Efficacy of Simple Ultrasound Staging System in Prediction of Placenta Accreta Spectrum

Sherwet M. Shawky[1], Ashraf S. F. Ali[1], Amira Elgamel[1] and Abd El Gany M. A. Hassan[2]

Department of Obstetrics & Gynecology, Faculty of Medicine, [1]Beni-Suef University, [2]Cairo University, Egypt

ABSTRACT

Introduction: Abnormal placentation leading to obstetric haemorrhage is a major obstetric emergency. Due to an increase in the number of cesarean sections over the past few years, the Incidence of placenta accreta spectrum has considerably grown. We aimed at evaluation of the predictability of simple ultrasound staging system in the women at high risk for placenta accreta spectrum through a prospective observational study.

Materials and Methods: The study was a prospective observational cohort. It was conducted in Beni-Suef University Hospitals. It included one hundred and twenty-one pregnant women in 3rd pregnancy trimester and at high risk for placenta accreta spectrum. The examination of all women by transvaginal or transabdominal ultrasound was based on a staging system according to the American Institute of Ultrasound in Medicine "AIUM" developed in 2015. This staging system used simple ultrasound parameters of myometrial placental invasion. Ultrasound staging was done among the participating women. The surgical team documented intraoperative findings and complications in patients' files postoperatively. The simple descriptive analysis in the form of numbers, percentages & arithmetic means was used for qualitative data. The Student t-Test was used to compare measurements of two independent groups for quantitative parametric data.

Results: The placenta was inseparable intraoperatively in 35 women (28.9%). The number of past caesarean sections & gestational age at time of caesarean delivery were associated with intra-operative placental invasion (*p value* 0.0001 and 0.01 respectively). Ultrasound staging prediction for placental invasion was 100%.

Conclusion: Ultrasound staging of the women at risk of placenta accreta spectrum has a very high predictability and strongly avoids adverse maternal and fetal outcomes through antepartum multidisciplinary delivery planning.

Key Words: Morbidly adherent placenta, placenta previa, ultrasound parameters, ultrasound staging.

INTRODUCTION

The Placenta Accreta Spectrum "PAS" is a disease of abnormal placentation. It is one of the main causes of peripartum haemorrhage causing significant maternal morbidity & mortality[1]. PAS involves placenta accreta, increta & percreta which accounts for 33-50% of all the emergency hysterectomies representing a critical problem for obstetricians[2,3].

The incidence of "PAS" has risen significantly along the last years. Different estimates place it at 1 per 533[4] to 1 per 2510 deliveries[5].

Placenta previa is considered a common risk factor for "PAS" especially with a previous caesarean delivery[6]. Previous caesarean delivery & the presence of anterior low-lying placenta, or placenta previa should alert the antenatal care team of the higher risk of placenta accreta spectrum[7]. This allows for a prelabour multidisciplinary approach. Moreover, a plan of delivery will be conducted avoiding life threatening vaginal bleeding and taking into consideration the woman's informed consent[8].

Ultrasound is a major diagnostic modality which is used for antenatal diagnosis of abnormal placentation[9]. The Ultrasound evaluation, with grayscale and colour Doppler imaging, is highly accurate for diagnosing PAS when performed by an experienced sonographer[7]. Grayscale ultrasound parameters which are suggestive of PAS involve clear space in myometrial or retroplacental interface, decreased myometrial thickness & presence of intraplacental lacunae[10]. In addition to colour doppler imaging that demonstrates increased vasculature, bridging from placental mass to uterine-bladder or myometrial interface & sometimes beyond, irregular intraplacental vascularization and turbulent placental lacunae with high velocity flow (>15 cm/s)[11].

Prediction of placental invasion by ultrasound involves using different grey scale and colour doppler sonographic parameters denoting PAS into a well-defined scoring

system. Various techniques have emerged for prenatal scoring of PAS using grey-scale ultrasound features.

Doppler imaging maps for placental vasculature and number of caesarean deliveries. Many of these studies were retrospective which carry bias of knowing the interventions or investigations done for participants and different interpretation of data[9,12,13,14]. Thus, our prospective cohort study evaluates the efficacy of a simple staging system introduced by American Institute of Ultrasound in Medicine (AIUM) in 2015 including simple sonographic parameters associated with placenta accreta syndrome in antenatal prediction of placental invasion[15]. Our objective is to assess prospectively the predictability of this simple staging system through its correlation with intraoperative findings.

MATERIALS & METHODS

This was a prospective cohort observational study using ultrasound parameters of the Placenta Accreta Spectrum in a simple staging system to predict abnormal placental invasion antenatally. It was conducted in BeniSuef University Hospital from March 2017 to December 2019. The study included 121 pregnant women at high risk of PAS who came in 3rd trimester for antenatal care. Inclusion criteria involved previous history of one or more caesarean sections and ultrasound documented anterior low-lying placenta (which was defined as placental edge with in 2 cm from the internal os) or placenta previa (which was defined as placenta covering completely the internal os)[7]. Exclusion criteria involved multifetal gestation and any hypertensive disorder with pregnancy or placental hematomas or abruption.

The evaluation was based on a staging system according to AIUM developed in 2015. This staging system used simple ultrasound parameters of PAS (Table 1): the loss of hypoechoic placental-uterine demarcation line, number of placental lacunae and interruption of bladder- uterine interface. Placental attachment had been classified into four stages: stage #0: normal placentation, stage # 1: low probability of adherent placenta, stage # 2: moderate possibility of adherent placenta and stage # 3: high suspicion of adherent placenta[15].

Table 1: Detailed staging system for evaluation of suspected morbidly adherent placenta

Stage	Loss of hypoechoic placental-uterine demarcation line	No. of placental lacunae	Interruption of bladder- uterine interface
Stage 0	No	0	No
Stage 1	< 1cm and/or	1	No
Stage 2	1-2 cm and/or	> 2	No
Stage 3	> 2 cm and/or	> 2 and	Yes

From: A novel sonographic scoring system for antenatal risk assessment of obstetric complications in suspected morbidly adherent placenta by Gilboa Y, SpiraM, Mazaki-Tovi S, Schiff E, Sivan E, Achiron R. J Ultrasound Med 2015; 34: 561–567.

Ultrasound examination was performed for all participants using a TUS-Xario200 diagnostic ultrasonography system (Toshiba America Medical Systems, Tustin, California, USA) which was equipped with a 2-MHz curvilinear trans abdominal transducer and a 5MHz transvaginal probe. Ultrasound examination was performed with transabdominal or transvaginal transducer according to women's preference. Each woman was counselled by more than one health personnel. However, ten women declined transvaginal ultrasound. This was related to a strong belief of injury of placenta by the transvaginal transducer and vaginal bleeding. However, Transvaginal Sonography "TVS" improves the accuracy of placental localisation particularly when the placenta is posterior or if the transabdominal sonography "TAS" is unclear, for example, due to maternal obesity, or the presence of the large uterine fibroids[16]. Moreover, it is safe[9]. Staff of sonographers were blinded to clinical history of all participants. Our primary outcome is evaluation of the predictability of this simple ultrasound staging system prospectively. Secondary outcomes included any intraoperative or postoperative complications including primary postpartum haemorrhage "defined as a blood loss of 500ml or more within the 1st 24 hours of delivery"[17], bladder injury (defined as soiling of operative field with urine or haematuria diagnosed by assessing the urinary catheter)[18] and prolonged hospital stay duration (defined as hospitalization for more than 7 days after caesarean section)[19].

Probability of placenta accreta spectrum was documented in each patient's file. Staging was done among the participating women according to the ultrasound parameters included. Through this staging system, the antenatal team counselled the participating women according to the ultrasound findings[15]. Moreover, the surgical team assigned for PAS in our department planned effectively for the caesarean delivery/hysterectomy through a multidisciplinary approach[8]. This approach includes a well-defined team which is available for prompt intervention. The team involves senior obstetricians and specialists in maternal- fetal medicine, expert seniors in pelvic surgery, urologists, senior anaesthesiologists, neonatologists and well qualified nurses. In addition to communication with intensive care unit senior staff for postoperative care in women with postoperative complications. Also, strong and early communication with the blood bank seniors in our institution who provide us with consistent protocols for blood transfusion. Through this team, every step in antenatal care was carried out until time of caesarean section including frequent maternal and fetal antenatal care appointments, giving hotline telephone number in case of emergency and inpatient care until time of delivery if required[7].

The surgical team documented intraoperative findings and complications in patients' files postoperatively. In addition, histological confirmation of trophoblast tissue invading myometrium was documented.

Sample size calculation

We were planning a prospective observational study of pregnant women with previous history of caesarean section & low lying placenta documented by ultrasound. Our primary outcome was to assess predictability of simple ultrasound characteristics of myometrial placental invasion in Placenta Accreta Spectrum. It was found by Rac *et al*. in 2015 that 29% of the retrospectively studied women had placental invasion[12]. We needed to study 117 women to have a 95% confidence level & a 5% error margin.

Statistical Analysis

For quantitative parametric data, standard deviations were employed as a measure of dispersion, while simple descriptive analysis in the form of numbers and percentages was utilized for qualitative data. One-Sample Kolmogorov-Smirnov tests were used to determine the normality of the quantitative data contained in the study for each study group, and then inferential statistical tests were used. Student t-Test was used to compare measurements of two separate groups of quantitative parametric data. For qualitative data, Chi square test was used to compare 2 or more than 2 qualitative groups. Sensitivity and specificity were used.

The threshold for significance was set at a *P-value* of 0.05

The Statistical Package of Social Science (SPSS) software version 18 running on Windows 7 was used to analyze the data after it had been gathered, double-entered, and coded to ease data manipulation.

RESULTS

Hundred and fifty pregnant women were recruited from antenatal clinic. Twenty women didn't meet inclusion criteria. Six women delivered in another place and 3 declined participation. Hundred and twenty-one pregnant women were included in the present study (Figure 1). Detailed staging system for evaluation of suspected morbidly adherent placenta is shown in table 1. Women were staged according to the used ultrasound parameters (Table 2). In 35 women (28.9%) the placenta could not be separated from the uterus intraoperative and caesarean hysterectomy was performed. While there was complete separation of the placenta in 86 women (71.1%). Myometrial trophoblastic invasion was confirmed histologically in the 35 women.

Table 3 shows that the number of past caesarean sections & gestational age at time of caesarean section were associated with intra-operative placental invasion (*p value* 0.0001 and 0.01 Respectively). Intra-operative placental invasion was significantly associated with stage 3 according to ultrasound parameters (Table 4). Frequency of complications among cases with intra-operative placental invasion is shown in (Table 5). There isn't a significant difference between stages 2 & 3 concerning frequency of intra-operative & post-operative complications.

(Table 6) displays the sensitivity, specificity, positive & negative predictive values, and accuracy of ultrasound staging.
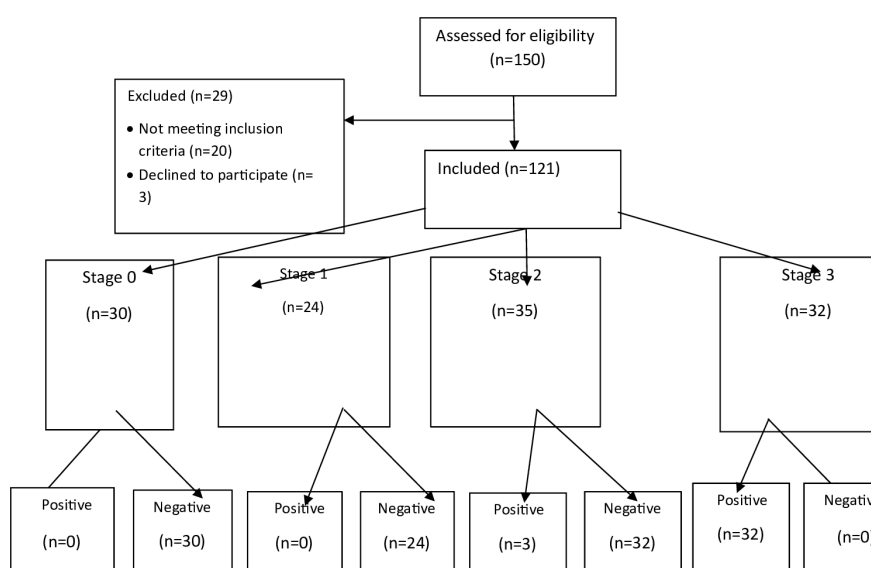

Fig. 1: Flow chart shows recruitment of participating women in the study and intraoperative placental invasion according to staging system used.

Table 2: Staging of women in the study group.

Stage	Number of participants(n=121)
Stage 0	30(24.8)
Stage 1	24(19.9)
Stage 2	35(28.9)
Stage 3	32(26.4)

Data are illustrated as n (%).

Table 3: Demographic characteristics according to intra-operative placental invasion

Variables	Negative (n=86)	Positive (n=35)	P value
Age (years)	28±3.4	31.5±3.9	0.40
Number of previous C. S.	2.9±0.8	4.2±0.4	0.0001**
Gestational age at time of C.S. (weeks)	36.6±1.3	36±0	0.01*

P value <0.001** highly significantData are illustrated as mean± SD

Table 4: Intra-operative placental invasion according to ultrasound staging

Stages	Negative (n=86)	Positive (n=35)	P value
Stage 0	30(35.2)	0	0.0001**
Stage 1	24(28.2)	0	0.0005**
Stage 2	32(36.6)	3(8.6)	0.02*
Stage 3	0	32(91.4)	<0.0001**

P value <0.001** highly significantData are illustrated as n (%)

Table 5: Frequency of complications among positive group for intraoperative placentalinvasion

variables	Stage 2 (n=3)	Stage 3 (n=32)	P value
Bladder injuries	1(33.3)	3(9.4)	0.22
Received packed RBCs	1(33.3)	10(31.3)	0.94
Longer hospital stays	0	13(40.6)	0.17

Table 6: Sensitivity, Specificity, negative and positive predictive values in ultrasound stages

Stages	Sensitivity(95 % CL)	Specificity(95 % CL)	PPV (95 % CL)	NPPV (95 % CL)	Accuracy
Stage 0	100(88.43-100)	100(88.43-100)	NaN%	100%	100(94.04-100)
Stage 1	100(85.75-100)	100(85.75-100)	NaN%	100%	100(92.60-100)
Stage 2	100(29.24-100)	100(89.11-100)	NaN%	100%	100(90-100)
Stage 3	100(89.11-100)	0	100%	0	0

DISCUSSION

In the present prospective observational study, we found that using simple ultrasound parameters in women at high risk of placenta accreta spectrum including the loss of Hypoechoic Placental-uterine Demarcation line, number of placental lacunae, and interruption of bladder-uterine interface and staging women accordingly is highly predictive to intra-operative placental invasion. Placenta was not separated intra-operatively in all women with stage 3 and only 3 women with stage 2 according to ultrasound findings. Positive predictive value of ultrasound staging system for placenta accreta in our study reached 100%.

Many studies concur with these findings[20,21,22]. It has been concluded by many investigators that there is a strong relation between placental lacunae and placenta accreta spectrum[6,9,23,24,25]. The number and irregular outlines of placental lacunae are the most important predictors of placental invasion[24,25]. However, in a study by Gilboa *et al*., who retrospectively evaluated 21 women, the detection rate of placental invasion was 64%. In that study, detailed intra-operative findings and same surgical interpreting team may not be present in all retrospectively evaluated women and number of assessed cases was only 21[15]. In addition, the sensitivity of grey-scale sonographic criteria (placental lacunae, absence of retroplacental clear zone & interruption of posterior bladder wall-uterine interface) ranges from 7% to 93%[21,26,27]. This wide range may be, to a great extent, related to different sonographic interpreters of different ultrasound findings used in retrospective studies and not all ultrasound parameters were recorded. Moreover, some ultrasound parameters are difficult to be interpreted by some sonographers as the interface between the myometrium & placenta which maybe troublesome on trans abdominal ultrasound during third trimester since the lower

uterine segment shows up as a thin line. In current study, number of previous caesarean sections & gestational age at time of caesarean delivery were highly related to intraoperative placental invasion. Number of previous caesarean deliveries was a strong predictor of invasion of myometrium by the placenta in many studies[4,5,28].

In this study, gestational age at time of caesarean section was 36 weeks in women positive for intraoperative inseparable placenta. In a retrospective study by Rac *et al*. in 2015, authors concluded that the likelihood of antepartum vaginal bleeding that needed emergency caesarean section/caesarean hysterectomy decreased with advancing gestation. Most of the women who delivered after the 36th weeks had less antepartum bleeding complications[29]. This may interpret the high association between gestational age at time of caesarean section and intraoperative placental invasion in the present study.

One of the limitations of our work is that the surgical team assigned for placenta accreta spectrum wasn't blinded to the ultrasound findings. This might give this study little bias as the surgical intervention received by participants maybe known preoperatively. However, this was in favour of women in our study as few complications involving morbidity and no mortality were seen due to good preparation and multidisciplinary approach depending on simple ultrasound parameters. Second, transvaginal ultrasound was not accepted by ten women in the present study. Including transabdominal sonography may affect the predictive value of some ultrasound findings[12]. Although some cases did not have a transvaginal approach, this staging ultrasound system still had high predictability for PAS. In addition, no studies concluded straightforwardly the diagnostic precision of trans abdominal vs. trans vaginal ultrasound within the issue of suspected myometrial placental invasion[8,28,30].

Despite the incidence of placenta accreta is increasing because of the increased rates of caesarean section, some institutions see few cases. So, investigators do multicentric studies which are almost always retrospective. This affects strength and adequacy of these studies as not the same

ultrasound parameters and sonographers are available[9]. Thus, the present work was carried out prospectively depending on same staff of sonographers and same way of interpretation for all ultrasound findings in our institution. This overcame the methodological imperfections inborn to other retrospective studies.

In our opinion, points of strength in the present study involve prospective methodological design and number of participants. Placenta previa/placenta accreta cases come to emergency unit each week as our University Hospital admits 1000 to 1500 deliveries per year. The extremely high rate of PAS at our institution is related to the fact that most of families in the district served by us as a university hospital are poor and cannot afford paying for private hospitals. In addition, the medical insurance in our country does not cover every family. All people have to pay lot of money for private health services. University hospital is a free health service place where there is blood bank, qualified medical staff, laboratory and intensive care unit for mothers and babies.

As a result, our prospective findings may outline a model to find out women at risk of placenta accreta spectrum who may need caesarean hysterectomy and blood transfusion.

This is so helpful for multidisciplinary approach of a case suspected to have placenta accreta, antepartum preparation for safe delivery and informative counselling for women through simple ultrasound staging system.

CONFLICT OF INTERESTS

There are no conflicts of interest.

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