Cesarean Section Scar Niche Evaluation in Non-Pregnant Women Using Three-Dimensional Ultrasound

Original Article

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ABSTRACT

Objective: To assess the prevalence and investigate possible risk factors of cesarean scar niche after one cesarean delivery using three-dimensional ultrasonography.

Methods: A descriptive cross-sectional study conducted on 250 non pregnant women attended to outpatient clinic in Mansoura university hospital. Patients with only one cesarean delivery done from 6 to 12 months prior to time of examination were evaluated by three-dimensional trans-vaginal ultrasonography to detect possible cesarean scar niche. The main outcome measure was the presence of cesarean scar niche. Women with cesarean scar niche were compared with those with intact scar (control group). Maternal demographic variables, obstetric and peri-operative variables were analyzed in both groups to detect possible risk factors of cesarean scar niche.

Results: Cesarean scar niche was found in 77.2% of study group, with 58.4% of all study group having large defect. The most common shape of cesarean scar niche was triangular (71.6%). The following variables were more detected in cesarean scar defect group than in control group; advanced maternal BMI (as mean BMI in cesarean scar defect group was 27.15 ± 4.17 versus 25.28 ± 2.90 in control group; *P value* 0.001), presence of active labor (45,6% of women in cesarean scar defect group had active labor versus only 17.5% in the control group; *P value* ≤ 0.001), peripartum fever (34.2% of cesarean scar defect group had peripartum fever versus only 17.5% in the control group; *P value* 0.016), and uterine retroversion (uterus was retro flexed in 26.4% in the cesarean scar defect group versus only 12.3% in the control group; *P value* 0.016). Gestational age at time of delivery and fetal weight were not found to affect the risk of cesarean scar niche formation.

Conclusion: Based on ultrasound examination, increased maternal BMI, presence of active labor, peripartum fever, and uterine retroversion were found to be associated with increased risk of cesarean scar niche. Reduced distance between cesarean section scar or niche and cervical internal os was associated with large defects.

Key Words: Cesarean delivery, cesarean scar defect, niche, isthmocele, ultrasonography.

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INTRODUCTION

Cesarean delivery (CD) has emerged as a life-saving procedure only when it is decided for its right indications[1]. The World Health Organization (WHO) had mentioned that CD delivery rates should not exceed 15%, and adherence to this practice leads to reduction in both maternal and neonatal mortality[2]. Rates of cesarean delivery are increasing worldwide, with rates of up to 50% have been reported. The problem is that some of these cesarean deliveries are performed without any medical indication[3,4].

One of the emerging complications of cesarean delivery is what is called cesarean scar defect (CSD) (also known as niche or isthmocele) and is associated with several obstetric complications. Uterine rupture and abnormal placental implantation that varies from cesarean scar pregnancy to placenta accrete spectrum are among the most important reported complications. These complications may be life threatening[5].

This CSD had also been linked to some gynecologic problems that include post menstrual bleeding, dyspareunia, dysmenorrhea, and chronic pelvic pain. The accumulation of blood in this defect may also have a negative impact on cervical mucus and semen leading to subfertility[6].

The term 'niche' or CSD is used to describe the presence of a hypo-echoic area usually triangular within the anterior myometrium of the lower uterine segment that reflects discontinuation of the myometrium present at the site of a previous cesarean delivery[7].

The depth of the defect within the myometrium should be at least 2 mm. The term large niche is used when the defect

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has a depth of 50% to 80% of the anterior myometrium, or when the residual myometrial thickness is less than 2.2 mm when evaluated by trans-vaginal sonography (TVS) or less than 2.5 mm when evaluated by Sono-hysterography[8].

There is a wide variation in the prevalence of cesarean scar defect that ranges from 6.9% to 69% depending on the method used for evaluation and the study population[5,9].

There are many risk factors for cesarean scar defect formation, with history of multiple repeated cesarean deliveries remains the main one. Other risk factors include retroflexion of the uterus and advanced stage of labor[10]. Also, medical disorders, suture material and suture technique may have a role[11].

In our locality, rates of cesarean delivery are increasing. Risk factors for cesarean scar defect formation are not well studied, which is very important in order to implement preventive strategies that may help to reduce this risk.

The aim of our study is to evaluate the rate and morphology of cesarean scar defect in non-pregnant women using three-dimensional ultra-sonography in order to investigate the associated risk factors.

MATERIALS AND METHODS

A descriptive cross-sectional study was conducted on 250 women attended gynecology clinic in Mansoura university hospital for follow up, contraceptive advice or due to any gynecological symptoms. The study was done during the period from January 2019 to January 2021.

Study protocol was submitted for approval by International Research Board on January 28th, 2019 (Code Number: MS.18.12.415) Faculty of medicine, Mansoura University. A written informed consent was obtained from all women sharing in the study. Respecting personal privacy at all levels of the study was the rule.

Patients were selected from non-pregnant women aged between 18 to 45 years old and delivered by single transverse lower segment Cesarean section for singleton pregnancy at Mansura University Hospital, 6-12 months ago prior to examination.

Women with history of more than one cesarean delivery, other uterine surgery, and congenital uterine anomalies were excluded. Also, women who suffered from a medical disorder such as diabetes mellitus and hypertensive disorders or were receiving corticosteroids were ruled out.

Selected women were interviewed to complete a questionnaire previously designed to collect demographic data and detailed obstetric history. Other information regarding pregnancy, whether the delivery was elective or emergent, indication of cesarean delivery, presence of active labor at time of delivery, degree of cervical dilatation, presence of premature rupture of membranes, operative technique, and perioperative febrile condition were obtained from patient's medical reports and electronic database.

Then, an ultrasonographic examination and assessment of the cesarean section scar was conducted by an examiner expertise in ultrasound using 3D Samsung H60 with a 4–9 MHz TVS probe without using contrast. The ultrasound assessment was undertaken at 6 – 12 months after the cesarean delivery regardless to the menstrual cycle.

Women with their bladder empty lied in a lithotomy position during the examination. Then, complete visualization of the uterus in sagittal and axial plane. The lower uterine segment was examined carefully to identify the cesarean section scar and possible niche. The distance between cesarean section scar and cervical internal os was measured. Also, the uterine position whether ante-flexed or retro-flexed was documented.

When a niche was found, the following parameters were assessed in the midsagittal plane; Residual myometrial thickness (RMT), measured from the serosa covering the uterus to the niche apex, Depth (D), distance from niche apex to the base of the niche, Width (W) measured in the widest diameter of the hypoechoic area of niche base, and Total Myometrial thickness (TMT) in the healthy myometrium adjacent to the niche. In the transverse plane the length (L) of the niche was measured.

For the diagnosis of cesarean scar defect or niche we depended on the definition of the presence of defect at least 2mm in depth. Cesarean scar defect was considered large when the depth of the defect was more than 50% total myometrial thickness. Women with no cesarean scar defect were considered as a control group.

Data were analyzed using the Statistical Package of Social Science (SPSS) program for Windows (Standard version 21). Firstly, the data normality was tested using one-sample Kolmogorov-Smirnov test. Qualitative data were described in numbers and percent. Categorical variables association was tested with Chi-square test. While continuous variables were expressed as mean ± standard deviation (for normally distributed data) and median, min and max (for non-normal data). Both groups were compared using Student t-test for normal data and Mann-Whitney test (non-parametric). Spearman correlation was used to correlate continuous variables. The threshold of significance is fixed at 5% level. The results were considered significant when $p \leq 0.05$. The smaller the *p-value* obtained, the more significant are the results.

RESULTS

(Table 1) shows baseline demographic and obstetric data among study group with the mean age was 28.92 ± 5.82 years at time of their CD. Also, the mean BMI was 26.89 ± 4.18 at time of delivery.

Table 1: Baseline demographic and obstetric data among the study group

	Mean ± SD Median (min-max)	Frequency (%)
Age (years)	28.92 ± 5.82	
BMI	26.89 ± 4.18	
History of abortion		65 (26.0%)
History of previous vaginal delivery		
Primipara		100 (40.0 %)
Multipara		150 (60.0 %)
Gestational Age (weeks)	39.09 ± 1.38	
Fetal weight (gm)	3226.36 ± 326.51	
Type of CS		
Elective		139 (55.6%)
Emergent		111 (44.4%)
Women in labor during CS		98 (39.2%)
Women received induction		12 (4.8%)
Women received augmentation		16 (6.4%)
Cervical dilatation at time of CS (cm)	2.0 (0-6)	
PROM prior to CS		78 (31.2%)
Peri-operative Fever		76 (30.4%)

BMI, body mass index. **PROM,** premature rupture of membrane

Using three-dimensional ultrasound scan on 250 non pregnant women, 57 women (22.8%) had intact scar (no CSD or niche) (considered as a control group) while CSD was found in 193 women (77.2 %), of them 47 women had small defect, and 146 women had large defect (Table 2) (Figure 1). The most common morphology of the niche in our study was triangular (71.6.%). Other less common shapes were semicircular (5.2%), quadrangular (4.4%), and there was a total defect in 18.8% of cases.

Table 1: Baseline demographic and obstetric data among the study group

	Mean ± SD Median (min-max)	Frequency (%)
Women with intact scar		57 (22.8%)
Women with scar defect		193 (77.2%)
Size of scar defect		
Small defect		47 (18.8%)
Large defect		146 (58.4%)
Total myometrial thickness (mm)	11.35 ± 3.32	
Residual myometrial thickness (mm)	4.70 (1.20-14.70)	
Depth (mm)	5.70 (0.0-14)	
Width (mm)	4.10 (0.0-18.9)	
Length (mm)	11.00 (0.0-30)	

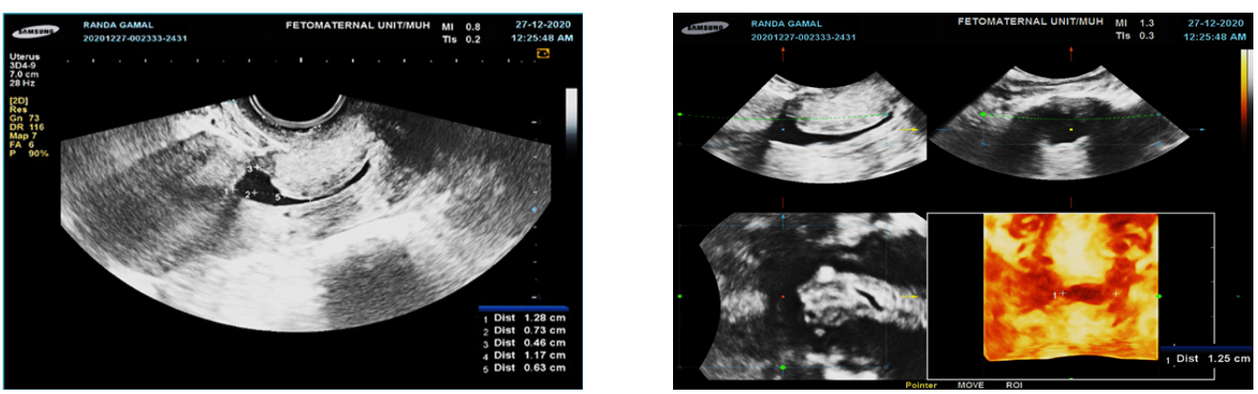

Fig. 1: Large CSD in sagittal view (upper one), and 3D reconstructed image (lower one)

Demographic and obstetric variables were analyzed in both groups (Table 3). The mean age was found to be older in women with scar defect (29.43 ± 5.37) than those with intact scar (27.19 ± 6.93). Also, Women with higher BMI were more prone to have CSD defect than those with lower BMI, as mean BMI in CSD group was 27.15 ± 4.17 versus 25.28 ± 2.90 in control group. There was no significant difference regarding the fetal gestational age at time of delivery between the two groups.

Table 3: Demographic and obstetric variables in both groups

	CSD group (n=193)	Control group (n=57)	*P value*
Age (years)	29.43 ± 5.37	27.19 ± 6.93	0.011
BMI	27.15 ± 4.17	25.28 ± 2.90	0.001
Gestational age (Weeks)	39.01 ± 1.45	39.35 ± 1.07	0.108
Fetal weight (gm)	3195.80 ± 314.22	3329.82 ± 348.44	0.006
Type of CS			
Elective	97 (50.3%)	47 (73.7%)	0.002
Emergent	96 (49.7%)	15 (26.3%)	
Presence of active labor	88 (45.6%)	10 (17.5%)	≤0.001
Premature rupture of Membranes	67 (34.7%)	11 (19.3%)	0.027
Peripartum fever	66 (34.2%)	10 (17.5%)	0.016

There was a significant difference regarding the rate of emergent CD between both groups, as 49.7% of women with CSD had emergency CD, while only 26.3% of women with no defect had emergency CD. Also, there was a significant difference between the two groups regarding the presence of active labor at time of CD, with 45,6% of women in CSD defect group had active labor versus only 17.5% in the control group. In CSD group, also premature rupture of membranes was significantly higher than control group (34.7% in CSD had premature rupture of membranes group versus 19.3% in control group). Peripartum fever was significantly higher in CSD group than in control group, as 34.2% of CSD group had peripartum fever versus 17.5% only in the control group.

Uterine retroversion was significantly higher in CSD group than in control group, as the uterus was retro flexed in 26.4% in the CSD group versus only 12.3% in the control group. Also, the distance from cesarean section scar to the cervical internal os was significantly smaller in women with CSD than in those with intact scar, as the median distance was 5.1 mm in CSD group versus 10 mm in control group (Table 4).

Table 4: Association between scar defects and Uterine position and Distance from Cervical OS

	CSD group (n=193)	Control group (n=57)	*P value*
Uterine Position			
Ante-flexed	142 (73.6%)	50 (87.7%)	0.016
Retro-flexed	51 (26.4%)	7 (12.3%)	
Distance from CS scar to internal OS (in mm)	5.1 (0.0-20.7)	10 (4-20.1)	≤0.001

The Correlation between distance from cervical os and niche parameters were analyzed in (Table 5). There was a statistically significant positive correlation between the distance from cervical internal os and RMT. On the other hand, there was a significantly negative correlation between the distance from cervical internal os and depth, width, and length of CSD.

Table 5: Correlation between distance from cervical os and niche parameters

	Distance from cervical OS	
	r	*P value*
RMT (mm)	0.429	≤0.001*
Depth (mm)	- 0.189	0.003*
Width (mm)	- 0.460	≤0.001*
Length (mm)	- 0.445	≤0.001*

r: Spearman correlation

DISCUSSION

Cesarean scar niche or defect is a direct consequence of CD, and with increasing rates of CD worldwide, there was more attention and awareness of this problem. Appearance of several gynecologic and obstetric complications in women with history of CD had pushed researchers to improve methods of diagnosis and gain more experience about this pathology.

There is agreement that contrast-enhanced trans-vaginal sonography is the gold standard in the diagnosis of CSD[10] with much improvement of the examiners experience. On the other hand, risk factors of CSD remain non consistent in most studies.

In our study that included 250 non pregnant women, the prevalence of CSD was 77.2% and 58.4% of all women having large defect. The reported prevalence of niche using TVS varied between 24% and 70% in four studies that included a random population of women with one or multiple cesarean deliveries[12,13,14,15]. The prevalence of niche using Sono-hysterography varied between 56% and 84% in three studies that also included a random population[13,15,16].

This wide variation in the prevalence of niche could be attributed to the criteria used for diagnosis, study population and method used for detection. In our study we have included women attending the gynecologic outpatient

clinic. Some of these women were seeking medical advice because of their complaint. This may explain the high prevalence of niche in our study.

We have included only women with history of one CD and excluded women with multiple repeated cesarean deliveries, while most of the studies had included women with single or multiple cesarean deliveries. Our rational was that the presence of multiple repeated cesarean deliveries was reported as a well-known risk factor for niche formation with one study reporting presence of large defect in 61%, 81%, and 100% in women with one, two or three cesarean deliveries respectively[14]. Similar findings were found in another study as women reporting their first cesarean delivery had a 35% chance of having cesarean scar defect, while after 2nd, 3rd, or 4th cesarean deliveries the risk was 63%, 76%, and 88%, respectively[10].

We have done the examination 6 to 12 months after the CD; some other studies had performed earlier examination at 6 to 12 weeks after CD[17,18]. We preferred to do examination at this time because it was suggested that the healing process of cesarean wound takes at least 6 months[10].

Our study had revealed that maternal age was older in women with CSD (29.43 ± 5.37 years) than those with no CSD (27.19 ±6.93 years) (*P value* 0.011). In a study by Tang *et al*., 2019, it was found that women who underwent their last cesarean delivery at <30 years of age reported less CSD[19]. In another study, multivariate logistic regression analysis was performed for risk factor of post cesarean section scar defect and showed that age equal to or more than 30 years was a high-risk factor[20].

On the other hand, in a study by Antila-Langsjo *et al*., 2018, although women in CSD group had older age than those with intact scar, the difference was non-significant (*P value* .074)[10].

Our study had shown that women with CSD had higher BMI than those with intact scar (*P value* 0.001). This was the same result of another study that considered advanced maternal BMI to be independent risk factor for CSD with each additional unit of BMI raised the risk by 6%[10]. They have assumed that obesity had been linked with impaired healing of cutaneous wounds in general and associated with total wound failure after surgical procedures[21].

Our study had shown that presence of active labor was considered as a risk factor of CSD, because 45.6% of women in CSD group had active labor in contrast to only 17.5% in the group with intact scar (*P value* ≤0.001).

Other studies agree with our results, and in one study, it was shown that the mean duration of labor was longer in CSD group (16.2 hours) than in control group (13.9 hours) (*P value* .039)[10,19].

Our study had shown that presence of peripartum fever is more common in CSD group (34.2%) than in control group (17.5%) (*P value* 0.016). In a study by Tang *et al*., 2019, it was shown that CSD was more common in the presence of peripartum fever or infection. They have mentioned that peripartum infection is associated with impaired wound healing and this may contribute to development of CSD, and hence prevention of peripartum infection is very important[19].

In our study, we did not evaluate the effect of suture technique of uterine incision on development of CSD. This is because all our cases were closed by the same technique, which is double layered continuous unlocked sutures, using vicryl.

The relationship between closure technique and CSD was investigated by other studies. A randomized controlled trial had revealed that the use of full thickness technique (including the decidua) is less associated with niche formation when compared to split thickness technique (sparing the decidua)[22]. Also, another prospective cohort study found that single layer closure was associated with large niche when compared to double layer closure, but the difference was statistically non-significant[5].

Our results revealed that the uterus was retroverted at time of examination in 26.4% of cases with CSD despite only 12.3% in control group (*P value* 0.016). The association between uterine retroflexion and the development of CSD was investigated and it was assumed that the high mechanical tension on the lower uterine segment leads to poor perfusion and oxygen supply of the lower uterine segment leading to poor healing of the cesarean scar[23].

Our study had revealed that reduced distance between cesarean section scar or niche and cervical internal os was associated with reduced RMT and also associated with the development of large defects. In another study, the risk of large defects was increased if the duration of labor was equal to or more than 5 hours, cervical dilatation was equal to or more than 5 cm, and the station of the presenting part of the fetus at CD was below the pelvic inlet. All these factors are affecting the site of scar in the lower uterine segment. The same study had also revealed that large defects are located lower in the uterus than intact scars or scars with small defects[5].

The current study had revealed that increased maternal BMI, presence of active labor at time of cesarean delivery, peripartum fever, and uterine retroversion are considered risk factors for CSD. These results are confirmed in other studies.

Other risk factors mentioned in other studies include repeated cesarean delivery, and gestational diabetes mellitus. The effect of suture technique on CSD remains controversy in many studies. Awareness of these risk factors may help implementation of preventive measures that may help to reduce the problem of CSD.

The main limitation of our study is that the study cases are not selected at time of delivery in a random manner, and the participants were chosen from patients who visited the outpatient clinic seeking medical advice, many of them are symptomatic.

We have used basic sonographic measurements of CSD or niche, the use of three- dimensional saline contrast Sono-hysterography, and sonography-based Automated Volume Count software, referred to as the Sono-Hystero AVC had promising results in evaluation of uterus and uterine cavity, and this advanced technology began to be transmitted in evaluation of uterine niche[24].

The association between CSD, especially large defect and the development of symptoms needs further follow up on long term manner of the cases.

CONCLUSION

Based on ultrasound examination, increased maternal BMI, presence of active labor, peripartum fever, and uterine retroversion were found to be associated with increased risk of cesarean scar niche. Also reduced distance between cesarean section scar or niche and cervical internal os is associated with development of large defects.

ABBREVIATIONS

BMI: Body mass index, **CD:** Cesarean delivery, **CSD:** Cesarean scar defect, **PROM:** Premature rupture of membrane, **RMT:** Residual myometrial thickness, **TMT:** Total Myometrial thickness, **TVS:** Trans-vaginal sonography, **WHO:** World Health Organization.

CONFLICT OF INTERESTS

There are no conflicts of interest.

REFERENCES

1. Betran AP, Torloni MR, Zhang JJ, Gülmezoglu AM; WHO Working Group on Caesarean Section. WHO Statement on Caesarean Section Rates. BJOG. 2016 Apr;123(5):667-70.
2. Betran AP, Torloni MR, Zhang J, Ye J, Mikolajczyk R, Deneux-Tharaux C, Oladapo OT, Souza JP, Tunçalp Ö, Vogel JP, Gülmezoglu AM. What is the optimal rate of caesarean section at population level? A systematic review of ecologic studies. Reprod Health. 2015 Jun 21;12:57.
3. Betrán AP, Ye J, Moller AB, Zhang J, Gülmezoglu AM, Torloni MR. The Increasing Trend in Caesarean Section Rates: Global, Regional and National Estimates: 1990-2014. PLoS One. 2016 Feb 5;11(2):e0148343.
4. Souza JP, Gülmezoglu A, Lumbiganon P, Laopaiboon M, Carroli G, Fawole B, Ruyan P; WHO Global Survey on Maternal and Perinatal Health Research Group. Caesarean section without medical indications is associated with an increased risk of adverse short-term maternal outcomes: the 2004-2008 WHO Global Survey on Maternal and Perinatal Health. BMC Med. 2010 Nov 10;8:71.
5. Vikhareva Osser O, Valentin L. Risk factors for incomplete healing of the uterine incision after caesarean section. BJOG. 2010 Aug;117(9):1119-26.
6. Woźniak A, Pyra K, Tinto HR, Woźniak S. Ultrasonographic criteria of cesarean scar defect evaluation. J Ultrason. 2018;18(73):162-165.
7. Bij de Vaate AJ, Brölmann HA, van der Voet LF, van der Slikke JW, Veersema S, Huirne JA. Ultrasound evaluation of the Cesarean scar: relation between a niche and postmenstrual spotting. Ultrasound Obstet Gynecol. 2011 Jan;37(1):93-9.
8. Vervoort AJ, Uittenbogaard LB, Hehenkamp WJ, Brölmann HA, Mol BW, Huirne JA. Why do niches develop in Caesarean uterine scars? Hypotheses on the aetiology of niche development. Hum Reprod. 2015 Dec;30(12):2695-702.
9. Wang CB, Chiu WW, Lee CY, Sun YL, Lin YH, Tseng CJ. Cesarean scar defect: correlation between Cesarean section number, defect size, clinical symptoms and uterine position. Ultrasound Obstet Gynecol. 2009 Jul;34(1):85-9.
10. Antila-Långsjö RM, Mäenpää JU, Huhtala HS, Tomás EI, Staff SM. Cesarean scar defect: a prospective study on risk factors. Am J Obstet Gynecol. 2018 Nov;219(5):458.e1-458.e8.
11. Voet LLFV, Vaate AMJB, Heymans MW, Brölmann HAM, Veersema S, Huirne JAF. Prognostic Factors for Niche Development in the Uterine Caesarean Section Scar. Eur J Obstet Gynecol Reprod Biol. 2017 Jun;213:31-32.
12. Armstrong V, Hansen WF, Van Voorhis BJ, Syrop CH. Detection of cesarean scars by transvaginal ultrasound. Obstet Gynecol. 2003 Jan;101(1):61-5.
13. Bij de Vaate AJ, Brölmann HA, van der Voet LF, van der Slikke JW, Veersema S, Huirne JA. Ultrasound evaluation of the Cesarean scar: relation between a niche and postmenstrual spotting. Ultrasound Obstet Gynecol. 2011 Jan;37(1):93-9.
14. Osser OV, Jokubkiene L, Valentin L. High prevalence of defects in Cesarean section scars at transvaginal ultrasound examination. Ultrasound Obstet Gynecol. 2009 Jul;34(1):90-7.
15. Osser OV, Jokubkiene L, Valentin L. Cesarean section scar defects: agreement between transvaginal sonographic findings with and without saline contrast enhancement. Ultrasound Obstet Gynecol. 2010 Jan;35(1):75-83.
16. Menada Valenzano M, Lijoi D, Mistrangelo E, Costantini S, Ragni N. Vaginal ultrasonographic and hysterosonographic evaluation of the low transverse incision after caesarean section: correlation with gynaecological symptoms. Gynecol Obstet Invest. 2006;61(4):216-22.
17. van der Voet LF, Bij de Vaate AM, Veersema S, Brölmann HA, Huirne JA. Long-term complications of caesarean section. The niche in the scar: a prospective cohort study on niche prevalence and its relation to abnormal uterine bleeding. BJOG. 2014 Jan;121(2):236-44.

18. Yazicioglu HF, Sevket O, Ekin M, Ozyurt O, Aygun M. Incomplete healing of the uterine incision after cesarean section: is it preventable by intraoperative digital dilatation of the internal cervical ostium? Gynecol Obstet Invest. 2012;74(2):131-5.

19. Tang X, Wang J, Du Y, Xie M, Zhang H, Xu H, Hua K. Caesarean scar defect: Risk factors and comparison of evaluation efficacy between transvaginal sonography and magnetic resonance imaging. Eur J Obstet Gynecol Reprod Biol. 2019 Nov;242:1-6.

20. Chen Y, Han P, Wang YJ, Li YX. Risk factors for incomplete healing of the uterine incision after cesarean section. Arch Gynecol Obstet. 2017 Aug;296(2):355-361.

21. Guo S, Dipietro LA. Factors affecting wound healing. J Dent Res. 2010 Mar;89(3):219-29.

22. Yazicioglu F, Gökdogan A, Kelekci S, Aygün M, Savan K. Incomplete healing of the uterine incision after caesarean section: Is it preventable? Eur J Obstet Gynecol Reprod Biol. 2006 Jan 1;124(1):32-6.

23. Ofili-Yebovi D, Ben-Nagi J, Sawyer E, Yazbek J, Lee C, Gonzalez J, Jurkovic D. Deficient lower-segment Cesarean section scars: prevalence and risk factors. Ultrasound Obstet Gynecol. 2008 Jan;31(1):72-7.

24. Ludwin A, Martins WP, Ludwin I. Evaluation of uterine niche by three-dimensional sonohysterography and volumetric quantification: techniques and scoring classification system. Ultrasound Obstet Gynecol. 2019 Jan;53(1):139-143.