Research Journal of Obstetrics & Gynecology

ISSN 1994-7925

science alert

ANSInet
an open access publisher
http://ansinet.com

OPEN ACCESS Research Journal of Obstetrics and Gynecology

ISSN 1994-7925
DOI: 10.3923/rjog.2019.17.22

Research Article
Lower Uterine Scar Thickness Predicts Timing of Next Cesarean Section in Iraqi Pregnant Women with Previous Multiple Operations

[1]Ulfat Mohammad Ali Al-Nakkash, [1]Marwa Malik Anas, [1]Alaa Ali Hussein, [2]Faris Anwer Rasheed and [3]Saad Abdulrahman Hussain

[1]Department of Gynecology and Obstetrics, Al-Elweyia Maternity Teaching Hospital, Baghdad, Iraq
[2]Department of Gynecology and Obstetrics, Al-Zuhur Private Hospital, Baghdad, Iraq
[3]Department of Pharmacology and Toxicology, Faculty of Pharmacy, Al-Rafidain University College, 10052 Al-Mustansiriya St. 75, Baghdad, Iraq

Abstract

Background and Objective: Caesarean section is considered as the most common obstetrical operation worldwide. The ultrasonography-aided assessment of the lower uterine segment scar is crucial in determining the time of the next cesarean section. The present study aims to determine the optimal time of the next cesarean section according to gestational age and lower uterine segment thickness measured by transabdominal ultrasound. **Methodology:** Three hundred pregnant women were enrolled in a prospective follow up study at Al-Elweyia Maternity Teaching Hospital/Baghdad/Iraq from January, 2016-January, 2017 with two or more cesarean sections, all assessed for lower uterine segment thickness at term by ultrasonography and followed up for one month after labor. **Results:** The lower uterine segment thickness was significantly associated with the earlier gestational age of the pregnant women ($p = 0.01$), dehiscent uterine scar ($p<0.001$), low APGAR score ($p<0.001$) and low birth weight of neonates ($p = 0.006$). The lower uterine segment thickness cutoff value in predicting dehiscent scar was 3.9 mm (78.2% sensitivity and 82.3% specificity); while it was 3.9 mm in predicting shorter gestational age but with lower validity scores (69% sensitivity and 50% specificity). **Conclusion:** The lower uterine segment thickness can be considered as an appropriate predictor of dehiscent scars and shorter gestational age of pregnant women with previous two or more cesarean section in subsequent pregnancies.

Key words: Cesarean section, dehiscent scar, lower uterine segment, APGAR score

Citation: Ulfat Mohammad Ali Al-Nakkash, Marwa Malik Anas, Alaa Ali Hussein, Faris Anwer Rasheed and Saad Abdulrahman Hussain, 2019. Lower Uterine Scar thickness predicts timing of next cesarean section in Iraqi pregnant women with previous multiple operations. Res. J. Obstet. Gynecol., 12: 17-22.

Corresponding Author: Saad Abdulrahman Hussain, Department of Pharmacology and Toxicology, Faculty of Pharmacy, Al-Rafidain University College, 10052 Al-Mustansiriya St. 75, Baghdad, Iraq Tel: +9647901712624

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Cesarean Section (CS) is the most common and well established obstetrical operation worldwide. In many countries, the CS rate was 5% for a long time and was mainly performed for non-progressive labor. The adoption of continuous fetal monitoring in the early 1970s contributed to an increase in the CS rate, resulting in non-progressive labor and suspected fetal distress as the most common indication for CS[1]. The few previous decades showed an exponential increase in the number of CS worldwide. In contrast to the Renaissance, when CS implicated for certain death of the patient, CS rates in well-resourced settings nowadays rarely results in the death of the woman during or after the procedure and considered a safe procedure[2]. The World Health Organization (WHO) stated that a population-level CS rate above 10-15% is hardly justified from the medical perspective and exceeding this rate implicates an overuse of CS without improvement of the neonatal outcomes[3,4]. The progressive increase in maternal adverse outcomes such as adhesion formation, scar dehiscence, surgical injury, postoperative infection, hemorrhage, blood transfusion, hysterectomy and death was associated with the increased number of previous cesarean deliveries[5]. Although, various techniques were followed during cesarean delivery, the transverse incision is the preferred approach since it is associated with less postoperative pain, greater wound strength, less blood loss, less need for bladder dissection, lower risk of scar rupture in subsequent pregnancies and better cosmetic outcomes[6,7]. The use of ultrasound imaging has accelerated the assessment of CS scars before and during pregnancy[8,9], where normal Lower Uterine Scar (LUS) appeared as a two-layer structure of a hyperechoic layer representing the bladder wall and a less echogenic layer representing the myometrium[10]. During pregnancy, various methods have been developed to correlate measurement of LUS with the risk of uterine scar dehiscence[11,12]. Although, a strong association between LUS measurement in pregnancy and the risk of uterine scar complications were reported, which may serve as a predictor of uterine rupture, no cutoff value has been developed and tested[13]. Moreover, there is an increased risk of placenta previa and accreta with every subsequent repeat CS, which maybe associated with higher rates of peripartum hysterectomy[14]; meanwhile, uterine rupture requires immediate surgical intervention and can result in severe morbidity and mortality for both the mother and the infant[15]. For the aim of improving the experience of the staff about this approach and establishing local data in this regard, the present study was designed to detect the optimum time of the next CS according to gestational age (GA) and LUS measured by trans-abdominal ultrasound.

MATERIALS AND METHODS

Study design and enrollment: Three hundred pregnant women were enrolled in a prospective follow up study at Al-Elweyia Maternity Teaching Hospital, Baghdad, Iraq from January-December, 2016. All of them with two or more previous cesarean sections and were evaluated for lower uterine segment thickness at term by trans-abdominal ultrasonography and followed up for one month after labor. The inclusion criteria include singleton pregnancy, two or more CS scars, Gestational Age (GA) between 28-40 weeks, normal amount of liquor and vertex presentation. The exclusion criteria include emergency CS, multiple pregnancies, GA less than 28 weeks, fetal congenital anomalies, women with a medical problem, one previous CS scar, midline incision of the uterus (classical CS), lower uterine segment mass and those refuse to participate. The research protocol was approved by the local Research Ethics Committee of Al-Elweyia Maternity Teaching Hospital (CR-382/September, 2017) and signed written consent was obtained from each woman before inclusion in the study.

Ultrasound evaluation and follow-up: Prospective sonographic assessment of lower uterine segment thickness was carried out for the participants few hours before CS. Routine antepartum trans-abdominal sonography was performed with moderately filled bladder[16] using convex transducer frequency 3-5 MHZ (Siemens-ACUSON X300) and (GE-VOLUSON E6) in the Radiology Department of the hospital. Transabdominal ultrasonography was performed in the supine position and the pregnant woman having a moderately full urinary bladder. The LUS was scanned in sagittal section under magnification to localize the thinnest zone. Measurements were obtained with the '+' shape cursors at the bladder wall-myometrium interface and myometrium/chorioamniotic membrane-amniotic fluid interface. An average of 2-3 readings were recorded with the vertical bar of the caliper being as parallel to the interface as possible. The examination was sustained when a uterine contraction was noted and was repeated after 30 min. The LUS thickness was measured as the distance from the posterior bladder wall interface to the uterine amniotic fluid-wall interface[17]. The women were followed up until one month after delivery through scheduled visits. After delivery, the

following markers were utilized to evaluate the neonatal outcomes: Transient tachypnea of the newborn (TTN) detected as the presence of tachypnea within hours after birth; respiratory distress syndrome (RDS) defined as the signs of respiratory distress (radiological features and oxygen therapy), sepsis and need for NICU hospitalization and 1st min and 5th min APGAR scores.

Statistical analysis: Statistical evaluation of data was performed using Statistics Package for Social Science (SPSS) software version 19.0 (IBM Corp., Armonk, NY, USA). Statistical analysis of continuous variables was performed utilizing descriptive statistics in addition to Student's t-test or Wilcoxon rank-sum test when applicable where appropriate. Categorical variables were evaluated utilizing the Fisher's exact test. Receiver operating characteristics (ROC) curve analysis was performed to predict the validity of LUS thickness regarding dehiscent scar. When applicable, a p-value <0.05 was considered statistically significant.

RESULTS

Demographic characteristics and LUS features: About 300 pregnant women were enrolled in this study with mean age of 30±5.1 years. Most of the participants are within 20-29 years (42.4%) and 30-39 years (53%) age ranges (Table 1). Table 1 also showed that the mean parity of the participants was 3±1 and the majority has 2-3 children (73.7%); meanwhile, the mean abortion rate was 0.2±0.6 and only 11.7% of them demonstrated positive abortion. Additionally, the mean previous CS of the enrolled pregnant women was 2.2±0.4; the majority of them (85%) experienced 2 CSs during their lives with no significant difference among women regarding their LUS thickness (Table 1). Moreover, the mean time of last CS was found to be 1.9±1 years with a significant association between shorter time since last CS and lower LUS thickness with the mean value of 2.2±1 years (p = 0.005) (Table 1). The presence of a dehiscent scar, detected by transverse abdominal ultrasonography (TAU), was reported in 20.7% of the enrolled cases and a highly significant association (p<0.001) was observed between dehiscent scar detected by the US and lower LUS thickness of the participants (Table 1).

LUS thickness and late GA ultrasound: Table 2 showed that the mean Gestational Age (GA) measured by late ultrasound was 37.5±8.0 weeks, while the mean Low Uterine Scar (LUS) thickness was 3.9±0.5 mm. Moreover, the majority of participants are presented with GA ≥37 weeks and no significant differences were reported regarding the association between the LUS thickness and the GA within the pregnant women with GA <37 weeks, while LUS thickness ≥4 mm was reported in the majority of women with GA ≥37 weeks which is significantly greater than those with LUS thickness <4 mm (Table 2). Table 3 showed that a cutoff point of LUS thickness of 3.9 mm had acceptable validity result (ROC curve analysis) in predicting of dehiscent scar (78.2% sensitivity and 82.3% specificity). Meanwhile, a cutoff point of LUS thickness of 3.9 mm had an acceptable validity result in predicting the shorter GA (69% sensitivity and 50% specificity). A highly significant difference was reported in the incidence of dehiscent scars when compared according to the LUS thickness distribution (Table 3-5).

APGAR score outcome: In Table 6, the mean APGAR score after 5 min of neonates was reported to be 7.8±0.9 and

Table 1: Demographic characteristics and LUS features

Variables	n (%)
Age (Mean±SD: 30±5.1 years)	
<20 years	4 (1.3)
20-29 years	127 (42.4)
30-39 years	159 (53.0)
≥40 years	10 (3.3)
Parity (Mean±SD: 3±1)	
2-3 children	221(73.7)
>3 children	79 (26.3)
Abortion (Mean±SD: 0.2±0.6)	
No abortion	262 (87.3)
1-2	35 (11.7)
≥3	3 (1.0)
Previous CS (Mean±SD: 2.2±0.4)	
2 CSs	255 (85.0)
3-4 CSs	45 (15.0)
Time of last CS (Mean ±SD) (1.9±1 years)	
<3 years	159 (53.0)
≥3 years	141(47.0)
Time since last CS (Mean ±SD) (2.2±1 years)	
<3 years	208 (69.4)
≥3 years	92 (30.6)
Dehiscent scar n (%)	
Yes	62 (20.7)
No	238 (79.3)

Table 2: LUS thickness and late GA ultrasound of pregnant women

Gestational age (GA) by the late US		LUS<4 mm	LUS≥4 mm
Mean GA (37.5±8.0 weeks)	n (%)	n (%)	n (%)
28-36 weeks	52 (17.3)	26 (50.0)	26 (50.0)
≥37 weeks	248 (82.7)	77 (31.0)[a]	171 (69.9)

LUS: Lower uterine scar

Table 3: Distribution of pregnancy outcome according to LUS dehiscence and thickness

Dehiscent scar	<4 mm n (%)	≥4 mm n (%)	p-value
Yes	51 (49.5)	11 (5.6)	<0.001* HS
No	52 (50.5)	186 (94.4)	

*Fisher's exact test, HS: Highly significant

Table 4: Receiver Operating Characteristics (ROC) curve of LUS thickness regarding dehiscent scar

LUS cutoff point (mm)	Sensitivity (%)	Specificity (%)
2.5	98.0	4.2
3.0	90.8	22.6
3.9	78.2	82.3
4.0	26.5	95.2
4.5	10.1	100.0

LUS: Lower uterine scar

Table 5: Receiver Operating Characteristics (ROC) curve of LUS thickness regarding shorter GA

LUS cutoff point (mm)	Sensitivity (%)	Specificity (%)
2.5	98.0	1.8
3.0	89.9	22.2
3.9	69.0	50.0
4.0	22.6	81.8
4.5	7.3	88.5

LUS: Lower uterine scar, GA: Gestational age

Table 6: Pregnancy outcome of the pregnant women enrolled in the study

Variables	n (%)
APGAR score after 5 min (Mean±SD: 7.8±0.90)	
<7	16 (5.3)
≥7	284 (94.7)
Neonatal weight (Mean±SD: 3±0.4 kg)	
Normal	291 (97.0)
Low	9 (3.0)
GA by pediatrician assessment (Mean±SD: 37.2±0.7 weeks)	
28-36 weeks	24 (8.0)
≥37 weeks	276 (92.0)
Other complication (RDS, birth asphyxia, etc.)	
Positive	18 (6.0)
Negative	282 (94.0)

284 neonates (84.7%) had a normal APGAR score (≥7.0), while 16 (5.3%) had a low APGAR score (<7.0). Moreover, the mean neonatal weight was found to be 3±0.4 kg and 291 neonates (97%) had a normal birth weight, while only 9 of them (3%) had a low birth weight. Table 6 also indicates that the mean GA of the neonates (measured by the pediatrician) were 37.2±0.7 weeks, where 276 of them (92%) had GA of ≥37 weeks, while 24 (8%) had an earlier GA. Only 18 (6%) of the neonates demonstrated early complications and were admitted to the Neonatal Intensive Care Unit (NICU).

DISCUSSION

The indications for CS are increasing with the involvement of fetal causes and with the advancement of anesthetic techniques and surgical skills, the survival rates were increased with fewer complications[18]. In the present study, the mean LUS thickness of the pregnant women was reported to be 3.9 mm. This finding was consistent with the previous data reported in Japan by Fukuda *et al.*[19], which revealed the same mean of LUS thickness. In a previous meta-analysis study carried out in Canada by Jastrow *et al.*[9] a strong link between thinning of LUS and future uterine defects were reported. Moreover, a significant association was reported between the lower LUS thickness and CS scar dehiscence in patients with two or more CS scars ($p<0.001$). This finding was similar to the results reported in Japan by Sawada *et al.*[20], which stated that uterine scar dehiscence is strongly correlated with the LUS thickness among pregnant women with previous CS scars. The cutoff value of LUS thickness in this study that predicts uterine scar dehiscence was 3.9 mm (78.2% sensitivity and 82.3% specificity). This finding is closely similar to the results of Kok *et al.*[21]; this meta-analysis study conducted in Netherland reported a cutoff value of 4.1 mm (94% sensitivity and 64% specificity). In Poland, Pomorski *et al.*[22] reported that the LUS thickness assessment of women, delivered previously by CS could be of value to predict the dehiscent scar in the subsequent pregnancies. The present study showed that pregnant women with LUS thickness less than 4 mm were significantly associated with earlier GA (28-36 weeks) ($p = 0.009$) and was predictive for shorter GA with a cutoff value of 3.9 mm (78.2 sensitivity and 82.3% specificity). This finding was in tune with the results reported by Singh *et al.*[23] which stated that thinner LUS of pregnant Indian women with previous CS scars was highly related to the premature labor and shorter GA. Meanwhile, in a prospective study, Rozenberg *et al.*[24] reported that the LUS of French women delivered by normal vaginal delivery was significantly thicker than women delivered by CS and recommended the use of trans-abdominal US in the assessment of LUS thickness. Moreover, another French study in France indicated that the thinness of LUS was highly correlated with the dehiscent uterine scar and preterm labor[25]. It has been previously reported that LUS thickness was positively correlated with GA of pregnant women with previous CS[26]. In Iraq, Samar and Kadem[27] reported that LUS assessment was a simple test that can be used to predict the uterine scar defect; however, this study revealed no reliable cutoff value in this regard. Meanwhile, others reported that the lower uterine thinning in pregnant women with previous CSs can be used to predict shorter GA and delivery complications with a cutoff value of 3.5-4 mm (79% sensitivity and 84% specificity)[28,29]. In the present study, the results showed that the shorter duration since last CS was significantly correlated with the LUS thinning ($p = 0.01$). This finding supports the results of Basic *et al.*[18], who stated that the duration since last CS is correlated positively with LUS thickness. It has been shown that the LUS of women delivered by CS was healed and became thicker with time[30], while an Indian data stated that women with a short interval

between pregnancies had thinner LUS[31]. The present study indicated that pregnant women with thinner LUS delivered neonates with a significantly lower APGAR score at 5 min ($p<0.001$). This was in tune with the results reported by Gupta *et al.*[32], who stated that the APGAR score was higher among women with thicker LUS after two or more CSs. However, Biler *et al.*[33] reported that repeated CSs had no significant effect on the APGAR score after 5 min for neonates. The current study also showed that pregnant women with thinner LUS delivered neonates with significantly lower birth weight and shorter GA according to the pediatrician assessment. This finding was consistent with that reported by Kumar *et al.*[34] in Pakistan, who revealed that thinning of LUS was strongly correlated with lower birth weight and shorter GA assessed by pediatricians. The strong points of the present study include the exclusion of emergency CS cases and the inclusion of pregnant women with previous multiple cesarean sections. The limitation of the present study was the relatively small sample size of recruited pregnant women, based on the rate of CS performed in the hospital.

CONCLUSION

The LUS thickness of 3.9 mm can be used as a cutoff value for the timing of the next CS in pregnant women with two or more previous CSs. Meanwhile, the LUS thickness could be an appropriate predictor for CS scar dehiscence and shorter GA for those women. Additionally, shorter duration since last CS and emergency CS represent the main risk factors for LUS thickness and the LUS thickness may impact the neonatal APGAR score, birth weight and GA.

SIGNIFICANCE STATEMENT

The present data addressed the importance of assessing the lower uterine segment thickness at term as a predictor of the next CS timing in Iraqi pregnant women with two or more previous CSs. The present work supported the previous idea that the LUS thickness could be an appropriate predictor of CS scar dehiscence and shorter GA and may help those interested in this field to clarify the importance of this marker in determining the fetal outcomes.

ACKNOWLEDGMENT

The authors gratefully thank the clinicians and medical staffs at Al-Elweyia Maternity Teaching Hospital for technical and logistic support.

REFERENCES

1. Jo, J.H., Y.H. Choi, J.H. Wie, H.S. Ko, I.Y. Park and J.C. Shin, 2018. Fetal Doppler to predict cesarean delivery for non-reassuring fetal status in the severe small-for-gestational-age fetuses of late preterm and term. Obstet. Gynecol. Sci., 61: 202-208.
2. Chalmers, B. and V. Mangiaterra, 2001. Appropriate perinatal technology: A world health organization perspective. J. Obst. Gynaecol. Can., 23: 574-575.
3. Montoya-Williams, D., D.J. Lemas, L. Spiryda, K. Patel, J. Neu and T.L. Carson, 2017. What are optimal cesarean section rates in the U.S. and how do we get there? A review of evidence-based recommendations and interventions. J. Women's Health, 26: 1285-1291.
4. Ye, J., A.P. Betran, M.G. Vela, J.P. Souza and J. Zhang, 2014. Searching for the optimal rate of medically necessary cesarean delivery. Birth, 41: 237-244.
5. Marshall, N.E., R. Fu and J.M. Guise, 2011. Impact of multiple cesarean deliveries on maternal morbidity: A systematic review. Am. J. Obstet. Gynecol., 205: 262.e1-262.e8.
6. Dahlke, J.D., H. Mendez-Figueroa, D.J. Rouse, V. Berghella, J.K. Baxter and S.P. Chauhan, 2013. Evidence-based surgery for cesarean delivery: An updated systematic review. Am. J. Obstet. Gynecol., 209: 294-306.
7. Morales, A., O. Reyes and G. Cardenas, 2019. Type of blunt expansion of the low transverse uterine incision during caesarean section and the risk of postoperative complications: A prospective randomized controlled trial. J. Obstet. Gynaecol. Can., 41: 306-311.
8. Yazicioglu, F., A. Gokdogan, S. Kelekci, M. Aygun and K. Savan, 2006. Incomplete healing of the uterine incision after caesarean section: Is it preventable? Eur. J. Obstet. Gynecol. Reprod. Biol., 124: 32-36.
9. Jastrow, N., N. Chaillet, S. Roberge, A.M. Morency, Y. Lacasse and E. Bujold, 2010. Sonographic lower uterine segment thickness and risk of uterine scar defect: A systematic review. J. Obstet. Gynaecol. Can., 32: 321-327.
10. Bujold, E., N. Jastrow, J. Simoneau, S. Brunet and R.J. Gauthier, 2009. Prediction of complete uterine rupture by sonographic evaluation of the lower uterine segment. Am. J. Obstet. Gynecol., 201: 320.e1-320.e6.
11. Ida, A., Y. Kubota, M. Nosaka, K. Ito, H. Kato and Y. Tsuji, 2014. Successful management of a cesarean scar defect with dehiscence of the uterine incision by using wound lavage. Case Rep. Obstet. Gynecol., Vol. 2014. 10.1155/2014/421014.
12. Sen, S., S. Malik and S. Salhan, 2004. Ultrasonographic evaluation of lower uterine segment thickness in patients of previous cesarean section. Int. J. Gynecol. Obstet., 87: 215-219.
13. Jurkovic, D., 2002. Three dimensional ultrasound in gynecology: A critical evaluation. Ultrasound Obstetr. Gynecol., 19: 109-117.

14. Silver, R.M., M.B. Landon, D.J. Rouse, K.J. Leveno and C.Y. Spong *et al*., 2006. Maternal morbidity associated with multiple repeat cesarean deliveries. Obstet. Gynecol., 107: 1226-1232.
15. Zwart, J.J., J.M. Richters, F. Ory, J.I.P. De Vries, K.W.M. Bloemenkamp and J. Van Roosmalen, 2009. Uterine rupture in the Netherlands: A nationwide population based cohort study. BJOG: Int. J. Obstetr. Gynaecol., 116: 1069-1080.
16. Kushtagi, P. and S. Garepalli, 2011. Sonographic assessment of lower uterine segment at term in women with previous cesarean delivery. Arch. Gynecol. Obstetr., 283: 455-459.
17. Seliger, G., K. Chaoui, C. Lautenschlager, M. Riemer and M. Tchirikov, 2018. Technique of sonographic assessment of lower uterine segment in women with previous cesarean delivery: A prospective, pre/intraoperative comparative ultrasound study. Arch. Gynecol. Obstetr., 298: 297-306.
18. Basic, E., V. Basic-Cetkovic, H. Kozaric and A. Rama, 2012. Ultrasound evaluation of uterine scar after cesarean section. Acta Inform. Medica, 20: 149-153.
19. Fukuda, M., K. Fukuda, T. Shimizu and E. Bujold, 2016. Ultrasound assessment of lower uterine segment thickness during pregnancy, labour and the postpartum period. J. Obstetr. Gynaecol. Can., 38: 134-140.
20. Sawada, M., S. Matsuzaki, R. Nakae, T. Iwamiya and A. Kakigano *et al*., 2017. Treatment and repair of uterine scar dehiscence during cesarean section. Clin. Case Rep., 5: 145-149.
21. Kok, N., I.C. Wiersma, B.C. Opmeer, I.M. De Graaf, B.W. Mol and E. Pajkrt, 2013. Sonographic measurement of lower uterine segment thickness to predict uterine rupture during a trial of labor in women with previous Cesarean section: A meta analysis. Ultrasound Obstetr. Gynecol., 42: 132-139.
22. Pomorski, M., T. Fuchs and M. Zimmer, 2014. Prediction of uterine dehiscence using ultrasonographic parameters of cesarean section scar in the nonpregnant uterus: A prospective observational study. BMC Pregn. Childbirth, Vol. 14. 10.1186/s12884-014-0365-3.
23. Singh, N., R. Tripathi, Y.M. Mala and R. Dixit, 2015. Scar thickness measurement by transvaginal sonography in late second trimester and third trimester in pregnant patients with previous cesarean section: Does sequential change in scar thickness with gestational age correlate with mode of delivery? J. Ultrasound, 18: 173-178.
24. Rozenberg, P., F. Goffinet, H.J. Phillippe and I. Nisand, 1996. Ultrasonographic measurement of lower uterine segment to assess risk of defects of scarred uterus. Lancet, 347: 281-284.
25. Ginsberg, Y., I. Goldstein, L. Lowenstein and Z. Weiner, 2013. Measurements of the lower uterine segment during gestation. J. Clin. Ultrasound, 41: 214-217.
26. Sanlorenzo, O., A. Farina, G. Pula, M. Zanello and A. Pedrazzi *et al*., 2013. Sonographic evaluation of the lower uterine segment thickness in women with a single previous cesarean section. Minerva Ginecol., 65: 551-555.
27. Sarsam, S.D. and H.A. Kadem, 2013. Measuring lower uterine segment thickness using abdominal ultrasound to predict timing of cesarean section in women with scarred uterus at Elwiya Maternity Teaching Hospital. Al-Kindy Coll. Med. J., 9: 9-13.
28. Naji, O., Y. Abdalla, A.J.B. De Vaate, A. Smith and A. Pexsters *et al*., 2012. Standardized approach for imaging and measuring cesarean section scars using ultrasonography. Ultrasound Obstet. Gynecol., 39: 252-259.
29. Mohammed, A.B.F., D.A. Al-Moghazi, M.T. Hamdy and E.M. Mohammed, 2010. Ultrasonographic evaluation of lower uterine segment thickness in pregnant women with previous cesarean section. Middle East Fertil. Soc. J., 15: 188-193.
30. Vervoort, A.J.M.W., L.B. Uittenbogaard, W.J.K. Hehenkamp, H.A.M. Brolmann, B.W.J. Mol and J.A.F. Huirne, 2015. Why do niches develop in Caesarean uterine scars? Hypotheses on the aetiology of niche development. Hum. Reprod., 30: 2695-2702.
31. Balachandran, L., P.R. Vaswani and R. Mogotlane, 2014. Pregnancy outcome in women with previous one cesarean section. J. Clin. Diagn. Res., 8: 99-102.
32. Gupta, P., I. Jahan and G.R. Jograjiya, 2014. Is vaginal delivery safe after previous lower segment caesarean section in developing country? Niger. Med. J., 55: 260-265.
33. Biler, A., A. Ekin, A. Ozcan, A.H. Inan, T. Vural and E. Toz, 2017. Is it safe to have multiple repeat cesarean sections? A high volume tertiary care center experience. Pak. J. Med. Sci., 33: 1074-1079.
34. Kumar, D., N. Mohan and N. Sharma, 2014. Evaluation of lower uterine segment in women with previous cesarean section by transabdominal ultrasonography and its relation to feto-maternal outcome. J. K. Sci., 16: 71-75.