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Diagnostic accuracy of uterine artery doppler velocimetry in patients with placenta previa

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Abstract---Background; The placenta previa (PP) is an obstetric problem in which the placental tissue is improperly located inside the lower uterine segment. Aim and objectives: was to see how effective uterine artery Doppler velocimetry was in detecting unusually morbidly adhering placentas in patients who had had one or more prior caesarean sections with placenta previa. Subjects and methods; Cross-sectional research of 100 patients was undertaken in the Department of Gynecology and Obstetrics, El- Sayed Galal Hospital, AL- Azhar University. Result; Our results showed highly statistically significant correlation between the presence of abnormal lacunae and histopathological confirmation (P-value > 0.001). In addition, the overall Sensitivity, specificity, PPV, NPV and accuracy were 90%, 100%, 100%, 64.2%, 91.6%. This criterion showed very high sensitivity and specificity with very high positive predictive value and accuracy to become the most important criteria, Conclusion; As a result of this, we conclude that the accuracy of abnormal placental lacunae, loss of the retro-placental clear zone, myometrial thinning, and utero-vesical hypervascularity are the most critical ultrasound criteria for diagnosing placenta accreta in patients who had a previous CS with a placenta previa overlying the previous uterine scar.

Keywords---Diagnostic accuracy, Uterine Artery Doppler, Velocimetry, Placenta Previa, lower uterine segment.

Introduction

The challenging problem of abnormal placentation has become increasingly clinically significant in obstetric practice due to the dramatic rise in cesarean deliveries over the past four decades (Fathy et al., 2018).

Placenta previa (PP) is a potentially serious obstetric complication where the placental tissue abnormally lies within the lower uterine segment (Sanad et al., 2018).

The precise pathophysiology of this serious condition is not exactly known. However uterine scarring is a potential risk factor. Other risk factors for placenta previa include advanced maternal age, high parity, history of placenta previa and congenital uterine malformations (Arlier et al., 2017).

The estimated prevalence of placenta previa is 5.2 per 1000 pregnancies or about 0.5% of all pregnancies. However, there is evidence of regional variation (Cresswell et al., 2013; Sanad et al., 2018). This prevalence has been increasing in the past decade mainly due to an elevated cesarean section rate (Sekiguchi et al., 2015). According to International Federation of Gynecology and Obstetrics (FIGO) 2018 consensus the term "Placental Accreta spectrum (PAS)" refer to all three condition (accrete, increta, percreta). Morbidly adherent placenta is important etiology maternal morbidity and mortality. Placental accrete Spectrum (PAS) are commonly together with placenta previa is due to uterine damage (due to previous surgery, cesarean deliveries, curettage, myomectomy) poor handling allow the placenta to grow with absent Nitabuch Layer in myomectomy (Asghar and Naz, 2020).

A large number of sonographic findings have been associated with placenta accreta. The presence of a placenta previa in most cases leads to the adhesion of the lower uterus in the previous cesarean surgery. These findings include loss of clear zone, myometrial thinning, focal exophytic mass, bladder wall interruption, lacunar flow, diffuse lacunar flow, focal lacunar flow, subplacental vascularity, and uterovesical hypervascularity (Kamankesh et al., 2020).

Adding color Doppler ultrasonography for diagnosing the invasion to the myometrium has a high predictive power. When the distance between the uterine serosal bladder interface and retroplacental arteries is less than 1mm and large retroplacental lacunae can be seen, these indicate a myometrial invasion (Amirabi et al., 2018)

Method

Patients and Methods

Cross-sectional research of 100 patients was undertaken in the Department of Gynecology and Obstetrics, El- Sayed Galal Hospital, AL- Azhar University. **Sample size justification:** The EPI info 2000 statistical program was used to compute sample sizes. The original trial's sample size was computed using Amirabi et al., 8 with an incidence of roughly (22.1%), a power of 0.80, a type I

error of 5%, a 90.6 percent sensitivity ratio, a 5% error level, and an accuracy of 4%, and a sample size of was considered. The sample size was estimated based on these parameters, and 96 instances were found to be sufficient. To account for drop-outs and incomplete cases, the sample size will be increased to 100 cases in order to ensure that this number is reached in the analysis.

Inclusion Criteria for study group: Patients aged 20-40 years (childbearing age), pregnant women over 28 weeks gestation who are identified with placenta previa by 2D ultrasound (the US diagnosis of placenta previa will be considered when the placental mass reaches the interior cervical os, singleton pregnancy) will be examined. Patients who have had at least one cesarean section

Exclusion Criteria for groups: Patients with bleeding disorders or on anticoagulant therapy, systemic chronic diseases as chronic liver diseases, chronic kidney disease, hypertensive patients, diabetes, complicated pregnancies like hypertension, diabetes mellitus, cardiac disease, poly hydramnios and multifetal pregnancy and primigravida

The eligible subjects included in this study will be subjected to the following:

1) Informed consent: was obtained from all participants before they were enrolled in the research, and after they were told what the study's goal was.

2) Complete history taking: Personal history, menstrual history, history of lmp, obstetrics history, past history of medication and surgeries and any complain as ante-partum hemorrhage

3) Examination: General examination: Signs of life (Blood pressure, Temperature, Heart rate, Respiratory rate)

4) Abdominal and local clinical examination: Abdominal inspection, abdominal palpation: Light palpation of the abdomen and deep palpation of the abdomen, abdominal percussion, abdominal auscultation and bimanual examination: The bimanual evaluation is used to identify the uterus' size and type, as well as the occurrence or lack of adnexal masses.

5) Ultrasonographic (US) Evaluation: For determining fetal number, fetal biometry, AFI, fetal viability, and placental size and position in detail, as well as any signs indicating an improperly attached placenta.

6) Doppler US diagnosis Doppler measurements: It was performed on the left and right uterine arteries, and the mean PI and resistive index (RI) was defined as the average of the two vessels.

7) Decision making for the planned date of termination

8) In cases with placenta previa and no signs of PAS disorders, pregnancy termination will be scheduled at >37 weeks. Moreover, patients will be categorized into groups with and without PAS disorders post-surgery. All cases will be delivered by caesarean sections: (Either elective at term or emergency in case of attack of antepartum hemorrhage).

Perioperative preparations: Complete blood picture (CBC): Preoperative preparation of cross matched at least 4 units of packed RBCs. Counseling the patient and her family for the possibility of incidence of C.S hysterectomy, together with taking written high risk consent and consent for hysterectomy. Later on, the diagnosis will be performed based on clinical operative findings and histopathological evidence provided by the surgical team or in hysterectomy cases, respectively

Ethical Consideration: The Al-Azhar University Institutional Review Board has to approve the study procedure. Each individual who took part in the research gave verbal informed permission. At all stages of the research, confidentiality and personal privacy were protected.

Data management and Statistical Analysis: Microsoft Excel software was used to code, input, and analyze data obtained during the history, basic clinical examination, laboratory tests, and outcome measures. The information was then entered into the Statistical Package for the Social Sciences (SPSS) (SPSS version 20.0) For analysis, use the SPSS program.

Results

This study was a prospective study at Gyn/Obs. Hospital – Beni-Suef general hospital during time interval from November 2018 to May 2019, the included 100 pregnant women who presented to our out-patient clinic or casualty department with diagnosis of placenta previa, all selected patients met the inclusion criteria and further subdivided into two groups

Out of 100 patients **US** suggested that 72 patients were placenta accreta and 28 were placenta non accreta. However, **intra-operative assessment** suggested that 56 patients were placenta accreta and 44 were placenta non accreta. Moreover, **histopathological assessment** showed that 51 patients (out of 60 specimens) had placenta accreta and 9 were not placenta accreta. Table (1)

Table (1)

Number of placenta accreta and placenta non accreta cases with Ultra-Sound evaluation, intra- operative assessment or Histopathological pattern

		Count	%
Ultrasound evaluation	Accrete	72	72.0%
	Non accrete	28	28.0%
Intra-operative assessment	Accrete	56	56.0%
	Non accrete	44	44.0%
Histopathological Pattern	Accrete	51	85.0%
	Non accrete	9	15.0%

The average age of the patients participating in the trial was 31.14 years, and the average gestational age was 36 weeks. The average number of CS is 2.59.

Table (2)

Table (2)

Mean age, gestational age, parity, number of CS and surgical evacuation among the patients included in the research

	Mean	SD	Median	Minimum	Maximum
Age	31.14	5.01	32.00	20.00	40.00
GA	36.11	2.06	36.00	28.00	39.00
Parity	2.98	1.19	3.00	1.00	6.00
NO. of CS	2.59	1.09	2.00	1.00	5.00
NO. of SE	.21	.57	.00	.00	3.00

There was no statistical significance regarding social status of patients enrolled in the study. History of post partum complications were observed and showed no statistical value. Table (3)

Table (3)

Comparing instances of placenta accreta group and placenta non accreta group regarding social status and history of post-delivery complications

		Accreta(n=51)		Non accreta(n=49)		P value
		Count	%	Count	%	
Social status	HIGH	6	11.8%	6	12.2%	0.666
	mid	24	47.1%	27	55.1%	
	low	21	41.2%	16	32.7%	
H/O of post delivery complications	wound infection	1	2.0%	1	2.0%	0.493
	puerperal sepsis	1	2.0%	0	.0%	
	Pp hemorrhage	2	3.9%	0	.0%	
	ICU admission	1	2.0%	0	.0%	
	Blood transfusion	0	.0%	2	4.1%	
	bladder injury	0	.0%	1	2.0%	
	No	46	90.2%	45	91.8%	

Our results showed highly statistically significant correlation between loss of clear zone and histopathological confirmation (**P-value 0.001**). In addition, the overall Sensitivity, specificity, PPV, NPV and accuracy were 82.3%, 77.7%, 95.5%, 43.7%, 81.6%. This criterion showed high sensitivity with very high positive predictive value. Table (4)

Table (4)

Significance of Loss of clear zone by ultrasound and histopathological Pattern

		Histopathological Pattern				P value
		Accreta (n=51)		Non accrete (n=9)		
		Count	%	Count	%	
loss of clear zone	Yes	42	82.4%	2	22.2%	0.001
	No	9	17.6%	7	77.8%	
Statistic		Value		95% CI		
Sensitivity		82.35%		69.13% to 91.60%		
Specificity		77.78 %		39.99% to 97.19%		
Positive Predictive Value		95.45%		86.00% to 98.63%		
Negative Predictive Value		43.75 %		28.10% to 60.75%		
Accuracy		81.67%		69.56% to 90.48%		

Our results showed highly statistically significant correlation between the presence of abnormal lacunae and histopathological confirmation (**P-value > 0.001**). In addition, the overall Sensitivity, specificity, PPV, NPV and accuracy were 90%, 100%, 100%, 64.2%, 91.6%. This criterion showed very high sensitivity and specificity with very high positive predictive value and accuracy to become the most important criteria. Table (5)

Table (5)

Significance of the presence of abnormal lacunae by ultrasound and histopathological Pattern

		Histopathological Pattern				P value
		Accreta (n=51)		non accrete (n=9)		
		Count	%	Count	%	
Abnormal lacunae	yes	46	90.2%	0	.0%	< 0.001
	no	5	9.8%	9	100.0%	

Statistic	Value	95% CI
Sensitivity	90.20%	78.59% to 96.74%
Specificity	100.00 %	66.37% to 100.00%
Positive Predictive Value	100.00%	
Negative Predictive Value	64.29 %	43.91% to 80.54%
Accuracy	91.67%	81.61% to 97.24%
Accuracy	46.67%	33.67% to 60.00%

Our results showed no statistically significant correlation between the presence of placental bulge and histopathological confirmation (**P-value =0.7**). In addition, the overall Sensitivity, specificity, PPV, NPV and accuracy were 47%, 44.4%, 82.7%, 12.9%, 46.6%. Table (6)

Table (6)

Significance of the presence of placental bulge by ultrasound and histopathological Pattern

		Histopathological Pattern				P value
		Accreta (n=51)		non accreta (n=9)		
		Count	%	Count	%	
Placental bulge	yes	24	47.1%	5	55.6%	0.727
	no	27	52.9%	4	44.4%	

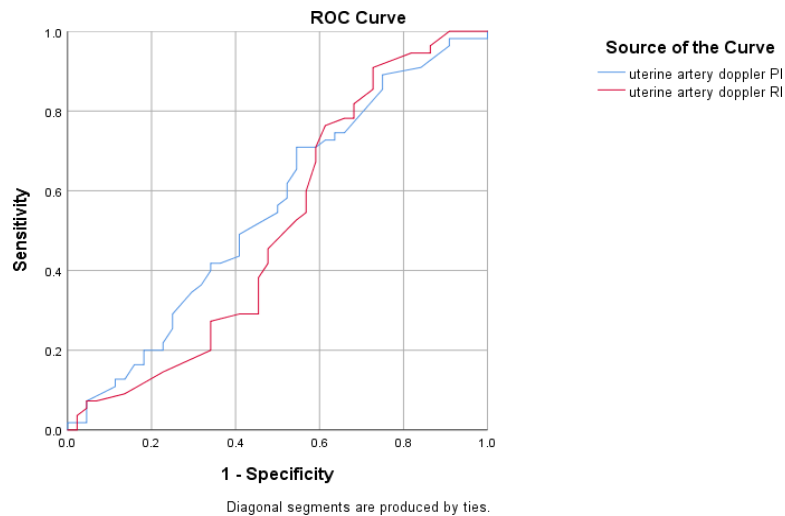
Statistic	Value	95% CI
Sensitivity	47.06%	32.93% to 61.54%
Specificity	44.44 %	13.70% to 78.80%
Positive Predictive Value	82.76%	71.42% to 90.22%
Negative Predictive Value	12.90 %	6.39% to 24.33%

Our results showed no statistically significant correlation regarding average values of Uterine artery Doppler PI and RI between cases of placenta accreta and placenta non accreta by histopathological examination (**p value =.078 & 0.58 respectively**). Table (7)

Table (7)

Comparison between cases of placenta accreta group and placenta non accreta group regarding average values of uterine artery Doppler PI and RI in correlation with Histopathological pattern

	Histopathological Pattern										P value
	Accrete(n=51)					Non accrete(n=9)					
	Mean	SD	Median	Minimum	Maximum	Mean	SD	Median	Minimum	Maximum	
uterine artery doppler PI	.81	.21	.81	.40	1.50	.91	.22	1.03	.52	1.12	.078
uterine artery doppler RI	.54	.12	.52	.32	.80	.58	.17	.52	.39	.81	.583



Test Result Variable(s)	Area Under the Curve	P value	95% Confidence Interval	
			Lower Bound	Upper Bound
uterine artery doppler PI	.556	.342	.440	.672
uterine artery doppler RI	.511	.855	.390	.632

Figure (1): ROC curve for prediction of accrete by operative findings using Doppler measures

Discussion

This study aims to measure the ability of Doppler ultrasound (either placental morphology or uterine artery Doppler) to detect placenta accreta in patients with placenta previa.

This study showed Sensitivity, specificity, PPV, NPV and accuracy were 90.2%, 100%, 100%, 64.2% and 91.6% respectively in correlation with histopathological assessment, in addition our study showed Sensitivity, specificity, PPV, NPV and accuracy were 83.93%, 81.8%, 85.4%, 80% and 83% respectively in correlation with intraoperative assessment.

Highly statistical difference was noticed between 2 groups 90% of cases with histopathological confirmation had abnormal lacunae vs 0% to the non accreta group.

Our study agreed with **Maged and his colleagues (2017)** a study concluded at the same institute of our study, who found that the presence of abnormal lacunae sensitivity 93%, PPV80.82%, NPV 85.19%, Accuracy 82.00%

Pilloni and his co-workers (2016) suggested the presence of abnormal lacunae with 94.6% specificity and with 48.6% sensitivity.

Whereas **Cali and his co-workers (2013)** found that presence of abnormal lacunae showed Sensitivity 73.0%, specificity 86.7%.

Yang and his associates (2006) who found that the presence of abnormal lacunae showed sensitivity 86.9%, specificity 78.6%, PPV 76.9 and NPV 88%, In a recent systematic review, the overall pooled sensitivity and specificity from 13 studies of lacunar spaces diagnosing MAP was 77% and 95% respectively, with an overall diagnostic accuracy of 88% (**D'Antonio et al., 2013**).

Abnormal placental lacunae have the highest accuracy among other criteria of US findings with high sensitivity and specificity.

This study showed Sensitivity, specificity, PPV, NPV and accuracy were 82.35%, 77.7%, 95.4%, 43.7% and 81.6% in correlation with histopathological assessment, in addition our study showed Sensitivity, specificity, PPV, NPV and accuracy were 78.5%, 88.6%, 89.8%, 76.4% and 83 % in correlation with intra-operative assessment.

Maged and his co-workers (2017) suggested the loss of retro-placental clear zone to have 87.3% sensitivity, 89.1% specificity, 93% PPV, 80% NPV and 88% Accuracy which agreed with our study.

Pilloni and his co-workers (2016) suggested 81% sensitivity and 97% specificity to the retro placental zone disruption

In a recent systematic review, the overall pooled sensitivity and specificity from 13 studies of loss of retroplacental clear zone diagnosing MAP was 66% and 95% respectively

Wong and his colleagues (2012) found absence of the clear space in 37 (65%) women without placenta accreta and in 100% of those women with it. Hence, it is sensitive but not specific.

This study showed Sensitivity, specificity, PPV, NPV and accuracy were 80.342.9%, 44.4 and 89%, 28% and 75% Respectively in correlation with histopathological assessment, in addition our study showed Sensitivity, specificity, PPV, NPV and accuracy were 80%, 75%, 80%, 75% and 78% respectively in correlation with intra-operative assessment.

Our study agreed with **Budorick and his colleagues (2016)** in being a sensitive sign who suggested myometrial thinning with 79% sensitivity and 77 % specificity.

This study showed Sensitivity, specificity, PPV, NPV and accuracy were 47.06%, 44%, 82.6%, 12.9 % and 46.6% respectively in correlation with histopathological assessment, in addition our study showed Sensitivity, specificity, PPV, NPV and accuracy were 46%, 75%, 70%, 52% and 59% respectively in correlation with intra-operative assessment.

Our study agreed with **Comstock (2005)** who stated that placental bulge isn't sensitive and agreed with him in being specific where he found it a specific sign.

In a recent systematic review, the overall pooled sensitivity and specificity from 9 studies of abnormalities of utero-bladder interface diagnosing MAP was 49% and 99% respectively (**D'Antonio et al., 2013**).

Cali and his co-workers (2013) suggested that this criterion showed Sensitivity 70%, specificity 100%, PPV 100%, NPV 100%, Unlike **Comstock (2011)**, where this finding had Sensitivity 20%, PPV 75%, and (**Wong et al., 2012**) sensitivity 11%, specificity 100%.

The interruption of this line is a result of increased vascularity in this space, as they showed using colour Doppler; it does not signify invasion of the bladder because interruption can be seen in placenta accreta (**Comstock et al., 2014**).

This study showed Sensitivity, specificity, PPV, NPV and accuracy were 82%, 33%, 87%, 25% and 75% respectively in correlation with histopathological assessment, in addition our study showed Sensitivity, specificity, PPV, NPV and accuracy were 83%, 70%, 78%, 77% and 78% respectively in correlation with intra-operative assessment.

Our study did not agree with **Pilloni et al. (2016)** where it showed 10.8% sensitivity and 98% specificity.

Our study agreed with a recent systematic review, the overall pooled sensitivity and specificity from 12 studies of abnormalities of colour Doppler diagnosing MAP was 90% and 89% respectively (**D'Antonio et al., 2013**).

Our study agreed with **Cali et al. (2013)** where it showed Sensitivity 90%, specificity 100%, PPV 100%, NPV 97%.

Our study agreed with **Cali et al. (2013)** where it showed sensitivity 39%, but didn't agree regarding specificity as it showed specificity 100%, in contrary our study didn't agree with **Comstock & Bronsteen (2014)** who showed that the bridging vessels had sensitivity, specificity, PPV and NPV 89, 96, 80 and 98%, respectively.

Our results showed no statistically significant correlation regarding mean values of Uterine artery Doppler PI and RI between cases of placenta accreta and non accreta (p value = .078 & 0.58 respectively) in correlation with histopathological assessment. Our results showed no statistically significant correlation regarding mean values of Uterine artery Doppler PI and RI between cases of placenta accreta and placenta non accreta (p values = 0.341, 0.953 respectively) in correlation with intra-operative assessment.

A study was held by **Hee Young and his colleagues (2015)** reported that the mean uterine artery PI was significantly lower in the placenta accreta group compared to placenta previa group and this disagreed with the present study as we found no significant association.

Conclusion

From this we conclude that the accuracy of abnormal placental lacunae, loss of retro-placental clear zone, myometrial thinning and utero-vesical hypervascularity are the most important ultrasound criteria in the diagnosis of placenta accreta among the patients who had a previous CS with a placenta previa overlying the previous uterine scar.

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