Arch Clin Exp Med 2019;4(3):118-121. e-ISSN: 2564-6567

DOI:10.25000/acem.586513 Araştırma makalesi / Research article

Does the measurement of the size of the first trimester subchorionic hematoma by 2D and 3D ultrasonographic techniques have any effect on adverse pregnancy outcomes?

Birinci trimester subkoryonik hematom boyutunun 2B ve 3B ultrason ölçüm tekniği ile ölçümünün olumsuz gebelik sonuçlarına etkisi var mıdır?

Sibel Özler [1], Başak Gümüş Güler [2]

Abstract

Aim: We aimed to evaluate whether the measurement of subchorionic hematoma (SCH) size with 2D and 3D ultrasonography affects adverse pregnancy outcomes.
Methods: One hundred fifty-eight pregnant patients having SCH were enrolled in the study. The diagnosis of SCH was made by 2D and 3D ultra-sonographic methods in the first trimester, between 6th and 14th gestational weeks. Patients having SCH were determined with adverse pregnancy outcomes such as miscarriage, intrauterine fetal death (IUFD), and preterm labor (PL). Logistic regression analyses were applied for the relationship of miscarriage, IUFD, PL, and SCH.
Results: There were no statistically significant differences for body mass index, 2-D hematoma sizes, 3-D hematoma sizes, and pregnancy outcomes between the groups. Miscarriage/IUFD rate was 4.6%, PL rate was 6.9%, and the term delivery rate was 88.5% in the primiparas having SCH. Miscarriage/IUFD rate was 7%, PL rate was 3.5%, and the term delivery rate was 89.5% in the multiparas having SCH. No significant association was observed between 2D and 3D hematoma sizes and IUFD and PL. In the logistic regression model, SCH ≥ 500 cm3 was found to be a risk factor associated with PL, not regarding the measurement technique (OR:1.008, 95% CI: 1.002-1.012, p=0.006).
Conclusion: We determined that SCH size increases the risk of PL. We observed no effect of diagnosis and follow-up of SCH, by 2D and 3D ultrasonography techniques on adverse pregnancy outcomes such as miscarriage, IUFD, and PL.

Keywords: Subchorionic hematoma, three dimensional, two-dimensional, ultrasound, adverse pregnancy outcome.

Öz

Amaç: Subkoryonik hematom (SKH) boyutunun 2B ve 3B ultrason ile ölçülmesinin olumsuz gebelik sonuçlarına etkisini değerlendirmeyi amaçladık.
Yöntemler: Yüz elli sekiz SKH olan gebe çalışmaya alındı. SKH tanısı ilk trimesterde, 6. ve 14. gebelik haftaları arasında, 2 ve 3 boyutlu ultra-sonografik yöntemlerle konuldu. SKH olan gebelerin düşük, intrauterin fetal ölüm [IUFÖ] ve preterm doğum [PD] gibi olumsuz gebelik sonuçları belirlendi. SKH ile düşük, intrauterin fetal ölüm ve erken doğum arasındaki ilişkiyi belirlemek için lojistik regresyon analizleri yapıldı.
Bulgular: Primipar ve multipar gebeler arasında vücut kitle indexi, 2B ultrasonografik hematom boyutları, 3B ultrasonografik hematom boyutları ve gebelik sonuçları açısından istatistiksel olarak anlamlı bir fark yoktu. SKH olan primiparlarda düşük/ IUFÖ hızı %4,6, PD hızı %6,9 ve miad doğum hızı %88,5 idi. SKH olan multiparlarda ise düşük/ IUFÖ hızı %7, PD hızı %3,5 ve miad doğum hızı %89,5 idi. 2B ve 3B hematom büyüklüğü ile IUFÖ ve PD arasında anlamlı bir ilişki gözlenmedi. Lojistik regresyon modelinde ölçüm tekniğinden bağımsız olarak SKH'un ≥500 cm3 olması erken doğumla ilişkili risk faktörü olarak bulundu (OR:1,008, %95 CI: 1,002-1,012, p=0,006).
Sonuç: SKH boyutunun PD riskini artırdığını belirledik. SKH'un teşhis ve takibinin 2B ve 3B ultrasonografik ölçüm ile yapılmasının düşük, IUFÖ ve PD gibi olumsuz gebelik sonuçlarına etkisinin olmadığını gördük.

Anahtar Kelimeler: Subkoryonik hematom, 3 boyutlu, 2 boyutlu, ultrason, olumsuz gebelik sonuçları.

[1] **Selcuk University Faculty of Medicine, Department of Perinatology, Konya, Turkey.**

[2] **Istinye University, Department of Health Sciences, Istanbul, Turkey.**

SÖ: 0000-0003-4577-8185
BGG: 0000-0002-0182-6774

Ethics Committee Approval: The study was approved by the local ethical authority (05.04.2019/004).
Etik Kurul Onayı: Çalışma lokal etik komite tarafından onaylanmıştır (05.04.2019/004).

Conflict of Interest: No conflict of interest was declared by the authors.
Çıkar Çatışması: Yazarlar çıkar çatışması bildirmemişlerdir.

Financial Disclosure: The authors declared that this study has received no financial support.
Finansal Destek: Yazarlar bu çalışma için finansal destek almadıklarını beyan etmişlerdir.

Geliş Tarihi / Received: 03.07.2019
Kabul Tarihi / Accepted: 16.08.2019
Yayın Tarihi / Published: 01.12.2019

Sorumlu yazar / Corresponding author:

Sibel Özler

Adress/Adres: Kozagaç Mah. Cakılkuyu Sok. No:4/1 Meram/Konya/Turkey.

Phone: +90 545 797 02 57

E-mail: sibelozler@gmail.com

Atıf yazım şekli: Özler S, Gümüş Güler B. Does the measurement of the size of the first trimester subchorionic hematoma by 2D and 3D ultrasonographic techniques have any effect on adverse pregnancy outcomes? Arch Clin Exp Med. 2019;4(3):118-121.
How to cite:

Introduction

Vaginal bleeding is observed approximately in one-fourth of all first- trimester pregnancies [1]. Subchorionic bleeding and hematoma are the leading cause of bleeding in the first trimester, and their incidence is 0.5-22 % [2]. Although many risk factors are leading to subchorionic hematoma (SCH), the etiopathogenesis is still unclear. SCH may be observed with symptoms like pelvic pain and vaginal bleeding, but can also be asymptomatic [3]. SCH has been associated with increased risk of adverse pregnancy outcomes; such as abruption, intrauterine fetal death (IUFD) [3], preterm premature rupture of membranes (PPROM), preterm labor (PL), preeclampsia, and fetal growth restriction (FGR) [4]. SCH is generally observed as an anechoic or hypoechoic area in between the fetal membrane and uterine wall in the first trimester, by ultrasonography [5].

Conventional two- dimensional (2D) ultrasonography technique is commonly used in the evaluation of placenta and the fetus in the pregnancy period [6]. Recently three- dimensional (3D) ultrasonography has been preferred in the assessment of placental and fetal pathologies. 3D imaging modalities are used in the evaluation of volumes of liquids, mass, tissues, and organs. Technically in the 3D method, the borders of the area to be measured are detected, and results are calculated automatically. However in 2D choice, the dimensions of the object to be measured are lined manually in 3 planes, and mathematical methods calculate the volume. In a 2D way, miss-calculation is observed in 2 % of the measurements of hematomas and/ or liquids having unclear borders [7].

We aimed to determine whether any significant difference in SCH measurement by 2D and 3D techniques and to observe if any of these techniques or SCH, regardless from the measurement technique, were associated with adverse pregnancy outcomes in the first trimester.

Material and methods

A prospective observational study was carried out between March 2017 and March 2019. We calculated the SCH areas by 2D and 3D ultrasonographical techniques in the first trimester. One hundred fifty-eight patients (87 primiparas and 71 multiparas), who were diagnosed to have SCH, were recruited consecutively from the Perinatology Department of Konya Education and Research Hospital. The study protocol was performed according to the principles of the Declaration of Helsinki and approved by the local ethical committee of our hospital (Approval date/number:05.04.2019/004).

The diagnosis of SCH is a frequent finding on routine obstetric ultrasonography. The determination of SCH was made by the presence of a hypoechoic or anechoic crescent area behind the gestational sac on ultrasonography, regardless of whether there is pelvic pain and/or vaginal bleeding in the first trimester between 6th and 14th gestational weeks. The age of the patients varied from 18 to 44 years.

Patients were excluded if any of the following criteria were present: multiple pregnancy, habitual aborts, use of anticoagulants, history of in vitro fertilization, excessive obesity, uterine anomaly, fetal chromosomal aneuploidy and/ or malformations.

The medical history and the physical examination of the patients were recorded. Body mass index (BMI) was calculated in kilograms/square meter (kg/m2) [8]. 2D and 3D scan were performed abdominally by using Samsung HS70A (Samsung Medision Diagnostic Ultrasound System, United States). The size of the gestational sac, crown-rump length (CRL) and fetal heartbeat were recorded, and places of hematomas were described their sites as being subchorionic if they were located between the chorion and the uterine wall, external to the chorionic leave. The longest transverse (A), sagittal (B), and horizontal (C) diameters of the hematomas were measured by Grayscale ultrasonography, and volumes were calculated by using the formula $0.625 \times A \times B \times C$ [9]. SCH area was drawn manually on 3D ultrasound and automatically determined according to the ellipsoid formula defined as volume measurement method on ultrasound. (Ellipsoid: The volume is calculated by using the length of the main and side axes. (4/3 x PI x Main/2 x (Side/2)^2) [10]. SCH with a bleeding area higher than fifty percent of the gestational sac was considered large size [11].

3D volume measurement was performed by using the same device and recorded. The follow up of the patients was repeated every two weeks or monthly, which was decided according to the dimensions of the hematoma. The occurrence of miscarriage, IUFD, and PL were followed up and recorded. The adverse pregnancy outcomes were defined as spontaneous miscarriage (designated as a fetal loss at less than 20 or 24 weeks of gestation), IUFD (defined as fetal death at the first trimester of gestation), and PL (defined as delivery before 36 or 37 weeks of gestation) [12, 13].

Statistical analysis

Therefore sample size calculation by G-power analysis and 136 participants was calculated to detect an anticipated effect size of 0.3 for the regression equation, at a power level of 0.95 ($\beta = 0.95$) and a probability level of 0.05 ($\alpha = 0.05$). Data analysis was performed by using SPSS for Windows, version 22 (SPSS Inc., Chicago, IL, United States). The Kolmogorov Smirnov test was used to test whether or not continuous variables were normally distributed. The Levene test evaluated the homogeneity of variances. Continuous variables were demonstrated as mean ± standard deviation (SD). The groups were divided into two; as SCH <500 cm3 and SCH ≥ 500 cm3. Student's t-test compared mean variations between the groups. We used the Mann-Whitney U test for non-parametric groups. For data not normally distributed, median with data range [minimum to maximum] were used. Pearson's chi-square test analyzed nominal data. Multivariate logistic regression analysis was used to determine if there there is a relationship between 2D hematoma size, 3D hematoma size, and IUFD, PL. Spearman's rho correlation analyses were used to calculate degrees of association between SCH ≥ 500 cm3, IUFD, and PD. A p-value < 0.05 was considered as significant.

Results

Forty-three (27.21%) of the patients had a SCH size ≥ 500 cm3, and 115 (72.79%) had SCH <500 cm3 in the study. 19 (23.45%) of primiparous patients and 24 (33.80%) of multiparous patients had SCH ≥ 500 cm3 (Table 1). When patients were having SCH < 500 cm3, and the ones having SCH ≥ 500 cm3 were compared, no significant difference in pregnancy outcomes (IUFD and PL) were observed (Table 2).

Term delivery rate was 88.5%, PL rate was 6.9%, and miscarriage /IUFD rate was 4.6% in the primiparas having SCH. Term delivery rate was 89.5%, miscarriage /IUFD rate was 7%, and PL rate was 3.5% in the multiparas having SCH (Table 3).

No significant association was observed in between hematoma size measured by 2D and 3D techniques and IUFD and PL, in the logistic regression model (Table 4).

In the logistic regression model, only SCH ≥ 500 cm 3 was found to be an independent risk factor for PL (OR:1.008, 95% CI: 1.002-1.012, p=.006). SCH size was not associated with IUFD (Table 5).

SCH ≥ 500 cm3 and PL were significantly positively correlated (r=.144, p=.046) (Table 6).

Table 1: Baseline characteristics and ultrasonographic subchorionic hematoma size of groups in the first trimester of pregnancy.

	SCH < 500 cm^3	SCH ≥ 500 cm^3	p
n β	115 (72.79)	43 (27.21)	
Age (year) ¥	27.30±6.57	25.95 ± 5.72	0.124
BMI (kg/m^2) ¥	31.26±14.23	30.58±17.43	0.683
Primipara β	62 (76.55)	19 (23.45)	0.141
Multipara β	47 (66.2)	24 (33.80)	

β: n(%),¥: mean±standard deviation, BMI: Body mass index.

Table 2. Pregnancy outcomes according to hematoma size in the first trimester of pregnancy.

	SCH < 500 cm^3	SCH ≥ 500 cm^3	p
n β	115 (72.79)	43 (27.21)	
Abortus/IUFD ¥	2.7	4.2	0.285
Preterm delivery ¥	1.9	2.7	
Term delivery ¥	65.3	23.3	

β: n(%), ¥: %, IUFD: Intrauterine fetal demise.

Table 3. Baseline characteristics and ultrasonographic data of groups having a subchorionic hematoma in the first trimester of pregnancy.

		Primipara (n=87)	Multipara (n=71)	p
Age (year) ¥		23.62±5.53	28.40±6.09	0.001
BMI (kg/m^2) ¥		30.14±11.02	29.85±13.14	0.754
2-dimensional hematoma size (mm^3) μ		2017.50 (585-19,250)	4060.00 (500-18,480)	0.285
3-dimensional hematoma size (mm^3) μ		195.43 (4.18-1,838.78)	229.85 (4.18-2,572.44)	0.264
Pregnancy outcome	Abortus/IUFD β	4 (4.6)	5 (7.04)	0.373
	Preterm delivery β	6 (6.9)	3 (4.22)	
	Term delivery β	77 (88.5)	63 (88.73)	

β: n(%),¥: mean±standard deviation, μ: mean (range), BMI; Body mass index, IUFD; Intrauterine fetal demise.

Table 4. Logistic regression analysis for the relationship between 2D hematoma size, 3D hematoma size, and IUFD and Preterm delivery groups.

	IUFD		Preterm Delivery	
	OR [Cl%95]	p	OR [Cl%95]	p
Age	1.051 [0.981-0.126]	0.161	1.043 [0.958-1.136]	0.329
2-dimensional hematoma size	1.003 [1.000-1.005]	0.248	0.923 [0.018-4.713]	0.968
3-dimensional hematoma size	1.001 [1.000-1.002]	0.129	1.001 [1.000-1.002]	0.247

OR: odds ratio, IUFD: Intrauterine fetal demise.

Table 5. Logistic regression analysis for the relationship between hematoma size, and IUFD and preterm delivery groups.

		IUFD		Preterm delivery	
		OR [Cl%95]	P	OR [Cl%95]	P
Age		1.051 [0.981-1.126]	0.161	1.043 [0.958-1.136]	0.329
SCH cm^3	<500	0.561 [0.208-1.511]	0.253	0.499 [0.153-1.632]	0.251
SCH cm^3	≥500	1.004 [1.000-1.008]	0.074	1.008 [1.002-1.012]	0.006

OR: odds ratio, IUFD: Intrauterine fetal demise, SCH: Subchoronic hematoma.

Table 6. Correlation analysis between SCH ≥ 500 cm3, IUFD, and Preterm delivery.

	SCH ≥ 500 cm^3	
	r	p
IUFD	0.117	0.547
Preterm delivery	0.144	0.046

R: Correlation coefficient, IUFD: Intrauterine fetal demise, SCH: Subchorionic hematoma.

Discussion

We observed no significant differences in miscarriage, IUFD, and PL rates in the patients having large-sized SCH. There are controversial results in the literature when SCH and adverse gestational outcome relation is in concern [15]. Hashem et al. [15] reported an increased risk of miscarriage, PL, IUGR, abruption, low birth weight, cesarean section rate, low Apgar score at 1 and 5 min, and need for NICU admission in the patients having SCH when they were compared to the ones having no SCH. They observed that the size of SCH was only correlated to miscarriage. Maso et al. [16] noticed increased miscarriage risk, especially before the 9th gestational week, in the patients having SCH in the first trimester. Nagy et al. [11] observed increased PL risk in SCH patients when compared to healthy controls. However, in another study, no relation was observed between PL risk and size of SCH [17]. Johns et al. [18] reported that there was no relation of SCH with first-trimester miscarriage risk and PPROM.

We observed no significant difference in miscarriage, IUFD, or PL rates when the size of SCH was in concern. However, regression analyses of our data revealed a significant relation between SCH size and PL. The low number of patients in our study may be the cause of indifference between the groups.

The extent of SCH is considered by comparing the longest linear dimension of the SCH with the size of the gestational sac in the first trimester. If the ratio is less than 20% the SCH is classified as small; if it is between 20-50% SCH is medium; and if it is more than 50%, SCH is large [11]. Studies are demonstrating that large SCH are related to adverse gestational outcome [19]. Ball et al. [20] showed the relation of first-trimester SCH with miscarriage, PL, PPROM, abruption of placenta, low birth weight, and stillbirth. Tuuli et al. [5] reported the relation of SCH with early and late pregnancy loss, PPROM and abruption of the placenta in their meta-analysis of cohort and case-control studies which were conducted in the years between 1981- 2010. However, Li et al. [21] evaluated the case-control and cohort studies of the years 2000- 2015 in their meta-analyses and observed that SCH caused an increased risk of spontaneous miscarriage but was not related to PL in ongoing pregnancies. Peixoto et al. [22] reported increased miscarriage risk in the patients having SCH in the first trimester. Avi et al. [23] reported that there was not a significant relationship between the 2D measurement of SCH, vaginal bleeding, and adverse pregnancy outcome.

Hata et al. [24] suggested the help of 3D method in the evaluation of placental thickness, SCH, and chorangioma to 2D and Doppler sonography. They observed that 3D imaging was more comfortable to apply in hematomas having irregular

borders. The use of 3D technology has been increasing in recent years. Sharma et al. [25] compared the estimation of fetal weights measured both by 2D and 3D technologies and observed that the 3D method was more accurate. Becsek et al. [26] reported a more accurate measurement of CRL by 3D technique when compared to the 2D approach. Sadek et al. [27] observed higher sensitivity in the diagnosis of the low-lying placenta with 3D transvaginal ultrasonography technique. There has not been any exact result in the evaluation of SCH in the first trimester when the 3D and the 2D methods are concerned; because there are only case reports. We suggest the conduction of prospective studies, including more patients having SCH to compare the values of two methods. We believe that to confirm the effect of SCH size on adverse pregnancy outcomes, large population-based controlled studies are needed.

We did not observe any significant results in the prediction of IUFD or PL when we compared the 3D and 2D measurements of SCH in the first trimester, in primiparas and multiparas. On the other hand, we found out that SCH size was correlated to PL.

As a result, SCH observed in the first trimester did not affect the adverse pregnancy outcome in primiparas and multiparas. Although 3D measurement of SCH is more accurate, it does not enhance the prediction of IUFD or PL when compared to 2D size. We think that the primary importance belongs to the diagnosis and follow up of SCH, rather than the technique of measurement.

References

1. Mallin M, Dawson M, Schroeder E, Hatch B, Jackson I, Ahern M, et al. Prospective outcomes of pregnant ED patients with documented fetal cardiac activity on ultrasound. Am J Emerg Med. 2012;30:472-5.
2. Seki H, Kuromaki K, Takeda S, Kinoshita K. Persistent subchorionic hematoma with clinical symptoms until delivery. Int J Gynecol Obstet. 1998;63:123–8.
3. Maso G, D'Ottavio G, De Seta F, Sartore A, Piccoli M, Mandruzzato G. First-trimester intrauterine hematoma and outcome of pregnancy. Obstet Gynecol. 2005;105:339–44.
4. Weiss JL, Malone FD, Vidaver J, Ball RH, Nyberg DA, Comstock CH, et al. Threatened miscarriage: A risk factor for poor pregnancy outcome, a population-based screening study. Am J Obstet Gynecol. 2004;190:745–50.
5. Tuuli MG, Norman SM, Odibo AO, Macones GA, Cahill AG. Perinatal Outcomes in Women With Subchorionic Hematoma. Obstet Gynecol. 2011;117:1205-12.
6. Brown DL, DiSalvo DN, Frates MC, Davidson KM, Genest DR: Placental surface cysts detected on sonography: Histologic and clinical correlation. J Ultrasound Med. 2002;21:641–6.
7. Riccabona M, Nelson TR, Pretorius DH, Davidson TE. In vivo three-dimensional sonographic measurements of organ volume: validation in the urinary bladder. J Ultrasound Med. 1996; 15:627-632.
8. Keys A, Fidanza F, Karvonen MJ, Kimura N, Taylor HL. Indices of relative weight and obesity. J Chron Dis. 1972;25:329–43.
9. Hartnell GG, Kiely EA, Williams G, Gibson, RN. Real-time ultrasound measurement of bladder volume: a comparative study of three methods.Br J Radiol. 1987;60:1063-5.
10. Finch W, Johnston R, Shaida N, Winterbottom A, Wiseman O. Measuring stone volume - three-dimensional software reconstruction or an ellipsoid algebra formula? BJU Int. 2014;113:610-4.
11. Nagy S, Bush M, Stone J, Lapinski RH, Gardo S. Clinical significance of subchorionic and retroplacental hematomas detected in the first trimester of pregnancy. Obstet Gynecol. 2003;102:94–100.
12. Zarko Alfirevic, Tamara Stampalija, Nancy Medley. Cervical stitch (cerclage) for preventing preterm birth in singleton pregnancy. Cochrane Database Syst Rev. 2017 Jun;2017(6):CD008991.
13. Committee on Obstetric Practice Society for Maternal-Fetal Medicine. Medically Indicated Late-Preterm and Early-Term Deliveries. Obstet Gynecol. 2019;133:400-3.
14. Xiang L, Wei Z, Cao Y. Symptoms of an intrauterine hematoma associated with pregnancy complications: a systematic review. PLoS One. 2014;9:e111676.
15. Hashem A, Sarsam SD. The Impact of Incidental Ultrasound Finding of Subchorionic and Retroplacental Hematoma in Early Pregnancy. J Obstet Gynaecol India. 2019;69:43-9.
16. Maso G, D'Ottavio G, De Seta F, Sartore A, Piccoli M, Mandruzzato G. First-trimester intrauterine hematoma and outcome of pregnancy. Obstet Gynecol. 2005;105:339-44.
17. Pedersen JF, Mantoni M. Large intrauterine haematomata in threatened miscarriage. Frequency and clinical consequences. Br J Obstet Gynaecol. 1990;97:552–3.
18. Johns J, Hyett J, Jauniaux E. Obstetric outcome after threatened miscarriage with and without a hematoma on ultrasound. Obstet Gynecol. 2003;102:483-7.
19. Ozkaya E, Altay M, Gelisen O. Significance of subchorionic hemorrhage and pregnancy outcome in threatened miscarriage to predict miscarriage, preterm, and intrauterine growth restriction. J Obstet Gynecol. 2011;31:210–212.
20. Ball RH, Ade CM, Schoenborn JA, Crane JP. Significance of ultrasonographically detected subchorionic hemorrhages. Am J Obstet Gynecol. 1996;174:996-1002.
21. Li Q, Zhu J, Hua K. Effects of the subchorionic hematoma on pregnancy outcome: a meta-analysis. Zhonghua Yi XueZaZhi. 2016;96:1383-5.
22. Peixoto AB, Caldas TMRDC, Petrini CG, Romero ACP Júnior LEB, Martins WP Araujo Júnior E. The impact of the first-trimester intrauterine hematoma on adverse perinatal outcomes. Ultrasonography. 2018;37:330-6.
23. Ben-Haroush A, Yogev Y, Mashiach R, Meizner I.Pregnancy outcome of threatened miscarriage with subchorionic hematoma: possible benefit of bed-rest?. Isr Med Assoc J. 2003;5:422-4.
24. Hata T, Kanenishi K, Inubashiri E, Tanaka H, Senoh D, Manabe A, Miyake K, et al. Three-dimensional sonographic features of placental abnormalities. Gynecol Obstet Invest. 2004;57:61-5.
25. Sharma KA, Das D, Dadhwal V, Deka D, Singhal S, Vanamail P. Two-dimensional fetal biometry versus three-dimensional fractional thigh volume for ultrasonographic prediction of birth weight. Int J Gynecol Obstet. 2019;145:47-53.
26. Becsek A, Tzanidakis N, Blanco M, Bollwein H. Transrectal three-dimensional fetal volumetry and crown-rump length measurement during early gestation in mares: Intra- and inter-observer reliability and agreement. Theriogenology. 2019;126:266-71.
27. Sadek SM, Ahmad RA, Atia H, Abdullah AG. Towards a more accurate measurement of edge to os distance in low-lying placenta using transvaginal ultrasound: an innovative technique. BMC Pregnancy Childbirth. 2018;18:472.