is no clear results for the correlation with neonatal features and the cut-off levels predicting these outcomes. Then, the researchers made an effort to determine cut-off levels for head circumference to predict operative deliveries and cesarean section. But, there was a conflicting results about this issue and the studies were lack of the categorization for parity (5,6,12).

Here, we aimed to determine the correlation between sonographic head circumference, neonatal head circumference and birth weight. Secondary aim was to determine the predictive role of sonographic head circumference for delivery mode and severe perineal laceration in vaginal birth. Additionally, the predictive role of sonographic head circumference was determined for primiparous and multiparous patients and aimed to be compared with estimated fetal weight.

MATERIAL AND METHOD

The present study was designed as a retrospective case control study. It was performed at University of Health Sciences, Bursa Yuksek Ihtisas Research and Training Hospital, Department of Obstetrics and Gynecology between April 2018 and September 2019. The local ethics committee approved the study (2011-KAEK-25 2019/10-17) and also it was in accordance with Helsinki declaration. For using medical records of study participants, written informed consent was taken from all patients.

Study Population

A total of 866 patients, who delivered in our clinic were admitted to the study. The participants were divided into two groups: vaginal delivery (n=604) and cesarean section (n=262) groups. The inclusion criteria were as follows: having term (37 to 42 weeks of gestation), viable, singleton pregnancy with vertex presentation, being 18 to 45 years old, having available perinatal records and sonographic measurements within 1 week of delivery. Exclusion criteria of the study consists of having fetal anomaly, preterm births, multiple pregnancy, previous uterine surgery, conditions leading to fetal growth restriction, malpresentations and elective cesarean section patients.

Demographic characteristics such as age, gravida, parity, height, weight, body mass index, sonographic head circumference and estimated fetal weight, birth week and mode, presence of severe perineal laceration (stage 3 and 4), birth weight, gender, head circumference of the baby, Apgar scores of neonates were recorded from hospital medical records.

In sonographic evaluation, we routinely use Hadlock formula for estimated fetal weight which use the biparietal diameter, head circumference, abdominal circumference and femur length for calculation. Biparietal diameter refers the measurement between outer and inner borders at the level of cavum septum pellucidum while head circumference presents elipsed-shape perimeter around fetal kranium. Perimeter of the fetal abdomen at the level of umbilical vein is defined as abdominal circumference. Fetal femur length refers to the distance between the diaphysis of femoral bones (13,14). Additionally, neonatal birth weight and head circumference are measured by widwifes in delivery room. Neonatal head circumference presents the maximal horizontal plane above eyebrows, ears and two occipital prominenses (15).

Statistical Analysis

The normality of variables were tested with Shapiro Wilk test. The Student t-test was used to compare normally distributed continuous variables whereas Mann Whitney-U test was performed for non-normally distributed variables. Categorical variables were compared with Chi-square or Fisher's Exact test. Data were presented as mean±standard deviation or median (minimum-maximum) values for continuous variables and frequency (percentages) for categorical variables. Spearman correlation coefficient was applied to assess the relationship between sonographic head circumference, estimated fetal weight, birth weight and neonatal head circumference. The predictive role

of sonographic head circumference and estimated fetal weight for delivery mode was assessed by ROC analysis. SPSS version 22.0 and MedCalc 18 programs were used for statistical analysis. An alfa value ≤0.05 was considered as statistically significant.

RESULTS

The demographic, sonographic and perinatal features of patients were presented in **Table 1**. There was no significant difference between vaginal delivery and cesarean section groups in terms of body mass index, parity, birth week, Apgar fifth minutes scores and neonatal intensive care unit admission rates. Statistically significant difference was present in according to age, sonographic head circumference, estimated fetal weight, neonatal head circumference, birth weight, fetal gender and first minutes Apgar scores.

The box-plot graph showing the distribution of head circumference and estimated fetal weight was presented in **Figure 1**. The median head circumference was 339 (302-384) milimeter in vaginal delivery group and 347 (314-384) milimeter in cesarean section group which was statistically significant. Similarly, estimated fetal weight, neonatal head circumference and birth weight were smaller in vaginal delivery group.

Spearman correlation coefficient was applied to assess the relationship between sonographic head circumference, estimated fetal weight, birth weight and neonatal head circumference. The correlation analysis was demonstrated in **Table 2**. Sonographic head circumference was found to be positively correlated with estimated fetal weight (r=0.561, p<0.001), birth weight (r=0.446, p<0.001) and neonatal head circumference (r=0.396, p<0.001).

Table 1. The demographic, sonographic and perinatal features of patients

	Vaginal delivery (n=604)	Cesarean section (n=262)	p
Age (years)	22 (18-42)	24 (18-42)	<0.001
Body mass index (kg/m2)	27 (21-37)	27 (23-36)	0.051
Parity (n,%)			
Primiparous	145 (24%)	55 (21%)	0.334
Multiparous	459 (75%)	207 (79%)	
Head circumference (mm)	339 (302-384)	347 (314-384)	<0.001
Estimated fetal weight (gram)	3156 (2001-4079)	3263 (2208-4439)	0.002
Neonatal head circumference (mm)	34 (32-38)	34 (32-39)	0.018
Birth week (week)	39 (37-41)	39 (37-41)	0.674
Birth weight (gram)	3154.64 ± 397.2	3239.05 ± 470.39	0.011
Fetal gender (n,%)			
Female	314 (52%)	116 (44.3%)	0.037
Male	290 (48%)	146 (55.7%)	
Apgar first minutes score	9 (2-9)	9 (1-9)	0.046
Apgar fifth minutes score	10 (6-10)	10 (4-10)	0.064
NICU requirement (n,%)	25 (4.1%)	19 (7.3%)	0.081

NICU: neonatal intensive care unit

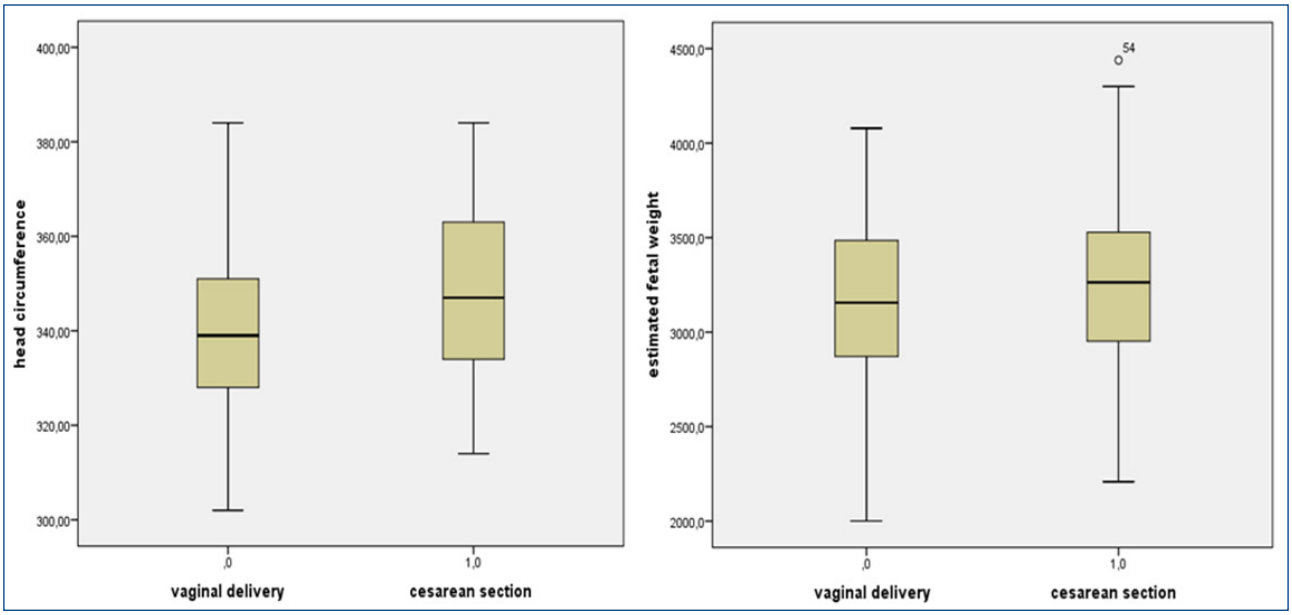

Figure 1. The box-plot graphs showing the distribution of head circumference (left) and estimated fetal weight (right)

Table 2. The correlation analysis for sonographic head circumference, estimated fetal weight, birth weight and neonatal head circumference

	Correlations			
	Head Circumference	**Estimated fetal weight**	**Birth weight**	**Neanatal head Circumference**
Spearman's rho				
Head circumference				
Correlation coefficient	1000	.561**	.446**	.369**
Sig. (2-tailed)	.	.000	.000	.000
N	866	866	866	866
Estimated fetal weight				
Correlation coefficient	.561**	1.000	.524**	.344**
Sig. (2-tailed)	.000	.	.000	.000
N	866	866	866	866
Birth weight				
Correlation coefficient	.466**	.524**	1.000	.597**
Sig. (2-tailed)	.000	.000	.	.000
N	866	866	866	866
Neanatal head circumference				
Correlation coefficient	.369**	.344**	.597**	1.000
Sig. (2-tailed)	.000	.000	.000	.
N	866	866	866	866

**: Correlation is significant at the 0.01 level (2-tailed)

Severe perineal laceration was detected in 14 patients (2.3%) in vaginal delivery group. The predictive role of sonographic head circumference and estimated fetal weight for delivery mode and perineal laceration was assessed by ROC analysis and demonstrated in **Figure 2**.

Sonographic head circumference >35.4 centimeter was found to predict cesarean section with 36.3% sensitivity and 84.8% specificity (AUC=0.637, p<0.001). Also, sonographic head circumference >35.2 centimeter was found to predict perineal laceration with 78.6% sensitivity and 85.4% specificity (AUC=0.853, p<0.001).

The comparison of the predictive role of sonographic head circumference and estimated fetal weight for delivery mode and perineal laceration was shown in **Figure 3**.

Head circumference was found to be superior for cesarean section as compared to estimated fetal weight (p=0.003) whereas no difference was found between head circumference and estimated fetal weight for perineal laceration (p=0.64).

The predictive role of sonographic head circumference for delivery mode in primiparous and multiparous patients were presented in **Figure 4**. Sonographic head circumference was found to predict cesarean section with a cut-off value 34.9 centimeter, 60% sensitivity and 73.8% specificity (AUC=0.692, p<0.001) in primiparous women while a cut-off value 35.4 centimeter predicted cesarean section with 34.3% sensitivity and 84.5% specificity in multiparous women (AUC=0.624, p<0.001).

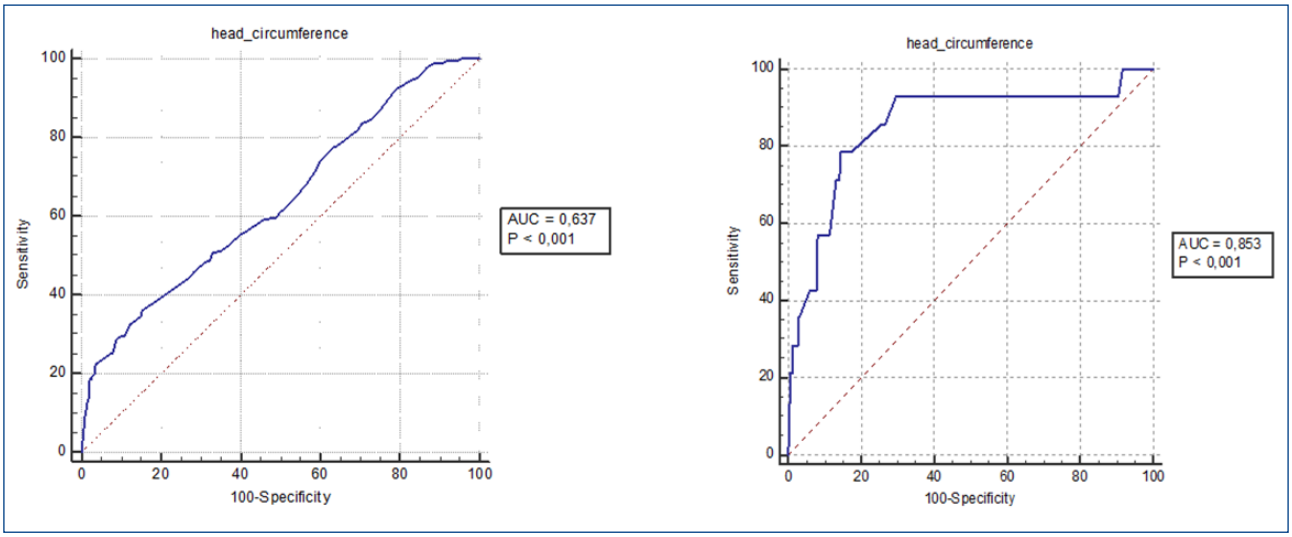

Figure 2. The ROC analysis of sonographic head circumference for delivery mode (left) and perineal laceration (right)

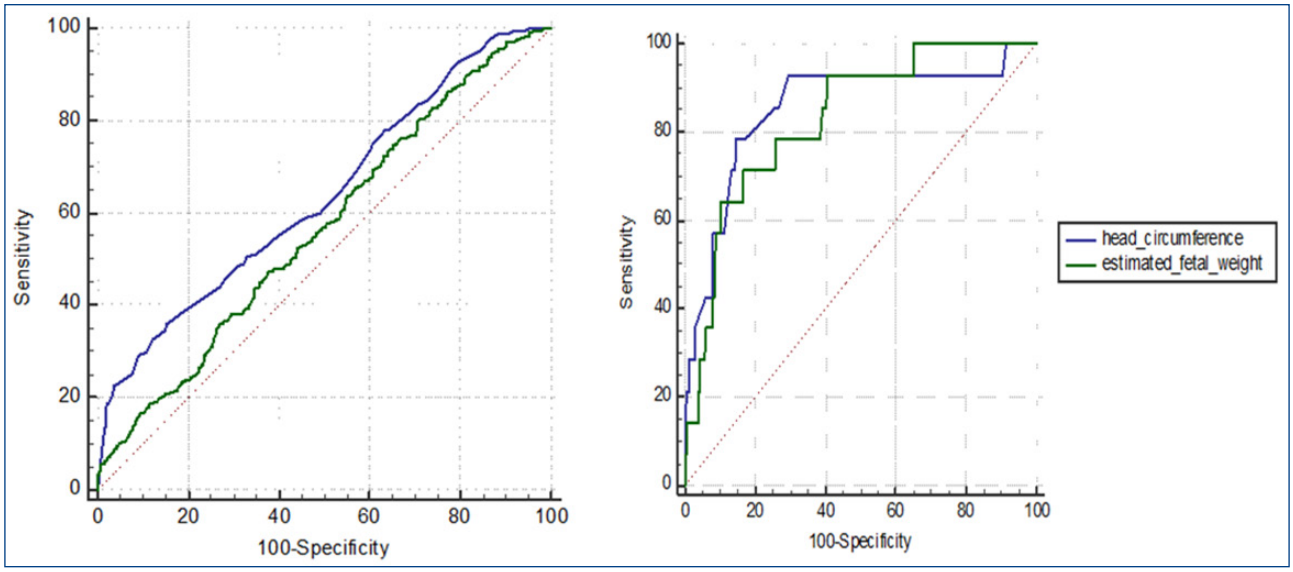

Figure 3. The comparative ROC analysis of sonographic head circumference and estimated fetal weight for delivery mode (left) and perineal laceration (right)

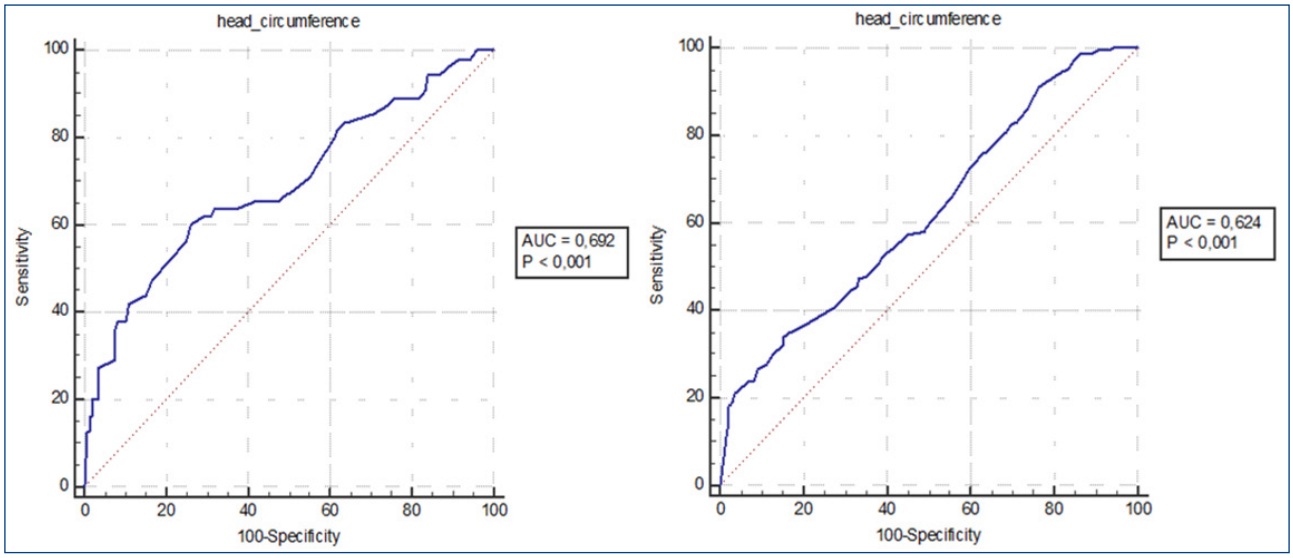

Figure 4. The predictive role of sonographic head circumference for delivery mode in primiparous (left) and multiparous (right) patients

DISCUSSION

Influence of fetal anthropometric measurements has been studied in previous studies. Estimated fetal weight which is the determinator of fetal macrosomia has been claimed to be a good predictor for adverse perinatal outcomes and obstructed labor (16-18). Similar to increased estimated fetal weight, large head circumference was found to be related to the increased rates of unplanned cesarean section, operative delivery, prolonged second stage, neonatal asphyxia and perineal lacerations (12). In 2015, Lipschuetz et al. demonstrated that large head circumference is associated with nearly 2.13 fold increased risk for operative delivery and 2.58 fold increased risk for unplanned cesarean section. This risk was more prominent in primiparae patients. Moreover, infants who have large head circumference and normal birth weight were more prone to cesarean section and instrumental delivery as compared to infants with normal head circumference and normal birth weight. Interestingly, infants with normal head circumference and high birth weight combination was not associated with cesarean section. In this study, large head circumference was defined as being above 95th persentile and no cut-off was determined (19). Similarly, Passerini et al. showed that large head circumference is associated with increased risk of instrumental delivery and cesarean section independent of fetal real weight (12). In another study, head circumference was related to the unplanned cesarean section independent from maternal height and epidural analgesia (20). In the

literature, a few studies are present comparing the role of estimated fetal weight and head circumference in predicting delivery mode. In our study, similar to study of Lipschuetz et al, we found that head circumference was superior for cesarean section as compared to estimated fetal weight. In contrast, other studies claimed that estimated birth weight and head circumference have an equal role for successful vaginal delivery (8,11,19).

The cut-off value of head circumference for adverse perinatal outcomes is controversial. Lipschuetz et al. reported that sonographic head circumference ≥35 centimeter is an independent risk factor for cesarean section. Furthermore, head circumference ≥35 centimeter combined with estimated fetal weight greater than 3900 gram increases the risk of prolonged second stage (5). Kennelly et al. claimed that head circumference >37 centimeter is associated with prolonged labor (8). For the same cut-off values, Ayinde and Mujugira reported elevated risk for cesarean section and instrumental delivery (21,22). In a study of Elvander et al, increased instrumental delivery rate was reported in a group with head circumference between 38-41 centimeter as compared to 35 centimeter group (23). Passerini et al. presented 63.6% sensitivity and 47.7% specificity for a cut-off value of 35 centimeter, 37.3% sensitivity and 81% specificity for a cut-off value of 36 centimeter and 11.6% sensitivity and 95.3% specificity for a cut-off value of 37 centimeter (12). In a study of Rabei et al, head circumference ≥36.8 centimeter was associated with an increased risk of instrumental delivery with 44.7% sensitivity and 91.9% specificity (6). In our study, sonographic head circumference >35.4 centimeter was found to predict cesarean section with 36.3% sensitivity and 84.8% specificity.

Another issue about head circumference is the correlation with neonatal head circumference. We found correlation between neonatal and sonographic head circumference. Likewise, Lipschuetz et al. showed this correlation (19). In the literature, due to the skin, hair and edema in postnatal period, 1 centimeter difference is acceptable for head circumference (24,25).

Different from previous studies, we evaluated the predictive role of sonographic head circumference for delivery mode both in primiparous and multiparous patients. Sonographic head circumference >34.9 centimeter was found to predict cesarean section with 60% sensitivity and 73.8% specificity in primiparous women while a cut-off value 35.4 centimeter predicted cesarean section with 34.3% sensitivity and 84.5% specificity in multiparous women. Leading to this result, we suggest that measurement of head circumference is more beneficial in primiparous women to determine the delivery mode.

Head circumference has been widely studied in perineal laceration. In a study of Nelson et al, sonographic head circumference was found to be associated with mode of delivery but not with the risk of anal sphincter injury (26). Similarly, Meyer et al. demonstrated that head circumference and estimated fetal weight was not associated with anal sphincter injury in unassisted vaginal births (27). In another study of Meyer et al, significant relationship was reported between anal sphincter injury and head circumference above 90 percentile on vacuum deliveries in primiparous women and this association was stronger than fetal weight (9). Chill et al. demonstrated a correlation between large head circumference and the severity of anal sphincter injury (28). In our study, sonographic head circumference >35.2 centimeter was found to predict severe perineal laceration with 78.6% sensitivity and 85.4% specificity (AUC=0.853, $p<0.001$). But the number of patients with perineal laceration was small in our study. These conflicting results can be due to the confounding factors such as primiparity, instrumental delivery and prolonged labor. Another reason can be the acceptance of head circumference as categorical or continuous variables in different studies.

Limitations

The present study has some limitations. It has a small sample size and retrospective design leading to selection and information biases. Sonographic measurements were not done by same researchers. All infants with large head circumference did not have high birth weight, and vice versa. Thus, stratification and multinominal regression analysis may be appropriate for the analysis.

CONCLUSION

Although the importance of estimated fetal weight can not be ignored, our study demonstrated that head circumference has an essential role for predicting unplanned cesarean section and severe perineal lacerations. Even, large head circumference was more strongly associated with cesarean delivery and perineal lacerations than estimated fetal weight. Thus, we suggest that measuring head circumference would be an appropriate approach for determining delivery mode and complications.

ETHICAL DECLARATIONS

Ethics Committee Approval: The local ethics committee approved the study (University of Health Sciences, Bursa Yuksek Ihtisas Research and Training Hospital; 2011-KAEK-25 2019/10-17) and also it was in accordance with Helsinki declaration.

Informed Consent: For using medical records of study participants, written informed consent was taken from all patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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