

ACCURACY OF DOPPLER ULTRASOUND IN PREDICTION AND DIAGNOSIS OF PLACENTA ACCRETE

By

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ABSTRACT

Background: The worldwide incidence of placenta accreta spectrum (PAS) is rapidly increasing, following the trend of rising cesarean delivery. PAS is an heterogeneous condition associated with a high maternal morbidity and mortality rate, presenting unique challenges in its diagnosis and management.

Objective: This study aims to compare between the role of Transabdominal ultrasound vs Transvaginal ultrasound in assessment of placental invasion in cases of placenta previa anterior wall with previous uterine scar applying the unified descriptors of the "EW-AIP" and also to evaluate the sensitivity and specificity of each criterion by comparing them with the final outcome of pregnancy.

Patients and methods: This study was conducted on (50) pregnant women diagnosed as placenta previa by ultrasonography and were candidates for repeated elective CS or elective hysterectomy (if the diagnosis of placenta accreta is confirmed). All of those patients presented during the period of December 2018 till August 2020 to El-sheikh Zayed Specialized Hospital Obstetrics outpatient clinic during their follow up visits in the 3rd trimester.

Results: Combined gray-scale ultrasonography and color Doppler increased the accuracy for diagnosis of placenta accreta to 100% as approved intra-operatively and by the histopathological examination. In our study: As regards the analysis of gray-scale ultrasonographic criteria, loss of the hypo-echoic retroplacental sonolucent zone has the highest percentage among the studied group (87.5%), followed by presence of abnormal placental lacunae (79.2%) then thinning or disruption of hyperechoic serosa – bladder interface and the presence of focal exophytic masses invading the urinary bladder (41.7%), (25%) respectively.

Conclusion: Combined gray-scale ultrasonography and color Doppler ultrasound are suggested for all patients with placenta previa and pervious CS to find out the features which suggest presence of placenta accreta, and this allows the surgical team to plan ahead of each case individually according to the variable morphological and vascular patterns.

Keywords: Accuracy of Doppler ultrasound, Placenta accrete.

INTRODUCTION

Placenta accreta related to considerable maternal morbidity which includes massive blood transfusion, urinary tract injury, hysterectomy, admission to intensive care unit (ICU) admission, sepsis, and long hospital stay. The term

PAS refers to variable degrees of adherence and invasion of the uterus and / or surrounding organs by the placenta, i.e. placenta accreta, increta and percreta (*Sentilhes et al., 2018*).

Placenta accreta spectrum (PAS) disorders have become a significant life-

threatening obstetrical issue due to its increased incidence from 0.12 to 0.31% in the last 30 years and the reported mortality rate of approximately 7.0% (*Zhang et al., 2017*).

Prenatal diagnosis of MAP and its variants can help reduce maternal/fetal morbidity and mortality by allowing us to choose the best time and place of birth. Multidisciplinary surgical management, neonatal intensive care, prophylactic hypogastric artery balloon occlusion, uterine artery embolization and an adequate number of blood units available in the operating room can only be achieved effectively through early detection of the placental pathology (*Cali et al., 2013*).

Several authors have reviewed the diagnostic accuracy of sonographic criteria for placenta accrete. The risk of performing an unnecessary hysterectomy (false positive) or the risk of secondary bleeding following attempted placental removal (false negative) should always be considered. An evaluation based solely on sensitivity and specificity is not sufficient to legitimize the use of diagnostic criteria; assessing PPV and NPV is mandatory to planning appropriate management and information of patients (*Wong et al., 2012*).

A review of the last decade's literature shows an increasing incidence of placenta accreta, mainly due to more frequent CSs. In almost all cases, abnormal placental invasion is at the site of a previous uterine scar. Other risk factors, which are related less strongly to MAP, include advanced maternal age, myometrial damage due to a myomectomy with endometrial entry, heavy curettage with secondary Asherman

syndrome, submucosal myoma (*Cali et al., 2013*).

Women at most increased risk of abnormally invasive placenta is, however, those who had a previous CS with a placenta previa overlying the previous uterine scar (*Comstock et al., 2011*).

The diagnosis of morbidly adherent placenta involves a number of different ultrasound variables, some qualitative and others that have been quantified. Several studies have assessed the predictive value of different ultrasound markers of AIP. However, the performance of these markers shows considerable variability among studies using the same signs. These differences have been attributed previously to a combination of limited sample size, retrospective design and variability of study inclusion criteria and eventual diagnosis of AIP (*D'Antonio et al., 2013*).

Furthermore, as with all diagnostic techniques reliant on subjective opinion, the recorded presence or absence of each sign will be influenced by the operator's interpretation of what constitutes that marker. This is particularly important to clinicians, who may not have much experience with ultrasonography of the placenta or diagnosing AIP. Additionally, there is no published consensus on the definition of the ultrasound markers used commonly for AIP. Many signs have been described under different names, and in other cases the same term has been used for different findings (*Collins et al., 2016*).

This study aims to compare between the role of Transabdominal ultrasound vs Transvaginal ultrasound in assessment of placental invasion in cases of placenta

previa anterior wall with previous uterine scar applying the unified descriptors of the "EW-AIP" and also to evaluate the sensitivity and specificity of each criterion by comparing them with the final outcome of pregnancy.

PATIENTS AND METHODS

This study was conducted on 50 pregnant women diagnosed as placenta previa by ultrasonography and were candidates for repeated elective CS or elective hysterectomy (if the diagnosis of placenta accreta is confirmed). All of those patients presented during the period of December 2018 till August 2020 to El-sheikh Zayed Specialized Hospital Obstetrics outpatient clinic during their follow up visits in the 3rd trimester.

Inclusion criteria: Maternal age from 20 to 40 years, gestational age >28 weeks, confirmed by the first day of the last menstrual period or first trimesteric ultrasound, single living fetus, one or more cesarean section, and Placenta previa (all grades) with high possibility of morbidly adherent placenta accreta (all types).

Exclusion criteria: Maternal chronic medical disorder (diabetes mellitus or hypertension), pregnancy induced disorders (pre-eclampsia or gestational diabetes), associated fetal anomalies, and emergency or unplanned cesarean for cesarean hysterectomy.

All patients were subjected to:

1. Personal History: Name, age, residence, occupation, marital status and special habits of medical importance particularly smoking, alcohol intake and drug abuse.

2. Obstetric History: Obstetric code and mode of delivery, gestational age by date and first trimesteric ultrasound, and Past obstetric history including recurrent miscarriage, preterm delivery, preeclampsia, unexplained stillbirth.

3. Past History: History of medical diseases particularly diabetes mellitus, hypertension, coronary heart disease, liver and kidney, history of previous operations or accidents, history of previous blood transfusions, and history of drug intake.

4. Full clinical examination: General examination: Including vital signs, chest, cardiac, lower limbs, upper limbs and breast examination.

Abdominal examination:

Inspection: looking for fetal movements, scars of previous operations, any stria gravidarum or linea nigra and to assess the shape of the uterus and note any asymmetry.

- **Palpation:** assessment of fundal level, fetal lie, presentation.

- **Auscultation:** fetal heart auscultation.

5. Investigations:

- All patients were subjected to routine preoperative labs to exclude uncontrolled medical condition (CBC, Coagulation profile, Urea, Creatinine, ALT, AST & Random blood sugar).

- Ultrasound examination (2D gray scale and color doppler) via transabdominal and/or transvaginal approach using an ultrasound machine (Voluson Pro-V and GE Voluson E10):

- a. Routine obstetric ultrasound including confirmation of the gestational age.
 - b. Confirming the presence of placenta previa (presence of placental tissue covering the internal os) or low lying placenta (presence of placental tissue within 2 cm from the internal os and does not cover it).
 - c. To assess the possibility of concomitant placenta accreta (Sonographic findings that have been associated with placenta accrete: (1) Loss of normal hypoechoic retroplacental zone. (2) Multiple vascular lacunae (irregular vascular spaces) within placenta, giving "Swiss cheese" appearance (3) Blood vessels or placental tissue bridging uterine-placental margin, myometrial-bladder interface, or crossing uterine serosa. (4) Retroplacental myometrial thickness of 1 mm (5) Bladder wall interruption (6) Presence of placental bulge (7) Utero-vesical hypervascularity (8) presence of lacunae feeder vessels.
 - d. Assessment of the adjacent structures that may be invaded by placenta percreta.
- 6. Termination of pregnancy** by elective cesarean section and/or cesarean hysterectomy.
 - 7. Documentation of the operative findings** during cesarean section and/or cesarean hysterectomy procedures.
 - 8. Histopathological examination** of the hysterectomy specimens to assess the degree of myometrial invasion.
 - 9. Statistical analysis of the collected data:**

Data were coded and entered using the statistical package SPSS (Statistical Package for the Social Sciences) version 24. Data was summarized using mean and standard deviation in quantitative data and using frequency (count) and relative frequency (percentage) for categorical data. Standard diagnostic indices including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and diagnostic efficacy were calculated. Comparisons between groups were done using unpaired t test. For comparing categorical data, Chi square (χ^2) test was performed. Exact test was used instead when the expected frequency is less than 5. P value less than 0.05 was considered as statistically significant.

N.B. Ultrasound was performed by two expert sonographers.

**Table (1): Diagnostic accuracy of different items of TAS & TVS
Subplacental hypervascularity TVS * Clinical.evaluation1**

			Clinical.evaluation1		Total
			Abnormal	No abnormal	
Subplacental hypervascularity TVS	Yes	Count	10	0	10
		% within Subplacental hypervascularityTVS	100.0%	0.0%	100.0%
		% within Clinical.evaluation1	23.3%	0.0%	20.0%
		% of Total	20.0%	0.0%	20.0%
	No	Count	33	7	40
		% within Subplacental hypervascularityTVS	82.5%	17.5%	100.0%
		% within Clinical.evaluation1	76.7%	100.0%	80.0%
		% of Total	66.0%	14.0%	80.0%
Total	Count	43	7	50	
	% within Subplacental hypervascularityTVS	86.0%	14.0%	100.0%	
	% within Clinical.evaluation1	100.0%	100.0%	100.0%	
	% of Total	86.0%	14.0%	100.0%	

Sensitivity 23.3%, specificity 100%, PPV 100%, NPV 17.5%, accuracy 34.0%

**Table (2): Comparison of the accuracy between TAS & TVS
Clear.zone.TAS * Clear.zone.TVS**

			Clear.zone.TVS		Total
			Correct	Incorrect	
Clear zone TAS	Correct	Count	26	1	27
		% within Clear.zone.TAS	96.3%	3.7%	100.0%
		% within Clear.zone.TVS	68.4%	8.3%	54.0%
	Incorrect	Count	12	11	23
		% within Clear.zone.TAS	52.2%	47.8%	100.0%
		% within Clear.zone.TVS	31.6%	91.7%	46.0%
Total	Count	38	12	50	
	% within Clear.zone.TAS	76.0%	24.0%	100.0%	
	% within Clear.zone.TVS	100.0%	100.0%	100.0%	

**Table (3): Comparison of the accuracy between TAS & TVS
SubPlacenta. Vascular. TAS * S.placenta. vascularity. TVS**

			S.placenta vascularity TVS		Total
			Correct	Incorrect	
SubPlacenta. Vascular. TAS	Correct	Count	13	2	15
		% within SubPlacenta. Vascular. TAS	86.7%	13.3%	100.0%
		% within S.placenta. vascularity. TVS	76.5%	6.1%	30.0%
	Incorrect	Count	4	31	35
		% within SubPlacenta. Vascular. TAS	11.4%	88.6%	100.0%
		% within S.placenta. vascularity. TVS	23.5%	93.9%	70.0%
Total	Count	17	33	50	
	% within SubPlacenta. Vascular. TAS	34.0%	66.0%	100.0%	
	% within S.placenta. vascularity. TVS	100.0%	100.0%	100.0%	

**Table (4): Comparison of the accuracy between TAS & TVS
Bridge.V.TAS * Bridge.V.TVS**

			Bridge.V.TVS		Total
			Correct	Incorrect	
Bridge.V.TAS	Correct	Count	35	2	37
		% within Bridge.V. TAS	94.6%	5.4%	100.0%
		% within Bridge.V. TVS	92.1%	16.7%	74.0%
	Incorrect	Count	3	10	13
		% within Bridge.V. TAS	23.1%	76.9%	100.0%
		% within Bridge.V. TVS	7.9%	83.3%	26.0%
Total	Count	38	12	50	
	% within Bridge.V. TAS	76.0%	24.0%	100.0%	
	% within Bridge.V. TVS	100.0%	100.0%	100.0%	

**Table (5): Comparison of the accuracy between TAS & TVS
PL.feeder.v.TAS * PL.feeder.v.TVS**

		PL.feeder.v.TVS		Total	
		Correct	Incorrect		
PL.feeder.v.TAS	Correct	Count	20	6	26
		% within PL.feeder.v.TAS	76.9%	23.1%	100.0%
		% within PL.feeder.v.TVS	76.9%	25.0%	52.0%
	Incorrect	Count	6	18	24
		% within PL.feeder.v.TAS	25.0%	75.0%	100.0%
		% within PL.feeder.v.TVS	23.1%	75.0%	48.0%
Total	Count	26	24	50	
	% within PL.feeder.v.TAS	52.0%	48.0%	100.0%	
	% within PL.feeder.v.TVS	100.0%	100.0%	100.0%	

Table (6): Comparison between the overall accuracy of TAS vs TVS

	Transabdominal ultrasound	Transvaginal ultrasound
Sensitivity	94.2	98.1
Specificity	85	93.8
Positive predictive value	96	99
Negative predictive value	66.7	88.2
Accuracy	91.5	97.5
Validity (out of 43 patients)	Detected 37	Detected 42

DISCUSSION

They showed Sensitivity 93.0%, specificity 66.7%, PPV 97.6%, NPV 85.7%, accuracy 90% by transabdominal ultrasonography (TAS), and Sensitivity 88.4%, specificity 85.7%, PPV 97.4%, NPV 85.7%, accuracy 88.0% by transvaginal ultrasonography (TVS).

The PPV of lacunae shows more variation from author to author than other signs, they were reported as sensitive and specific in some studies and no so in others.

This study agrees with what *Comstock et al. (2011)*, where the found them to be

93% sensitive in women at 20 weeks of gestation and beyond with a 93% PPV. Whereas, *Cali et al. (2013)* found that presence of abnormal lacune showed sensitivity 73.0%, specificity 86.7%.

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*).

Regarding loss of the retroplacental clear zone:

This study showed Sensitivity 51.2%, specificity 71.4%, PPV 91.7%, NPV 19.2%, accuracy 54.0% by TAS.

And Sensitivity 74.4%, specificity 85.7%, PPV 97.0%, NPV 35.3%, accuracy 76.0% by TVS.

Unlike *Cali et al. (2013)*, study which showed that the loss of retroplacental clear zone had Sensitivity 90%, specificity 81%, PPV 57%, NPV 97%. However, Finberg and Williams in 1992 stated that the loss of the retroplacental clear zone accounts for the majority of False Positive results and the criterion should not be used by itself to make the diagnosis.

Wong et al. (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. The primary use of the clear space appears to be that its presence effectively excludes placenta accreta because it has a high negative predictive value (NPV).

Regarding interruption of the bladder wall, this study showed it to have sensitivity 4.7%, specificity 100.0%, PPV 100.0%, NPV 14.6%, accuracy 18.0% by TAS and Sensitivity 9.3%, specificity 100%, PPV 100%, NPV 15.2%, accuracy 22.0% by TVS, which agrees with Comstock CH in 2011, where this finding had Sensitivity 20%, PPV 75%, and *Wong et al. (2012)* sensitivity 11%, specificity 100%, unlike *Cali et al. (2013)* where this criterion showed sensitivity 70%, specificity 100%, PPV 100%, NPV 100%.

The cause of the low sensitivity reported in the papers by both *Wong et al.*

(2013) and *Comstock et al. (2014)* may be that not all women had transvaginal ultrasound with the quite specific conditions used by *Cali et al. (2013)* in that large study the authors first determined that 300 ml in the bladder resulted in the best visualization of the uterine–bladder interface and then instilled this amount into each woman's bladder.

Regarding the uterovesical hypervascularity using color doppler flow:

This study shows Sensitivity 86.0%, specificity 71.4%, PPV 94.9%, NPV 45.5%, accuracy 84.0% by TAS, and Sensitivity 93.0%, specificity 57.1%, PPV 93.0%, NPV 57.1%, accuracy 88.0% by TVS. The sensitivity of this descriptor significantly increased using TVS. Also, this agrees with *Cali et al. (2013)*, where it showed Sensitivity 95.0%, specificity 100%, PPV 100%, NPV 97%.

Regarding presence of abnormal bridging vessels between the placenta and the bladder wall:

This study showed Sensitivity 69.8%, specificity 100%, PPV 100%, NPV 35.0%, accuracy 74.0% by TAS, and Sensitivity 71.2%, specificity 100%, PPV 100%, NPV 36.8%, accuracy 76.0% by TVS which also confirms with *Cali et al. (2013)*.

Although no studies have been performed that directly compare the diagnostic accuracy of transabdominal vs transvaginal ultrasound in the setting of suspected placental invasion, transvaginal ultrasound allows for a more complete evaluation of the lower uterine segment

and is the current recommended standard of care (*Rac et al., 2014*).

This study used aimed mainly to compare between the role of Transabdominal ultrasound vs Transvaginal ultrasound in assessment of placental invasion in cases of placenta previa anterior wall with previous uterine scar applying the criteria of the "EW-AIP".

Although no studies have been performed that directly compare the diagnostic accuracy of transabdominal vs transvaginal ultrasound in the setting of suspected placental invasion, transvaginal ultrasound allows for a more complete evaluation of the lower uterine segment and is the current recommended standard of care (*Rac et al., 2014*).

Throughout the period of this study, every patient who was enrolled has undergone both Transabdominal sonography and transvaginal sonography and every one of the unified descriptors was assessed via both modalities, the accuracy of both modalities was calculated regarding their ability to evaluate each one of the unified descriptors as follows:

The accuracy of detection of the loss of the retroplacental clear zone was 76% by TVS and 54% by TAS

While that of the abnormal placental lacunae was 92 % by TAS and 88% by TVS

Myometrial Thinning detection accuracy was 66% by TAS and 72% by TVS.

While the Doppler assessment showed that the accuracy of detection of the

uterovesical hypervascularity was 84% by TAS and 88% by TVS.

While the detection of bridging vessels was 76% by TAS and 75% by TVS.

From this we conclude the accuracy of detection of the unified descriptors is quite close regarding TVS and TAS, however TVS was found to be more accurate in the exact placental localization putting in mind as well that the TVS was performed by a highly experienced operator whereas the TAS was performed by operators of less experience the overall accuracy of detection of TAS was 91% whereas that of TVS was about 97.1%.

Assigning a score in clinical practice may be helpful in the antenatal diagnosis of MAP and seems to be a key factor in reducing maternal and fetal morbidity and mortality, by allowing multidisciplinary counseling, and planning and timing of delivery.

Other studies suggested different scoring systems based on different criteria that would eventually enhance the ability of ultrasonography to predict abnormal placental invasion and thus enhance the offered approach

In conclusion, this study suggests that both transabdominal and transvaginal ultrasonographic modalities are complementary to each other, putting in mind that TVS had a slightly higher overall accuracy and was performed by a highly experienced operator.

Also, the unified descriptors suggested by the EW-AIP were found to be of dependable accuracy as well.

An important point to be considered is that all the patients who were in this study

and were exposed to transvaginal ultrasound, none of them had any attack of bleeding during the procedure, that proves the safety of this modality confirming many previous studies.

CONCLUSION

- Measures should be taken to decrease the rate of cesarean section to decrease the incidence of placenta accreta and its morbidity and mortality accordingly.
- To enhance patient safety, cases of placenta accreta should be managed in tertiary centers with available blood banks and the delivery should be performed in an operating room by an experienced obstetric team that includes an obstetric surgeon, with other surgical specialists, such as urologists, general surgeons, and gynecologic oncologists available if necessary.
- Combined gray-scale ultrasonography and color Doppler ultrasound are suggested for all patients with placenta previa and previous CS to find out the features which suggest presence of placenta accreta, and this allows the surgical team to plan ahead of each case individually according to the variable morphological and vascular patterns.

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دقة الموجات فوق الصوتية باستخدام الدوبلر في التنبؤ وتشخيص المشيمة الملتصقة

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خلفية البحث: إن معدل حدوث المشيمة الملتصقة في جميع أنحاء العالم يتزايد بسرعة، في أعقاب اتجاه ارتفاع الولادة القيصرية. إن المشيمة الملتصقة هو حالة غير متجانسة مرتبطة بارتفاع معدل مرضية ووفيات الأمهات، مما يمثل تحديات فريدة في تشخيصها وإدارتها.

الهدف من البحث: المقارنة بين دور الموجات فوق الصوتية عبر البطن مقابل الموجات فوق الصوتية عبر المهبل في تقييم غزو المشيمة في حالات المشيمة المنزاحة بالجدار الأمامي مع وجود ندبة رحم سابقة تطبق الواصفات الموحدة لـ "EW-AIP" وأيضًا لتقييم الحساسية و خصوصية كل معيار من خلال مقارنتها مع النتيجة النهائية للحمل.

المرضى وطرق البحث: أجريت هذه الدراسة على (50) امرأة حامل تم تشخيصهن على أنهن المشيمة المنزاحة عن طريق التصوير بالموجات فوق الصوتية وكانوا مرشحات لتكرار الولادة القيصرية الاختيارية أو استئصال الرحم الاختياري (إذا تم تأكيد تشخيص المشيمة الملتصقة). تم تقديم جميع هؤلاء المرضى خلال الفترة من ديسمبر 2018 حتى أغسطس 2020 إلى العيادات الخارجية بمستشفى الشيخ زايد التخصصي للولادة خلال زيارات المتابعة في الربع الثالث.

نتائج البحث: أدى التصوير بالموجات فوق الصوتية على المقياس الرمادي واللون دوبلر إلى زيادة دقة تشخيص المشيمة الملتصقة إلى 100% كما تمت الموافقة عليه أثناء الجراحة ومن خلال الفحص التشريحي المرضي. فيما يتعلق بتحليل معايير الموجات فوق الصوتية بالمقياس الرمادي، فإن فقدان المنطقة الرقيقة خلف الصدى خلف الصدى له أعلى نسبة بين المجموعة المدروسة

(87.5%)، يليه وجود ثغرات مشيمية غير طبيعية (79.2%) ثم ترقق. أو اضطراب واجهة المثانة والمصل المفرطة الصدى ووجود كتل خارجية بؤرية تغزو المثانة البولية (41.7%)، (25%) على التوالي.

الاستنتاج: يُقترح التصوير بالموجات فوق الصوتية على المقياس الرمادي والموجات فوق الصوتية الملونة دوبلر لجميع المرضى الذين يعانون من المشيمة المنزاحة والولادة القيصرية السابقة لاكتشاف الميزات التي تشير إلى وجود المشيمة الملتصقة، وهذا يسمح للفريق الجراحي بالتخطيط المسبق لكل حالة على حدة وفقاً لأنماط المورفولوجية والأوعية الدموية المتغيرة.

الكلمات الدالة: دقة الموجات فوق الصوتية دوبلر، المشيمة الملتصقة.