Original Article

PLACENTA ACCRETA SPECTRUM AND MODALITY OF CHOICE FOR PLACENTAL MAPPING AS CONFIRMED WITH INTRAOPERATIVE FINDINGS

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Objective: To find diagnostic accuracy of magnetic resonance imaging (MRI) and color doppler ultrasound for placenta accreta spectrum (PAS) by comparing them with intra operative findings.
Methods: This study was conducted at Lahore General Hospital, Lahore and Services Hospital, Lahore from 01-07- 2017 to 31-01- 2020. 36 pregnant patients with history of previous cesarean sections and ultrasound documentation of placenta previa at more than or equal than 32 weeks of gestation were included in the study. Both color doppler ultrasound and MRI evaluation for PAS were performed on all patients included in the study. Findings were confirmed intra operatively. Women with upper uterine segment placenta were excluded.
Results: Out of 36 patients enrolled for the study, color doppler USG confirmed diagnosis of PAS in 30 patients while MRI confirmed diagnosis of PAS in 31 patients. Intra operatively PAS was confirmed in 31 patients. Color doppler USG yielded 2 false negative cases and 1 false positive case with sensitivity, specificity, accuracy, positive predictive value and negative predictive value of 93.54%,(95% confidence interval [CI] , 77% to 98%), 80.0% (95% CI, 29% to 98%), 91.66%, 96.6%, 66.66% respectively while MRI yielded 1 false negative and 1 false positive case with all these values as 96.77% (95% CI, 81% to 99%), 80.0% (95% CI, 29% to 98%), 94.44%, 96.77%, 80.0% respectively.
Conclusions: Color doppler ultrasound and MRI are complementary investigations. MRI has superior sensitivity than color doppler USG but the specificity of both modalities are same for antenatal diagnosis of PAS.
Keywords: placenta accreta spectrum (PAS), magnetic resonance imaging (MRI), color doppler ultrasonography (USG), intra operative.

Introduction

Placenta accreta spectrum (PAS) is a relatively new obstetrical problem faced by obstetricians. Increasing number of cesarean sections over the past few decades have led to rising incidence of this life threatening condition. Accurate mapping of placenta is one of many other preoperative preparations. Gray scale ultrasound, color doppler ultrasound and magnetic resonance imaging (MRI) are among the different diagnostic modalities used for placental localization and defining the depth of placental invasion. Over the past few decades the increasing number of cesarean sections have lead to the dramatic rise in serious obstetrical complication called `Placenta accrete spectrum` (PAS).[1] There is 25% to 50% reported incidence of PAS in patients with placenta previa with previous cesarean section.[2] The hallmark for placenta accrete spectrum is absence of decidua and invasion of trophoblast and villous tissue into the myometrium.[3] Placenta accrete spectrum is divided into placenta accreta, placenta increta and placenta percreta based on the depth of chorionoc villi invasion into the myometrium.[4] The morbid adherence of placenta to maternal myometrium may have serious sequels. This may include need for blood transfusion, anaesthesia complications, prolonged surgery, damage to surrounding viscera, need for extensive investigations prior to surgery, obstetrical hysterectomy and psychological and emotional disturbances associated with this life saving procedure.[5] Accurately defining and mapping the placenta prior to surgery is crucial to the successful outcome.[6] Coordinated peripartum management matters the most in the face of heavy blood loss encountered during surgery.[7] Ultrasound is the routinely followed, observer dependent diagnostic imaging modality to identify PAS. The sensitivity of ultrasound ranges from 82.4% to 100% and specificity 92% to 96.8% in different studies.[8,9] MRI on the other hand is another promising imaging modality for mapping the placenta. MRI can be of help in cases of posteriorly located placenta.[10] It can also warn about involvement of adjacent visceras. A recent study compared the ultrasound and MRI. The reported sensitivity and specificity of USG and MRI was 77% and 88% while specificity was 96% and 100% respectively.[11]

Methods

This study was conducted in Lahore General Hospital, Lahore and Services Hospital, Lahore from 01-07-2017 to 31-01-2020. A total of 36 pregnant patients with previous cesarean section having initial

gray scale ultrasound documentation of placenta previa at gestation of≥ 32 weeks were included in the study. Women with ultrasound findings of upper uterine segment placenta were excluded. Informed and written consent of patients were taken. Both color doppler USG and MRI were performed and read for all the women in the study group by a radiologist who had more than 10 years of experience at Lahore General Hospital, Lahore. Patients were operated at Services hospital, Lahore. Ultrasound and MRI findings were recorded and tabulated. Findings were compared to intraoperative findings to identify the accuracy of imaging modality. These included location of placenta, loss of retroplacental hypo echoic clear zone, visualization of abnormal increased vascularity, presence of placental lacunae, decreased myeometrial thickness, loss of uterine serosa bladder interface and invasion of surrounded structures on color doppler USG. MRI findings for PAS included location of placenta, loss of junctional zone (heterogeneous signal intensity), presence of dark bands on T2W sequence, focal interruption in the myometrium, loss of uterine bladder interface and invasion of surrounding structures. Other findings suggestive of PAS on MRI included focal thinning of myometrium, localized outer bulge of uterus due to mass effect of placenta. All these findings were confirmed against gold standard intra operative findings. 31 out of 36 cases which were positive for PAS were statistically evaluated. Contingency tables were developed to identify the diagnostic accuracy of Color Doppler USG and MRI for PAS taking intra-operative findings as gold standard. p values for both USG and MRI were calculated. For comparison of categorical data Fisher Exact test was performed. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), accuracy, positive likelihood ratio and negative likelihood ratio were also calculated for color doppler USG and MRI. p value less than 0.005 was considered statistically significant. Results were calculated with SPSS (Statistical Package for Social Sciences) version 20.

Sensitivity =True positive÷[True positive + False negative].

Specificity =True negative÷[True negative + False positive].

Positive predictive value=True positive÷[True positive+ False positive].

Negative predictive value=True negative÷[True negative + False negative].

Overall accuracy=[True positive+True negative

]÷ All sample.

Positive likelihood ratio = sensitivity ÷ [1-specificity].

Negative likelihood ratio = [1-sensitivity] ÷ specificity.

Results

A total of 36 patients were included in the study. Age of patients ranged from 22-43 years. (mean age 29.16 years). **Table-1** shows the subdivision of placenta previa according to the placental position in relation to internal cervical Os.[12] Placenta previa was sub divided into low lying placenta, marginal previa, complete previa and central previa. Out of these 36 patients 31 had PAS confirmed intra-operatively. While pre-operativly 30 patients on color doppler USG and 31 patients on MRI had diagnosis of PAS as shown in **Table-2&3**. Color doppler USG overestimated 1 case and underestimated 2 cases while MRI overestimated and underestimated 1 case each. MRI has statistically higher diagnostic accuracy (p value 0.0004) than color doppler USG (p value 0.001). **Table-4** shows the diagnostic performance of color doppler USG and MRI. Color doppler USG has sensitivity of 93% (95% confidence interval [CI], 77%-98%) and specificity of 80% (95% CI, 29% to 98%). MRI has sensitivity of 96% (95% CI, 81% to 99%) and specificity of 80% (95% CI, 29% to 98%). We found no significant difference in specificity of both imaging modalities but sensitivity of MRI is more than color doppler USG. Visceral Injury was noted in 11.5% patients as given in **(Table-II)** .

Table-1: Subtypes of placenta previa

Placental Location	No of Patients	%Age
Low Lying Placenta	01	2.7%
Marginal Previa	06	16.6%
Complete Previa	13	36.1%
Central Previa	16	44.4%

Table-2: Color doppler USG and intra operative findings cross tabulation. N=36

Diagnosis on Ultrasound	Diagnosis on intra-operative findings		Total
	Morbidly Adherent Placenta	Non adherent Placenta	
Adherent Placenta	29	01	30
Non Adherent Placenta	02	04	06
Total	31	05	36

p value= 0.0012

Table-3: MRI and intra operative findings cross tabulation. n=36

Diagnosis on MRI	Diagnosis on intra-operative findings			
	Morbidly Adherent Placenta	Adh-erent Placenta	Non adherent Placenta	Total
Morbidly Adherent Placenta	30		01	31
Non Adherent Placenta	01		04	05
Total		31	05	36

p value= 0.0015

Table-4: Statistical analysis of diagnostic performance of color doppler ultrasonography and MRI.

Statistical Analysis	Color Doppler USG	MRI
Placenta Previa (no invasion)	6/36 (16.6%)	5/36 (13.88%)
PAS(morbidly adherent placenta)	6/36 (83.33%)	31/3 (86.11%)
True positive	29	30
False positive	01	01
True Negative	04	04
False Negative	02	01
Sensitivity	93.54%	96.77%
Specificity	80%	80%
Accuracy	91.66	94.44%
Positive Predictive Value	96.6%	96.77%
Nagitive Predictive Value	66.66%	80%
Positive likelihood ratio [95% confidence interval]	4.67(0.80-27.06)	4.83(0.83-27.96)
Negative likelihood ratio [95% confidence interval]	0.08(0.01-0.33)	0.04(0.005-0.300)

Color doppler USG and MRI findings were matching in 29 out of 36 cases (80.55%) while they were discordant for diagnosis in 5 out of 36 patients (13.88%). **Table No-5** and 6 show color doppler USG and MRI imaging findings of PAS in positive cases. Multiple findings were present in single patient.

Discussion

Placenta accreta spectrum is a relatively new term . It encompasses placenta accreta, placenta increta as well as placenta percreta.[4] Risk factors for this disorder include manual removal of placenta, overzealous curettage of uterus prior to pregnancy, myomectomy, previous cesarean section and placenta previa. Cesarean section scar in the uterus causes abnormal anchoring of trophoblastic villi into the myometrium. Risk of PAS increases with increasing number of cesarean sections as well as with placenta previa.[13] Here placenta overlies the uterine scar which predisposes to deep anchoring of villi. Massive hemorrhage can lead to disseminated intravascular coagulation, adult respiratory distress syndrome, organ failure and even death.[14] Prenatal mapping of placenta can prove life saving. For prenatal diagnosis ultrasound remains the primary modality. In a meta analysis by D'Antonio F et al, the over all sensitivity of USG was 90.72 % and specificity was 96.94%.[15] According to this study color doppler USG had best predictive accuracy. In our study the sensitivity of ultrasound is 93.54% while specificity is 80.00 %. MRI is another promising investigation. It is of special help in posteriorly located placenta.[16] As fetal parts obscure the placenta, ultrasound may find it difficult to exactly define the depth of placental invasion into myometrium. Depth of invasion and extension of placenta into surrounding structures can be mapped with MRI. However inter observer agreement may vary for interpretation of different MRI features.[17] Features specifically looked For PAS in MRI are heterogeneous signal intensity However inter observer agreement may vary for interpretation of different MRI features.[17] Features specifically looked for PAS in MRI are heterogeneous

Table-5: Color doppler USG findings in proved cases of PAS (31 cases).

Item	abnormal clear space /loss of retroplacental zone	Decreased myeo-metrial thickness	Placental lacunae	Loss of bladder uterine interface	Invasion of surrou-nding structures	Hyper vascularity
No. of Cases	20/31	13/31	22/31	11/31	09/31	23/31
Sensitivity	64.51%	41.9%	70.96%	35.48%	29.03%	74.19%

Table-6: MRI findings in proved cases of PAS (31 cases).

Item	Heterogeneous signal intensity/ loss of junctional zone	Focal interruption in myometrium	Dark intrapla-cental bands	Loss of bladder uterine interface	Invasion of surrou-nding structures	Uterine bulging
No. of Cases	24/31	21/31	18/31	12/31	16/31	19/31
Sensitivity	77.4%	67.74%	58.06%	38.70%	51.6%	61.29%

signal intensity within the placenta, dark intraplacental bands on T2 weighted images, focal interruptions in myometrial walls, tenting of the urinary bladder and direct visualization of the invasion of pelvic structures by placenta.[18] Whereas abnormal uterine bulging is a unique feature picked up by MRI which is specific to placenta accreta.[19] In our study loss of junctional zone was present in 24/31 (77.41%) proven cases of PAS. It was the most significant MRI feature followed by focal interruption in the myometrium in 21/31 (67.74%)proven cases of PAS. In the study of Alamo L et al, the most significant MRI feature was dark intra placental bands.[17] Rahaim NS et al, reported the sensitivity of MRI as 75-100% and specificity 65-100%.[19] In our study sensitivity and specificity of MRI is found to be 96.77 % and 80.00 % respectively. While in the study of Hashem LB et al the sensitivity of MRI was 80.00% and specificity was 85.71% .[18] Ultrasonographic features of PAS include loss of the normal retro-placental clear zone, myeometrial thinning, hyper vascularity on color doppler USG, loss of bladder uterine serosa interface, intraplacental lacunae and extension of placenta into surrounding structures.[20] Intraplacental lacunae with turbulent flow create a`moth- eaten` or `Swiss cheese` appearance. These appear as dark bands on MRI.[21] It is the presence of these placental lacunae that has the highest sensitivity in diagnosis of placenta accreta spectrum on color doppler USG. Its sensitivity and specificity is reported to be 86.9-100% and 78.6-97.2% respectively by Yang JI et al,[22] Japaraj RP et al, reported interface hyper vascularity with abnormal vessels linking placenta and bladder as the most prominent color doppler USG feature for the diagnosis of placenta accreta.[23] Loss of retroplacental clear zone signifies the morbid adherence of placenta with uterus. However it is also seen in normal pregnancies.[24] In our study we found hyper vascularity with abnormal vessels as the most frequently encountered feature on color doppler USG in 23/31 (74.19%) proved cases of PAS. For the prenatal mapping of PAS, MRI and color doppler USG are supportive investigations.The strength of our study is that it compared the accuracy of color doppler USG and MRI against gold standard intra operative findings in the same group of patients. The limitation of our study is that we had a relatively small sample size as MRI is an expensive and time consuming modality. Second limitation is that only those patients were selected for the study who were high risk for PAS on the basis of clinical history and gray scale USG.

Conclusion

Color doppler ultrasound and MRI are comple-mentary investigations. MRI has superior sensitivity than color doppler USG but the specificity of both modalities are same for antenatal diagnosis of PAS. Color doppler USG should be used as primary diagnostic tool however in doubtful cases of posteriorly located placenta MRI can be of valuable help.

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