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Diagnostic Accuracy of Transabdominal Ultrasonography in Evaluation of Uterine Scar in Previous Caesarean Section

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Abstract: ***Caesarean section (CS) is one of the most frequent abdominal surgical operations carried out in recent time. The World Health Organization suggests a medically adequate Caesarean delivery rate of 10%-15% to assure optimal prognosis for both mother and children.[10]The present study aims at the evaluation of post-caesarean uterine scar using transabdominal sonography in assessment of post-caesarean uterine scar and tried to the grades of uterine scar and probability of scar ruptures.***

Keywords: Caesarean, ultrasound, lower uterine segment

1. Introduction

Caesarean section (CS) is one of the most frequent abdominal surgical operations carried out in recent time. The World Health Organization suggests a medically adequate Caesarean delivery rate of 10%-15% to assure optimal prognosis for both mother and children.[10] However Caesarean Section rate varies from about 20% to 50%, depending on the country and clinical environment. This variation is attributable to a combination of factors, including the medical training, patient choice and the risk of litigation. The increasing CS rate and its associated complications has stimulated an interest in the behaviour of CS scars and their associated potential morbidity.[1]

A worldwide increase in the rate of deliveries conducted by lower segment caesarean section (LSCS) has been documented over the last two decades with resultant increase in the proportion of women with previous caesarean births requiring obstetric care during repeat pregnancies. The challenge faced by an obstetrician is to decide between a repeat caesarean versus vaginal birth after caesarean (VBAC), as later leads to increased chance of uterine scar dehiscence/rupture during labor, and consequent high maternal and neonatal mortality and morbidity. Despite a high success rate of VBAC (50-85%) obstetrician remain apprehensive for scar rupture, hence patient mostly end having repeat caesarean deliveries .[2]

Uterine scar dehiscence may present as an acute event in the antenatal or intrapartum period, leading to significant fetal and maternal morbidity. The frequency of uterine rupture is estimated at 0.2–3.8% and that of uterine dehiscence is between 0.6 and 3.8%. Uterine rupture is a rare complication, but has the potential of causing severe fetal morbidity, including asphyxia, neurological sequelae and even death. Uterine rupture can also be responsible for maternal complications, such as genitourinary tract damage, hemorrhage, shock and hysterectomy. Therefore, it is important to improve the evaluation of the risk of uterine rupture before attempting vaginal delivery after a previous Caesarean section. [3]

Ultrasound has been used to evaluate CS scars in late pregnancy. Routine surveillance of Caesarean section scars by ultrasonography during pregnancy has been proposed in an attempt to identify 'silent' or asymptomatic scar dehiscence. Several studies have been carried out to assess scar integrity during pregnancy, but the sonographic detection of uterine scars is easiest in the non-pregnant state. Scar integrity has also been assessed by saline contrast sonohysterography, in order to delineate scar deficiency more accurately. However this method is associated with risks like severe pelvic pain, vaginal symptom, hypotension, nausea vomiting etc and therefore is limited in its practical application.[3]

The method currently used to predict CS scar rupture is ultrasonographic measurement of the thickness of the uterine segment in gestational week 36-38 as pioneered by Rozenberg[5] et al. The recent meta-analysis by KoK at al. supports the use of LUS thickness for predicting uterine rupture.[4]

Several studies using various methods have been conducted to evaluate the correlation of LUS measurement with the risk of uterine rupture or dehiscence, with relative success. In some studies, the sonographers measured the entire LUS by transabdominal ultrasound, while in others, only the middle muscle layer was assessed as a result heterogeneity is seen in scar thickness measured.

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The present study aims at the evaluation of post-caesarean uterine scar using transabdominal sonography in assessment of post-caesarean uterine scar and tried to the grades of uterine scar and probability of scar ruptures.

Aims and Objectives

To assess diagnostic accuracy of Trans-abdominal Ultrasonography in evaluation of uterine scar

2. Materials and Methods

This study was aimed to assess diagnostic accuracy of sonography in assessment of post-caesarean uterine scar and correlation with operative finding and was carried out on patients being referred to Department of Radiodiagnosis from Obstetrics and Gynaecology department of Indira Gandhi Medical College and hospital, Shimla. Patient of gestational age 36-39weeks with history of previous caesarean section were included.

The research procedure was in accordance with the approved ethical standards of Indira Gandhi Medical College and Hospital, Shimla, Ethics Committee.

Study design: Prospective observational comparative study

Study duration: 15 July 2019 to 15 July 2020

No of cases: 30

Inclusion Criteria:

- Age 20 to 35 years
- Gestational age 36-39 weeks
- Having atleast one previous caesarean section
- All Booked and un-booked antenatal patient

Exclusion criteria:

- Patient with multiple pregnancies
- Polyhydramnios
- Oligohydramnios
- Low lying placenta
- Patients with history of uterine surgery other than caesarean section

Protocol for ultrasonography

All sonographic examinations were done after 36 weeks to assess the lower uterine segment (LUS), on GE healthcare US Logiq (P6) using a 3.5-MHz multi frequency convex transabdominal transducer.

Transabdominal ultrasonography was done with the patient having a moderately full urinary bladder in the supine position.

LUS was scanned in sagittal section under magnification to localize the thinnest zone. Measurement was taken with the '+' shape cursors at urinary bladder wall myometrium interface and myometrium/chorioamniotic membrane amniotic fluid interface. (Figure 1)

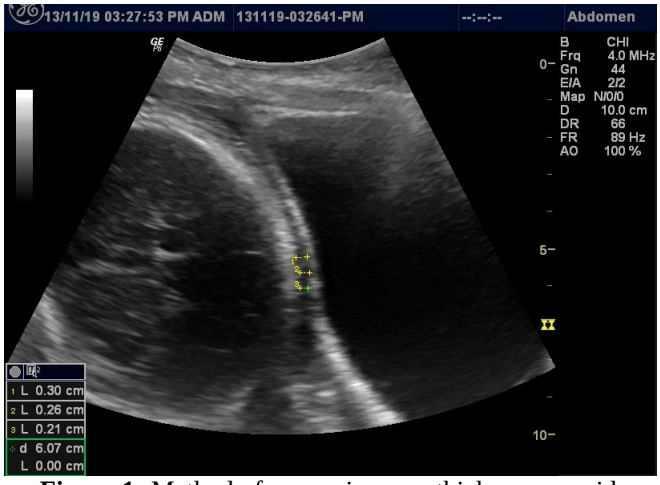

Figure 1: Method of measuring scar thickness on mid Sagittal USG image

Protocol for surgical scar grading

The LUS was assessed and graded according to the system developed by Qureshi et al.[8] during surgery:
Grade I: Well-developed LUS.
Grade II: Thin LUS, content not visible.
Grade III: Translucent LUS, content visible.
Grade IV: Well-circumscribed defect either dehiscence or rupture.
Grades IV and III will be considered abnormal LUS intraoperatively, and grades I and II will be considered normal.

Based on the surgical grading of the scar, patients in the study group were divided into four groups:

1) Group I-Patients with Surgical Grade I scars
2) Group II- Patients with Surgical Grade II scars
3) Group III-Patients with Surgical Grade III scars
4) Group IV-Patients with Surgical Grade IV scars

Statistical Analysis

Data was entered into MS excel spread sheet, cleaned and transferred to EPIINFO Version 7.2 software. The values of continuous variables were presented as Mean + SD. Pearson correlation test and chi-square test was used for data analysis. A P value < 0.05 was considered significant. Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) was calculated.

3. Observations and Results

A prospective study was conducted in department of Radio-diagnosis Indira Gandhi Medical College and hospital, Shimla (H.P) from July 2019 to July 2020. Twenty five pregnant women with previous history of atleast one lower segment caesarean section were included in the study. The study results are as follows.

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1) Age distribution of the patients:

Age of the patients ranged from 20 years to 35 years. Mean age was 27 years. Minimum age was 22 years and maximum age was 35 years. Most of the patients (48%) were between 20 to 25 years.

Table 1: Showing Age distribution of the patients

Age Group (years)	No of patients	Percentage (%)
20-25	12	48%
25-30	10	40%
30-35	3	12%

2) Number of Previous LSCS

Table 2: Patients with number of previous LSCS

No of previous LSCS	No of patients	Percentage (%)
1	17	68%
2	6	24%
3	2	8%

In our study 17 patient (68%) had single time previous LSCS, 6 patient (24%) had two time previous LSCS and only 2 patient (8%) had three time previous LSCS.

3) Patients were divided into four groups based upon the surgical grading of scar and are labelled as group I, group II, group III and group IV:

Table 3: Number of patients in different groups

Surgical Group	No of patients	Percentage (%)
I	6	24%
II	9	36%
III	10	40%
IV	0	0%

In our study 10 patient (40%) were in surgical group III scar, 9 patient (36%) had surgical group II scar and 6 patient (24%) had surgical group I scar. No patient in surgical group IV scar.

4) Mean LSCS scar thickness as measured on ultrasonography and surgery were calculated in each group. These mean values of LSCS scar thickness were compared with different groups.

Group I

Table 4: Showing thickness of LSCS scar on ultrasound in surgical Group I patients

Patient no	Group I Scar thickness (mm)	
	Intra-operative	Ultrasound
Patient 1	3.2	3.4
Patient 5	4.2	3.9
Patient 6	4.0	3.2
Patient 10	3.4	3.3
Patient 20	3.4	3.2
Patient 22	3.9	2.5
Mean	**3.78**	**3.13**
SD	**0.33**	**0.49**

Table 5: Comparison of Mean Scar thickness (mm) between Intra-operative and Ultrasound in Grade I group.

Technique	Mean	SD	Mean difference	t value	P value
Intra-operative	3.78	0.33	0.65	2.993	0.030 S
Ultrasound	3.13	0.49			

Statistical Analysis: Paired t test.
S: indicates significant at 5% level of significance
NS: Not significant
In Group I women Mean scar thickness was 3.13± 0.49 mm on USG.

On comparing the mean Scar thickness (mm) in group I, the difference was significant for ultrasound versus intraoperative measurements ($p < 0.030$).

Group II:

Table 6: Showing Thickness of LSCS scar on ultrasound in surgical Group II patients

Patient no	Grade II Scar thickness (mm)	
	Intra-operative	Ultrasound
Patient 2	3.1	3.2
Patient 7	2.8	3.0
Patient 12	2.8	2.5
Patient 16	2.6	3.0
Patient 17	3.0	3.2
Patient 21	3.0	3.4
Patient 23	3.0	2.3
Patient 24	3.8	2.7
Patient 25	3.2	3.4
Mean	**2.97**	**3.04**
SD	**0.20**	**0.40**

Table 7: Comparison of Mean Scar thickness (mm) between Intra-operative and Ultrasound in Group II patients

Technique	Mean	SD	Mean difference	t value	P value
Intra-operative	2.97	0.20	-0.07	0.655	0.531 NS
Ultrasound	3.04	0.40			

Statistical Analysis: Paired t test.
S: indicates significant at 5% level of significance
In Group II women Mean scar thickness was 3.04± 0.40 mm on USG.

On comparing the mean Scar thickness (mm) in group II, the difference was insignificant for comparison ultrasound versus intraoperative ($p< 0.531$).

Group III:

Table 8: Showing thickness of LSCS scar on ultrasound in surgical Group III patients

Patient no	Grade III Scar thickness (mm)	
	Intra-operative	Ultrasound
Patient 3	2.2	2.6
Patient 4	2.3	2.7
Patient 8	1.5	2.1
Patient 9	2.2	2.7
Patient 11	2.4	2.2
Patient 13	1.8	2.0
Patient 14	1.6	1.7
Patient 15	2.2	2.4
Patient 18	2.1	2.3
Patient 19	2.5	3.7
Mean	**2.08**	**2.44**
SD	**0.34**	**0.55**

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Table 9: Comparison of Mean Scar thickness (mm) between Intra-operative and Ultrasound in Group III patients

Technique	Mean	SD	Mean difference	t value	P value
Intra-operative	2.08	0.34	-0.36	3.062	0.014 S
Ultrasound	2.44	0.55			

Statistical Analysis: Paired t test.
S: indicates significant at 5% level of significance
NS: Not significant

In Group III women Mean scar thickness was 2.44± 0.55 mm on USG.
On comparing the mean Scar thickness (mm) in group III, the difference was significant for ultrasound versus intraoperative ($p < 0.014$).

Group IV: There were no patients in Group IV

Table 10: Comparison of Mean Scar thickness of different groups in Ultrasound

Ultrasound	Mean	SD	Mean difference	t value	P value
Group I	3.13	0.49	0.09	0.385	0.070 NS
Group II	3.04	0.40			
Group I	3.13	0.49	0.69	2.545	0.023 S
Group III	2.44	0.55			
Group II	3.04	0.40	0.60	2.724	0.014 S
Group III	2.44	0.55			

Statistical Analysis: Unpaired t test.
S: indicates significant at 5% level of significance
NS: Not significant

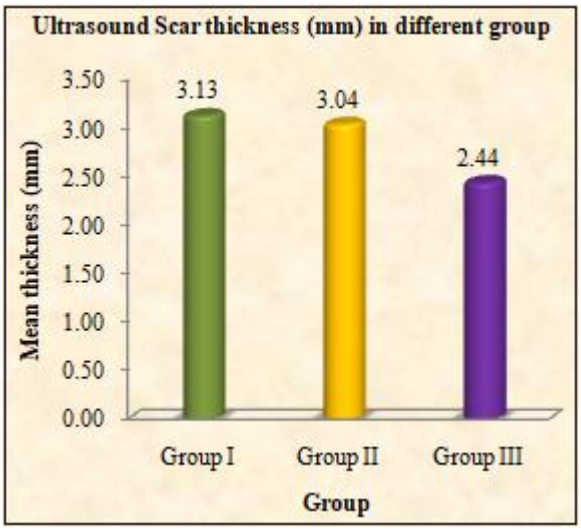

Figure 2: Showing ultrasound mean scar thickness of group I, group II and group III

On comparing the mean Scar thickness for different groups in ultrasound, differences was significant for Group I-III ($p<0.023$) and Group II-III ($p< 0.014$) and insignificant for Group I-II ($p<0.070$).

Table 11: Comparison of Mean Scar thickness (mm) between normal (Group I + II) and Abnormal (Group III)

Variables	Group	Mean	Std. Deviation	Mean difference	t value	P value
Intra-operative	Group I + II	3.29	0.48	1.21	6.901	0.000 S
	Group III	2.08	0.34			
Ultrasound	Group I + II	3.08	0.42	0.64	3.294	0.003 S
	Group III	2.44	0.55			

Statistical Analysis: Unpaired t test.
S: indicates significant at 5% level of significance
NS: Not significant

5) Appearance of LSCS scar on ultrasound:

Table 12: Distribution of Ultrasound appearance of scar

Ultrasound appearance of scar	N	%
Smooth	15	60.0
Irregular	10	40.0
Total	25	100.0

In our study 15 patients had smooth appearance of scar on ultrasound and 10 patients had irregular appearance of scar on ultrasound.

Table 15: ROC curve analysis

ROC curve analysis	Intra-operative		Ultrasound	
Associated criterion	≤2.5	95% C.I	≤2.7	95% C.I
Sensitivity	100.00	69.2 - 100.0	90.00	55.5 - 99.7
Specificity	100.00	78.2 - 100.0	73.33	44.9 - 92.2
+PV	100.00	--	69.20	48.7 - 84.2
-PV	100.00	--	91.70	62.6 - 98.6
P value	<0.0001 S		0.0008 S	

Statistical Analysis: ROC curve (AUC) analysis.

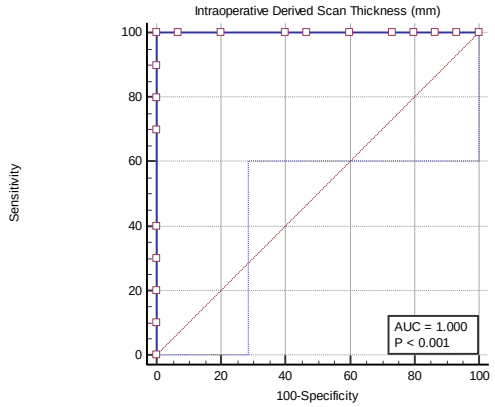

Figure 3(a)

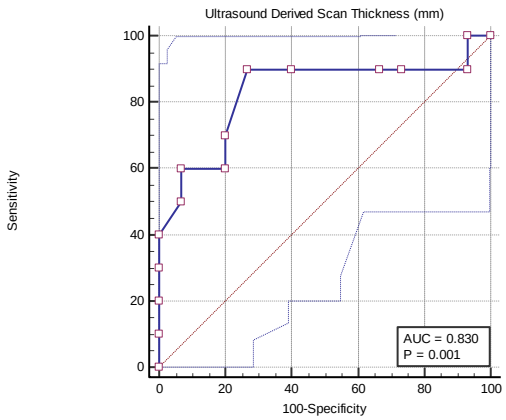

Figure 3 (b)

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Figure 3(a-b) showing AUC of intraoperative derived scar thickness(a) and AUC of USG derived scar thickness(b).

The ROC analysis assigned a cut-off value of 2.5 mm for intra-operative, 2.7 mm for ultrasound for the differentiation of a normal scar from an abnormal one. These thresholds carried a sensitivity of 100% (intraoperative) versus 90% (ultrasound), specificity of 100% (intraoperative) versus 73% (ultrasound), PPV of 100 % (intraoperative) versus 70% (ultrasound), and NPV of 100% (intraoperative) versus 90% (ultrasound). Accordingly, USG had a high AUC (intraoperative= 1.000 versus USG = 0.830) with the ultrasound scoring better for evaluation of uterine scar. Accordingly, the diagnostic accuracy of USG for differentiating a normal from an abnormal uterine scar was 90%.

Case No. 1

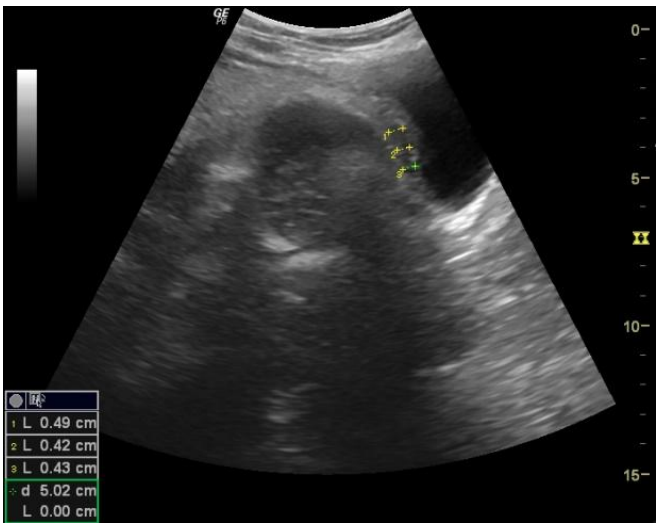

Figure 4: USG Sagittal image of a 35 years old G3P2+0 pregnant women having previous two times LSCS showing surgical Group I scar

Case No. 2

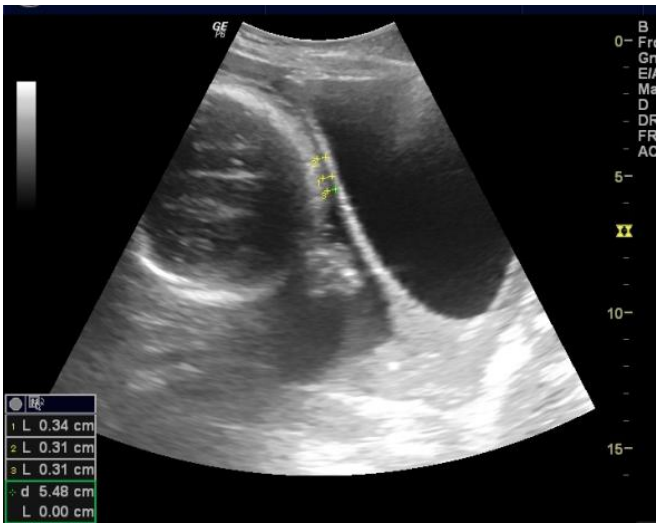

Figure 5: USG Sagittal images of a 28 years old G3P2+0 pregnant women with previous two times LSCS showing thin surgical Group II scar.

Case No. 3

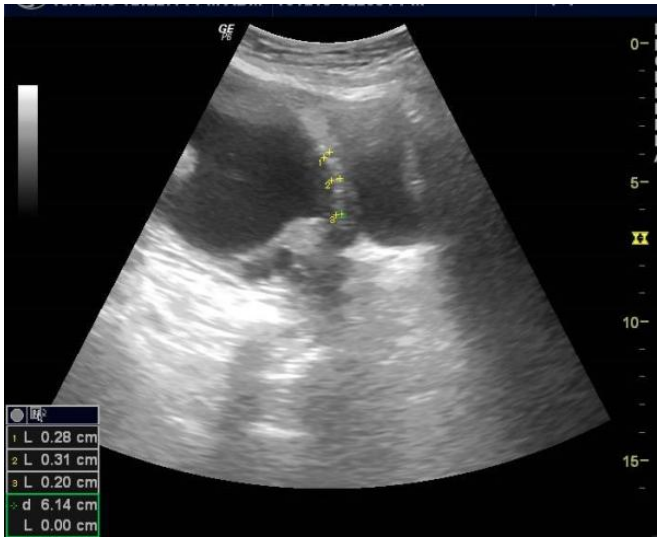

Figure 6: USG Sagittal imageof a 23 years old G3P2+0 pregnant women with previous two times LSCS showing thin surgical Group III scar.

4. Discussion

The present study was undertaken to assess diagnostic accuracy of Trans-abdominal ultrasonography in evaluation of LSCS scar in pregnant women while taking surgical measurement as gold standard. The study was performed in 25 pregnant women with history of at least 1 prior LSCS. Age of the patients was ranged from 22-35 years. Mean age was 27 years. Minimum age was 22 years and maximum age was 35 years. Most of the patients (48%) were between 20 to 25 years. All ultrasound measurements were done between 36-39 weeks of gestation. Seventeen women in the study had single time previous LSCS, 6 had two time previous LSCS and only 2 women had history of three time previous LSCS. Eighty percent women (n=20) had >2 years of interval between the consecutive caesarean sections and most of them had elective caesarean section, 20% (n=5) women had <2 years interval between consecutive caesarean sections and had undergone emergency caesarean section. Our study suggested that the incidence of abnormal scar (Group III) increased in proportion to increase in the number of prior LSCS. The incidence of abnormal scar (Group III) also increased with decrease in the interval between consecutive pregnancies. Highest incidence of abnormal scar was seen among patients with <2 years of interval between consecutive pregnancies.

Based upon the surgical scar thickness, women in our study were categorized into four groups- Group I: women with grade I scar thickness, Group II: women with grade II scar thickness, Group III: women with grade III scar thickness and Group IV: women with grade IV scar thickness. In our study, 6 women belonged to group I, 9 women to group II and 10 women belonged to group III. Group IV scar thickness was not seen in any women of our study group.

We again categorised women of different scar thickness groups (i.e Group I, Group II, Groups III and Group IV) into normal scar group (Group I & Group II) and abnormal scar group (Group III and Group IV). The results of our study suggests that ultrasound ($p<0.003$) can accurately categorise LSCS scar into normal (Group 1 & Group 2) and abnormal

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scar (Group 3 & Group 4). These results are comparable with results of study done by Satpathy et al.[9] on 30 pregnant women. In their study, the USG-derived mean scar thickness with normal scar (3.80 mm ± 0.75 mm for USG) had a statistically significant difference (p< 0.05) from that of an abnormal scar (2.22 mm ± 0.74 mm for USG).

The mean scar thickness of Group I was 3.13±0.49mm on USG, Group II was 3.04±0.40mm on USG and of Group III was 2.44±0.55mm on USG and were comparable with study done by Satpathy et al.[9] in 30 pregnant women with previous LSCS. In their study the mean scar thickness for grade I was 3.99 mm on USG, for Grade II was 3.49 mm on USG and for grade III was 2.22 mm on USG.

In Group II, the mean scar thickness difference was insignificant for ultrasound versus intraoperative (p< 0.531), which suggests that scar thickness on USG comparable with scar thickness measured intra-operatively.

In group III, the mean scar thickness difference was significant for ultrasound versus intraoperative (p< 0.014), which suggests that scar thickness measured on USG were not in concordance with the scar thickness measured intra-operatively.

Ultrasound in our study accurately differentiated Group I scar from group III scar (p< 0.023) and Group II scar from group III scar (p<0.014) while ultrasound could not accurately differentiate the Group I scar from Group II scar (p<0.070).

The results of our study assigned a cut of value of 2.7 mm on ultrasound to differentiate normal scar (Group I & Group II) from abnormal scar (Group III). These threshold carried sensitivity, specificity, PPV & NPV of 90%, 73%, 70% & 90% for USG. The diagnostic accuracy of ultrasound was 90%. These results are comparable with study done by Satpathy et al[9]**.**who compared the diagnostic accuracy of USG in 30 pregnant women with previous LSCS for the measurement of lower segment caesarean scar during trial of labor after caesarean (TOLAC) and assigned a cut-off value of scar thickness 3.5 mm on USG for the differentiation of a normal scar from an abnormal one. The threshold carried sensitivity, specificity, PPV & NPV of 100%, 85%, 94.2% (USG). Diagnostic accuracy of USG was 96.7%.

On ultrasonography, LSCS scar was hypoechoic in appearance in all women. In 15 patients, LSCS scar was smooth appearance & in remaining 10 patients scar was irregular appearance. Among patients with irregular scar, 5 patients had abnormal scar (grade III) on intraoperative evaluation, while among patients with smooth appearance of scar 11 had normal scar (group I and grade II) on intraoperative evaluation. Kushtagiet al.[7] conducted a study on 106 pregnant women & among them 2 women had irregular appearance of LSCS scar on ultrasound and 1 women showed scar dehiscence on intraoperative evaluation and the other one showed thinned out scar on intraoperative evaluation. Thus it is suggested that the appearance of the scar should also be noted in addition to scar thickness measurements, as irregular scar on USG can be a suspicious abnormal scar. In the study done by Qureshi et al.[8] on 48 pregnant women they described symmetrical and asymmetrical appearance of LSCS scar on ultrasound. The symmetrical or asymmetrical appearance of scar was categorised into normal LSCS scar if scar thickness was > 2mm and abnormal scar if scar thickness was <2 mm. However, they did not mention the significance of the symmetrical or asymmetrical appearance of scar in their study.

Almost in all previously done studies ultrasound was considered gold standard for evaluation of scar in women with previous LSCS. Our study similar to previous studies suggested that ultrasound is goodin evaluation of scar.

The ultrasound results in our study were in concordance with prospective study done by S. Malik et al[6] who had evaluated the lower uterine segment thickness of 71 pregnant women with previous LSCS and assigned cut off value of 2.5 mm for safe lower segment thickness with sensitivity, specificity, PPV & NPV of 90.9%, 84%, 71.4% & 95.5% respectively.

Finally it can be concluded that our study was not much different from the studies done previously. Our study again showed that ultrasound should be the first choice for evaluation of uterine scar.

5. Study Limitations

Our study had its limitations. It was small sample study conducted on 25 patients. However I will recommend toconduct the similar study with more number of patients to evaluate the further role of USG.

6. Conclusion

The present study concluded that ultrasound can accurately diagnose normal from abnormal scar. The cut off value of normal scar from abnormal scar is 2.7 mm on ultrasound. The diagnostic accuracy of USG is good with higher sensitivity, PPV and NPV. Thus ultrasound can be used as first imaging modality to evaluate LSCS, because of their higher accuracy, easy availability and cost effectiveness.

A major limitation of the study is small sample size and a similar study with more number of patients to evaluate the further role of USG is recommended.

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