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Value of Combined 2D and Color Doppler Ultrasound in Determining the Integrity of The Lower Uterine Segment cesarean section Scar

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Abstract: Introduction: Our cross sectional (observational) study aimed to evaluate Value of Combined 2D and Color Doppler Ultrasound in Determining the Integrity of The Lower Uterine segment cesarean section scar at Tanat University Hospitals. **Patients and Methods:** For the purpose of our study 50 patients were included and submitted to the following assessments thorough history taking, Complete clinical examination: and Tran abdominal 2D ultrasound and Color Doppler**. Results:** Only six (12.0%) showed ballooning of the scar which was interrupted, with outside scar border and non-homogenous echo structure. As regards the scar thickness, it ranged from 1.40-7.50 mm with a mean of 4.13±1.50**.** Avascular scar in 40 patients whereas, hypervascular and hypovascular ones were detected in only 16.0% and 4.0% of the studied women respectively. Intraoperative evaluation revealed well-developed lower uterine segment scar in more than half (58.0%) of the studied women while, the scar was thin without visible content in 32.0% and with visible content in 10.0% of patients. All (100%) cases who showed intraoperative thin scar with visible content and 6.2% of those with thin scar without visible content showed ballooned interrupted, non-homogenous scar with outside border in transabdominal us examination. Hypervascular and hypovascular scars were statically related to the presence of thin scar with or without visible content during intraoperative settings ($p<0.05$). **Conclusion:** Combined 2D and color Doppler US are better in predicting the integrity of the lower uterine segment with previous cesarean section scar.
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Keywords: Cesarean section**,** lower uterine segment, CS scare**.**

1. Introduction

Worldwide, the incidences of cesarean sections (CS) are highly elevated. Also it is observed a rising in the rates of gestational women with previous CS. Previous CS is becoming the most common indication for CS [1]

Anomalies in the healing of uterine scar post cesarean sections might affect the redevelopment of the uterine isthmus and create it more thinner, leading to considerably thinner lower uterine segment scar in subsequent pregnancy. Thin lower uterine segment scar is likely to rupture during labor. Unsecured forecast of the reliability of the scarred lower uterine segment throughout delivery seemed to be one of the causes for recurrence caesarean sections (C/S) [2].

Ultrasonography is considered a simple and easily accessible imaging method to use for detection of scar tissues in the uterus. Maybe, ultrasonography (US) can be used for estimation of the whole lower uterine segment or the scars from previous caesarean section and may be applied alone or in association with other clinical symptoms to evaluate the probability of rupture of the uterus or dehiscence arising impulsively [3].

Aim Of the study

To Evaluate the Value of Combined 2d and Color Doppler Ultrasound in Determining the Integrity of The Lower Uterine Segment Cesarean section scar.

Patients and Methods

2. Patients and Methods:

Study setting and sampling:

The patients enrolled in the study were selected from the inpatients wards and outpatient clinic of the Obstetrics and Gynecology department, Tanta University Hospitals in the period from May 2017 to May 2018.

Study design:

An observational cohort study.

Inclusion criteria:

Women with: 1- One previous transverse lower uterine segment caesarean section scar.

2- Singleton fetus.

3- Gestational age about 36 to38 weeks.

Exclusion criteria:

Women with: 1- A previous history of uterine rupture.

2- Disturbance of fetal heart rate using CTG.

3- Placenta previa.

4- Obese patients with body mass index more than 30 kg/m^2.

5- Co-existing medical conditions like hypertensive disease in pregnancy, uncontrolled diabetes mellitus in pregnancy.

Study approval

A-Ethical considerations

Approval was gotten from Research Ethics Committee as a part of Quality Assurance Unit in Faculty of Medicine at Tanta University to conduct this research and to permits to use the facilities in the hospital.

B-Consent

All patients participating in the study were writing informed consent after complete explanation of advantages and disadvantages of the investigation. Secrecy of all data concerning patients was granted by a special code number for every patient file that comprises all examinations.

Study subject:

The 50 women will be subjected to:

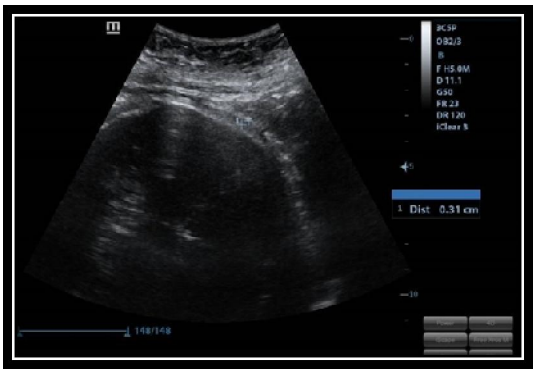

Fig 1: lower uterine segment by transabdominal ultrasound.

1- Full history taking with special emphasis on:

a- Menstrual history to be certain of the gestational age of patient between 36 and 38 weeks.

b- Obstetric history (number of normal vaginal deliveries, cause of previous cesarean section, complication in previous deliveries).

c- Past history of any medical condition.

d- Complain of the patient for the presence of any abdominal pain or any vaginal discharge or bleeding.

2- General examination of the patients with special emphasis on presence or absence of tender scar.

3- Transabdominal 2D ultrasound and Color Doppler using (Samsung ultrasound machine, model H60, USS- H60NF4K/WR (Samsung, Korea) with 3.5-MHz and 5-MHz convex probes)

To evaluate and analyse the thickness and integrity of lower uterine segment, Sonographically, it looks as a two –layered structure that formed from, the urinary bladder inward, of the echogenic visceral parietal reflection, involving the mucosa and the muscularis of the urinary bladder (the outer layer), and the relatively hypoechoicmyometrial layer Fig 11[45].

- The parameters that will be measured are:

a) Form of scarring which will be normal or ballooning.

b) Thickness: To measure the scar thickness the most suitable time to perform U/S is from 36-38 weeks gestation, as this allows for adequate lower segment progress and avoids of diagnosis difficulties when the donating part is located deep in the pelvis and when the amniotic fluid is decreased normally.

c) Continuity (continuous or interrupted).

d) Outer scar border (inside or outside).

e) The echo structure of the lower uterine segment (homogenous or nonhomogenous).

f) Vascularization of the lower uterine segment (avascular, hypovascular or hypervascular) Fig 2.

4- CTG of fetus.

5- Elective cesarean section based on maturity of fetus and complains of patient.

6- Evaluation of the uterine scar thickness and integrity intraoperatively (well developed lower segment, thin without visible content or thin with visible content).

7- Correlation between Ultrasound and Color Doppler findings with the intraoperative findings.

8- Statistical analysis:

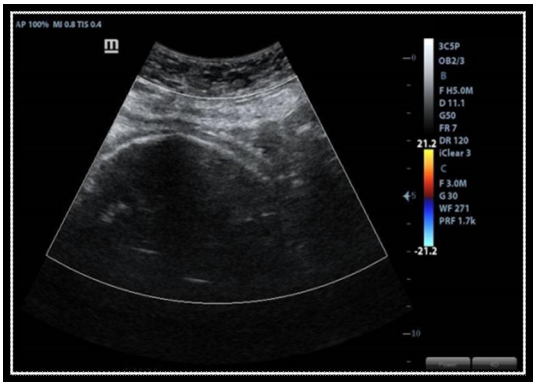

Fig 2: color doppler on lower uterine segment.

Statistics

The Shapiro-Wilk test for normality was done for numerical results. For normally distributed data, values were expressed as mean ± standard deviation. For data that were not normally distributed median

and interquartile range (expressed as 25th-75th percentiles) were determined. For comparison of the combined 2D US and color Doppler findings score in the three groups, Kruskall-Wallis test and the suitable post hoc test were done. As regards qualitative data, Fisher's exact test used to examine association between each of 2D US and color Doppler findings and intraoperative findings. Additionally, Receiver operating characteristics (ROC) curve was analyzes for prediction of the scar integrity by combined 2D US and color Doppler findings score. Significance was adopted at $p < 0.05$ for interpretation of results of tests. All analyses were done using SPSS version 20 (Knapp, 2017)

Knapp Herschel (2017): Introductory Statistics Using SPSS. SAGE Publications, Inc. [4].

3. Results

The present study was carried out on fifty women admitted in the Obstetrics and Gynecology Department at Tanta University Hospital in the period from May 2017 to May 2018.

Table 1: Anthropometric measurements of the studied women (N=50):

		Total (N=50)
Age (years)	Mean ±SD	25.44±3.98
Gestational age (weeks)	Median	37.60
	IQR	37.0-37.80
Gravidity	Median	3.0
	IQR	2.0-4.0
Parity	Median	2.0
	IQR	1.0-3.0
Number of normal vaginal deliveries	Median	1.0
	IQR	0.0-2.0

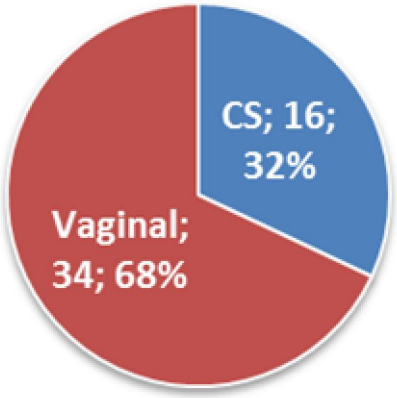

Fig 3: Pie chart showing method of delivery in the studied patients.

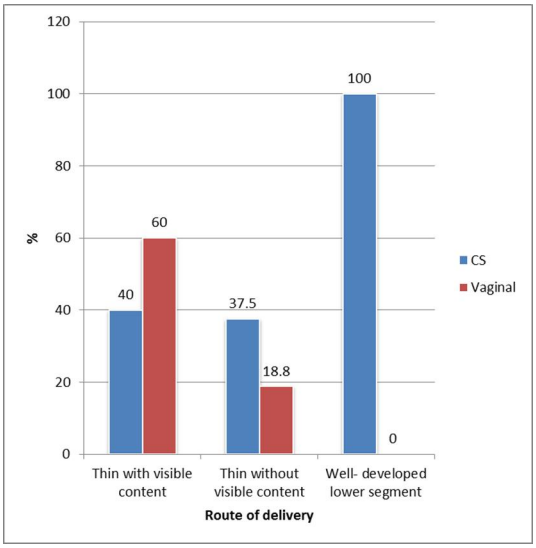

Fig 4: route of delivery in relation to scar integrity.

Table 2: 2D ultrasound findings in the studied women (N=50):

2D ultrasound findings		Total N=50	%
Scar shape	Normal	44	88.0
	Ballooning	6	12.0
Scar continuity	Continuous	44	88.0
	Interrupted	6	12.0
Scar border	Inside	44	88.0
	Outside	6	12.0
Echo structure	Homogenous	44	88.0
	Non-homogenous	6	12.0
Thickness	<3.5	15	30.0
	=3.5	4	8.0
	>3.5	31	62.0
Thickness (mm)	Minimum- Maximum	1.40-7.50	
	Mean ±SD	4.13±1.50	

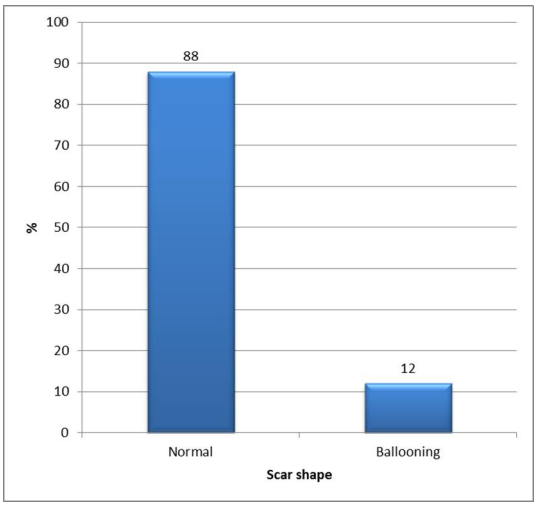

Fig 5: scar shape.

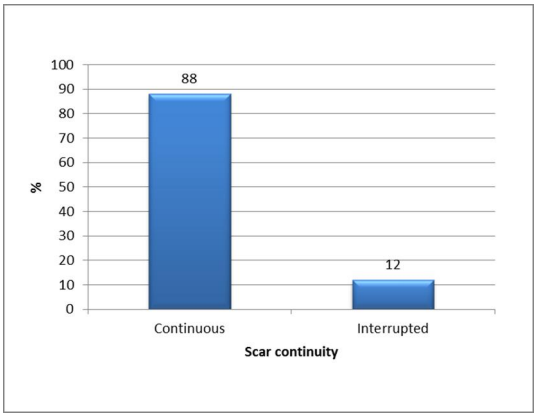

Fig 6: scar continuity.

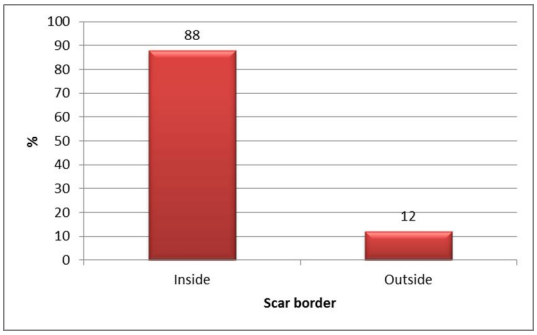

Fig 7: scar border.

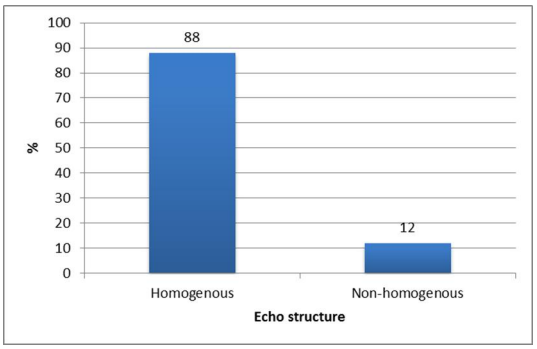

Fig 8: echo structure of lower uterine segment scar.

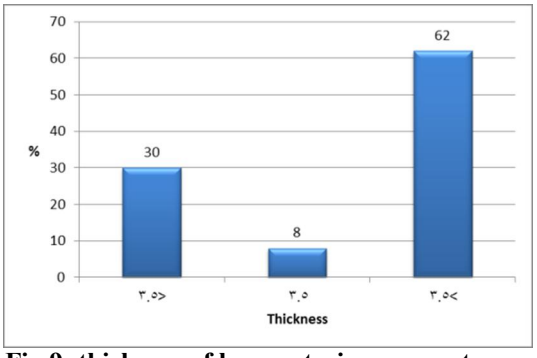

Fig 9: thickness of lower uterine segment scar.

Table 3: Color Doppler findings:

Color Doppler		Total N=50	%
Lower segment vascularization	Avascular	40	80.0
	Hypervascular	8	16.0
	Hypovascular	2	4.0

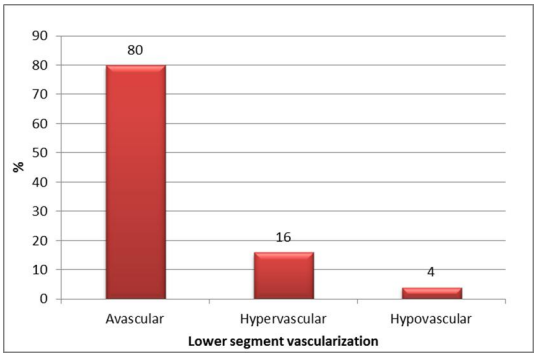

Fig 10: lower segment vascularization.

Table 4: Intraoperative findings:

Intraoperative findings		Total N=50	%
Scar integrity	Thin with visible content	5	10.0
	Thin without visible content	16	32.0
	well-developed lower segment	29	58.0

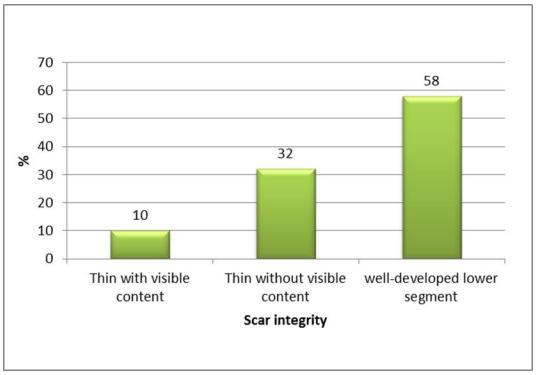

Fig 11: scar integrity.

Table 5: Association of 2D ultrasound findings with intraoperative findings:

2D ultrasound findings \ Scar integrity (intraoperative)		Thin with visible content		Thin without visible content		Well- developed lower segment		Fisher's exact test	
		N	%	N	%	N	%	X^2	P value
Scar shape	Normal	0	0.0	15	93.8	29	100.0	24.60	<0.001*
	Ballooning	5	100.0	1	6.2	0	0.0		
Scar continuity	Continuous	0	0.0	15	93.8	29	100.0	24.60	<0.001*
	Interrupted	5	100.0	1	6.2	0	0.0		
Scar border	Inside	0	0.0	15	93.8	29	100.0	24.60	<0.001*
	Outside	5	100.0	1	6.2	0	0.0		
Echo structure	homogenous	0	0.0	15	93.8	29	100.0	24.60	<0.001*
	Non-homogenous	5	100.0	1	6.2	0	0.0		
Thickness	<3.5	5	100.0	10	62.5	0	0.0	48.613	<0.001*
	=3.5	0	0.0	4	25.0	0	0.0		
	>3.5	0	0.0	2	12.5	29	100.0		

*significant at p<0.05.

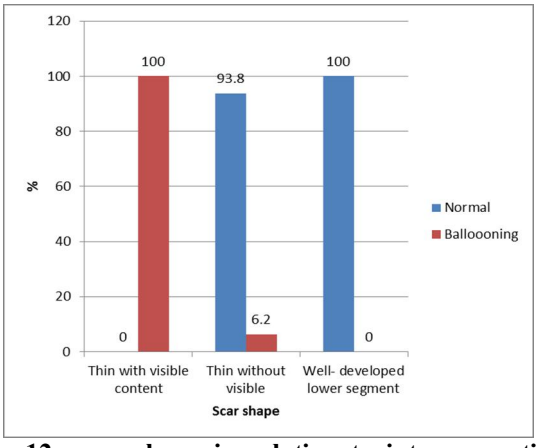

Fig 12: scar shape in relation to intra operative findings.

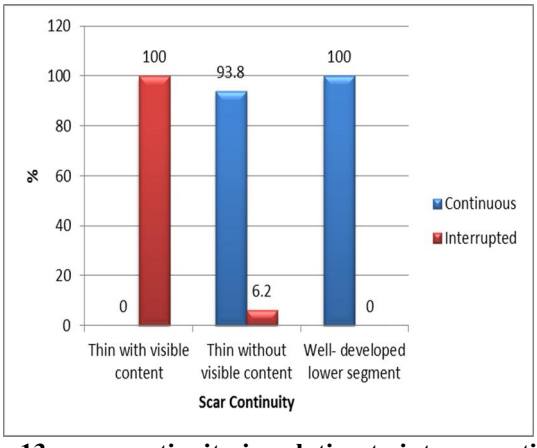

Fig 13: scar continuity in relation to intraoperative findings.

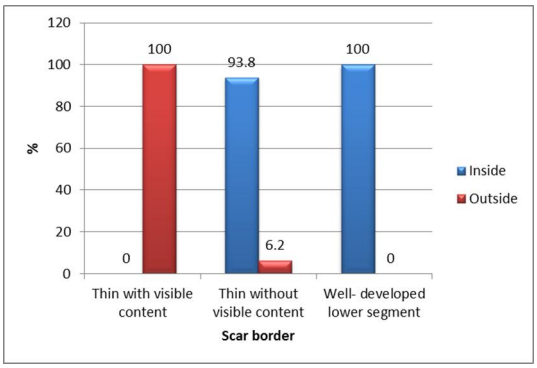

Fig 14: scar border in relation to intraoperative findings.

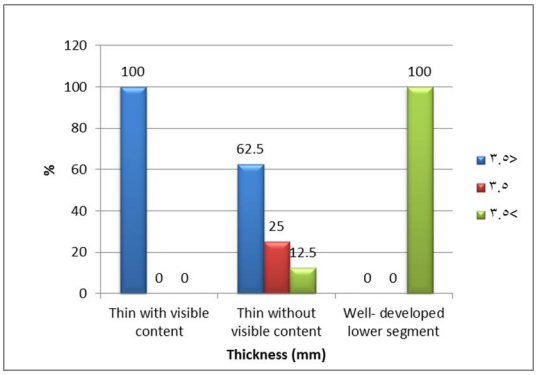

Fig 16: scar thickness in relation to intraoperative findings.

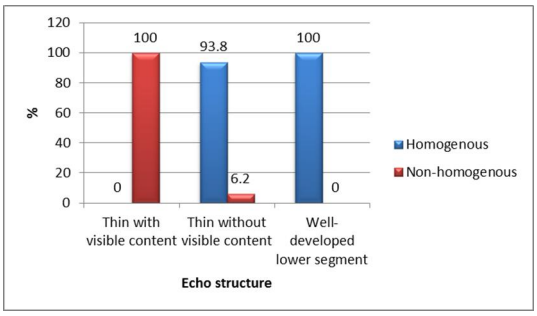

Fig 15: echo structure of lower uterine segment in relation to intra operative findings.

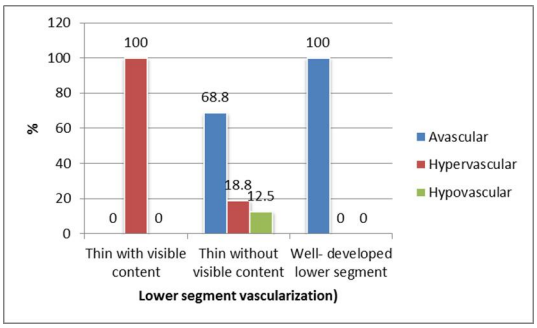

Fig 17: lower segment vascularization in relation to intraoperative findings.

Table 6: Association between Color-Doppler ultrasound findings and intraoperative findings:

Scar integrity (Intraoperative) / Color Doppler		Thin with visible content		Thin without visible content		Well -developed lower segment		Fisher's Exact test	
		N	%	N	%	N	%	X^2	P value
lower segment vascularization	Avascular	0	0.0	11	68.8	29	100.0	27.87	<0.001*
	Hypervascular	5	100.0	3	18.8	0	0.0		
	Hypovascular	0	0.0	2	12.5	0	0.0		

***significa**nt at p<0.05.

Table 7: Comparison between the different intraoperative findings as regards the combined 2D and color Doppler ultrasound score:

		Scar integrity (intraoperative)				Kruskal-Wallis test	
		Thin with visible content	Thin without visible content	Well -developed lower segment	Total	X^2	P value
Total score	Minimum-Maximum	7.0-7.0	6.0-11.0	11.0-11.0	6.0-11.0	30.599	<0.001*
	Median	7.0	11.00	11.00	11.00		
	Mean rank	4.0	21.34	31.50			
Pairwise comparison revealed significant differences between the three subgroups (p<0.05)							

Table 8: The best cut off, sensitivity and specificity for prediction of the scar integrity by thickness detected by 2D ultrasound alone:

	Cut off	Sensitivity	Specificity	Accuracy	AUC	P value
Thickness (mm)	≥ 3.75	100%	90.5%	96%	.916	.001*

AUC: area under the curve

Table 9: The best cut off, sensitivity and specificity for prediction of the scar integrity by combined 2D and color Doppler score:

	Cut off	Sensitivity	Specificity	Accuracy	AUC	P value
Combined 2D and color doppler score	≥ 10.50	100.0	57.1	82.0	.786	.001*

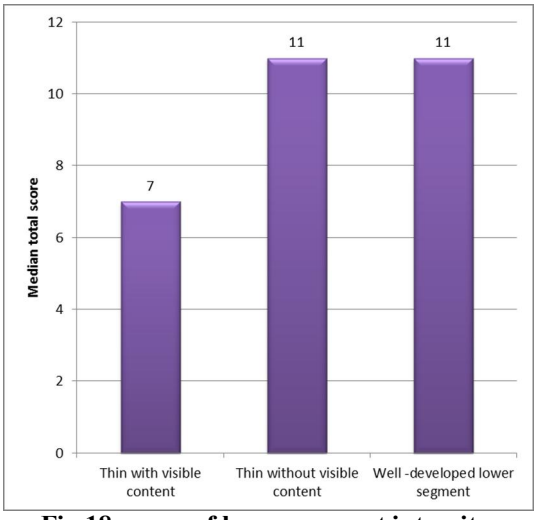

Fig 18: score of lower segment integrity.

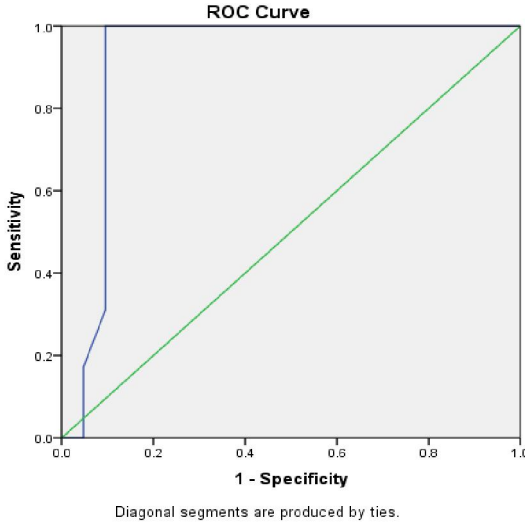

Fig 19.

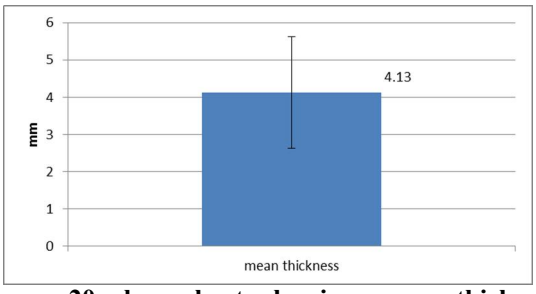

Figure 20: bar chart showing mean thickness (mm). Error bars represent one standard deviation.

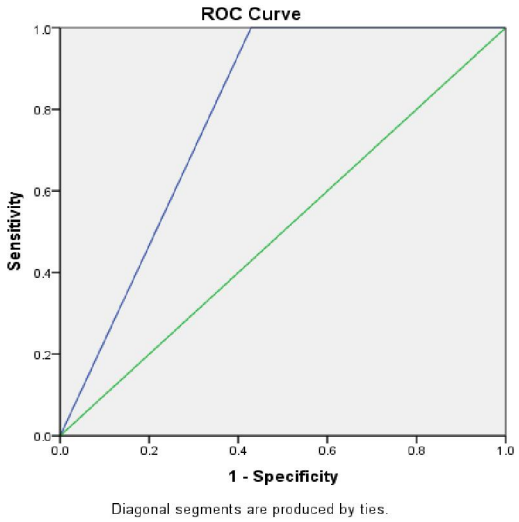

Fig 21. Diagonal segment

4. Discussion

Due to the characteristic of the lower uterine segment as carrying poor vascularization and thin of muscle layer which create as optional site to perform incision, in addition to "locus minoris" which have the capability for confrontation to uterine rupture. Mainly one of the important risks are the gestation and birth following former cesarean section, where the formed scar tissues represent another threatens the region of the lower uterine segment (LUS). In order to diminish the risk of rupture of uterus during pregnancy, it is recommended to perform intensive observation of labor and associated uses outside tocography, offer us more safety and better vision into uterine activity (Ejub Basic et al., 2012[5]).

Asakura et al., 2000[6] found that the incidence of uterine dehiscence of vaginal births after cesarean section (VBAC) was averaged 0.4–4.6 % of cases. Uterine dehiscence of (VBAC), may be asymptomatic and generally not threatened the life and furthermore it may occurs before the time of delivery.

Gestational women with a previous history of cesarean section should be prudently examined to avoid the complete rupture of the uterus which may lead to mortality of the fetus and the dam. The application of ultrasound as imaging tool is a harmless, noninvasive and easy-to-perform scanning modality that can be applied to assess the deviations in thickness of uterine wall in pregnant women who

performed a former cesarean section **Aysin Tanik et al., 1996**[7].

Peter Uharcˇek, et al., 2015[8] said that precise forecast of uterine dehiscence is considered significant and must be assessed tremendously particularly in women a planned cesarean section and at a high risk for uterine rupture. **Martins et al., 2007**[9] found that measurement of LUS muscular thickness by US assessed by transvaginal ultrasound was more consistent than measurement of whole LUS thickness determined by the transabdominal approach. The definite relationship between thin LUS size and rupture of uterus (in women undergoing parturition, with some unwanted uterine ruptures) has been evaluated merely via the transabdominal approach.

In our study we aimed to evaluate Value of Combined 2D and Color Doppler Ultrasound in Determining the Integrity of The Lower Uterine Segment cesarean section scar. We found that for prediction of well- developed lower segment scar through thickness detected by 2D ultrasound examination, ROC curve analysis revealed that a cutoff ≥ 3.75 was significantly highly valid ($p<0.05$, area under the curve =.916) with 100% sensitivity, 90.5% specificity and 96% accuracy.

Peter Uharcˇek, et al., 2015[8] recommended that for carryout spontaneous labor safely after former cesarean section that the thickness of the lower uterine segment must be more than 2.5 mm estimated by transabdominal US and measured within 2 weeks before delivery. Generally, <2.5 mm the thick of lower uterine segment is accompanied with increasing in the incidence of uterine dehiscence.

Similar results were obtained by **Rozenberg et al., 1996**[10], which ultrasonically measured thickness of the uterine scar in gestational women with former caesarean operation in assessing the risk of uterine rupture in the current pregnancy. The authors showed that the "cut-off value" for the size of the scar is 3.5 mm and the evaluation was performed using ultrasound. The sensitivity of the ultrasound was 88% and specificity of 73.2%. Similarly, the positive prognostic significance of ultrasound method was 11.8% and negative 99.3% **Rosenberg et al., 1996**[11]. Also Rosenberg et al. demonstrated that there are a positive relationship between the probability of rupture and the diameter of LUS, where the more risk of rupture directly proportional to the thinning of the lower uterine segment, which is analyzed in the 37th gestational week.

Abdel Baset et al., 2010[12] found that there was a positive association among intraoperative grading of the LUS and its thickness by US. This showed that, the higher the risk of scar dehiscence linked with the decrease in the LUS thickness. The relative risk of dehiscence using TA U/S was 92.9% and it was 7.1% for thicknesses of LUS more than 2.5 mm LUS thickness below or equal to the critical cutoff value ''2.5 mm'' and the identification of defects in the uterine wall differed among various studies according to the technique used for measurement of LUS thickness.

Suzuki et al., 2000[13] examined 39 patients undergoing elective CS; 20 patients of which had a prior CS. In the current study at 36 weeks gestation before labor all patients were subjected for examination by US manually. A preoperative diagnosis of wall dehiscence was performed in some conditions such as the LUS wall thickness was less than 2 mm with/or without the pregnant women felt tenderness and pain in the LUS. Dehiscence was distinct by surgical approach as a sub peritoneal disjointing of the uterine scar in the lower uterine segment. By using the US diagnosis, it was found that the sensitivity was averaged 100%, while the specificity was found to be 83% ($p<0.05$).

In counter with our study **Cheung et al., 2005**[14] reported a cut-off value of 1mm with a sensitivity of 100% and a specificity of 90%. The huge difference in the cut-off value between Cheung and colleagues and the current study is because Cheung and colleagues measured only the myometrial layer thickness, whereas here the full LUS thickness was measured.

In our study we found that patients with thin scar with visible content have taken a statistically lower median score (7.0) compared to those with thin scar without visible content (11.0).

Our results are similar to **Wang, 2009**[15] who found that the thickness of the wall of the LUS from 3.0 to 3.5 mm is accompanied by very low risk of uterine scar partition from former cesarean operation and the vaginal childbirth is permitted in those patients. A high risk of uterine scar dehiscence was recorded in women having the LUS thickness is lower than 2.0 mm.

In our study we found that the association between color Doppler examination and the intraoperative findings show that hypervascular and hypovascular scars were statically related to the presence of thin scar with or without visible content during intraoperative settings ($p<0.05$).

Ejub Basic et al., 2012[5] found that the homogeneity of the scar is attributed to the quality of the scar. Qualitatively richer the value of perfusion just about scar in evaluating the assessment of the scar (detected on color Doppler).

Tanik et al., 1996[7] found that, in spite of the before mentioned, confirming the value of sonography in determination of scar thickness, there remain some difficulties in applying this technique. by using the transabdominals onography, the scar cannot always be demonstrated until uterine rupture occur.

Asakura et al., 2000[6] found that, when a cut-off value is applied to patient, it is to be noted that inter-observer error exist. The variation may be large especially in measurement of a thin LUS. Also they conducted a study in which the thickness of the muscular layer of the lower uterine segment was measured in women with former uterine scars and its association with uterine dehiscence/rupture was studied. They concluded that an assessments of the LUS is valuable in forecasting the lack of dehiscence between gravidas with previous cesarean operation. If the thickness of the LUS is greater than 1.6 mm, the opportunity is very small of dehiscence during the following trials of delivery.

In our study we found that the association between color Doppler examination and the intraoperative findings revealed that hypervascular and hypovascular scars were statically related to the presence of thin scar with or without visible content during intraoperative settings.

In agree with our study **Ejub Basic et al., 2012**[5] found that multidimensional Color Doppler is the "gold standard" in estimating the quality of the scar tissue post a former cesarean operation and capability for natural parturition and The homogeneity of the scar is an feature that contributes to the scar quality.

Conclusion

Combined 2D and color Doppler US are better in predicting the integrity of the lower uterine segment with previous cesarean section scar.

Recommendations

Our study recommends the use of combined 2D and color doppler ultrasound in determining the integrity of the lower uterine segment cesarean section scar, also further studies with larger number of patients are needed.

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