Role Of Diagnostic Imaging And Surgical Outcomes In Abnormal Placental Invasion Spectrum Associated With Prior Caesarian Delivery Patients: A Prospective Case Series From Western India

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Abstract: Background: The aim of our study was to explore the demographics, surgical outcomes and performance of diagnostic imaging modalities namely Ultrasound and Magnetic Resonance Imaging for predicting abnormal placental invasion spectrum in females with history of past caesarian sections. Materials & Methods: We conducted a prospective study from February 2017 till December 2019 at a tertiary referral public hospital in western India. During this time-period we had 26 females satisfying our study criteria. They were subjected to imaging diagnostics to confirm abnormal placental invasion disorder in their present pregnancy. The imaging findings were compared with the final findings at the time of delivery and pathological examinations of placental specimens. Results: More than two thirds of our study patients were young and belonged to the age group of twenties (mean age 29.5 +/- 4.64). Half of them were 3rd gravidas and 77 % (> 3/4 th) of them were diagnosed in their second trimester of pregnancy. Majority of them had history of single past caesarian delivery and the commonest indication for performing it was placenta praevia. Both Ultrasound and MRI were found to be fairly accurate in diagnosing abnormal placental invasion with good sensitivities. Overall, in our series MRI scored an upper hand as a diagnostic imaging modality in posteriorly implanted placentas and cases with ambiguous USG findings. Conclusion: Both diagnostic imaging modalities USG and MRI can predict abnormal placental invasion spectrum with high sensitivity in the antenatal period. These imaging modalities can have a complimentary role, although MRI was found to be superior over USG in our case series with inconclusive findings. [Bhojwani N Natl J Integr Res Med, 2021; 12(1):22-29]

Key Words: Abnormal Placental Invasion; Prior C- section ; Ultrasound; MRI ; Diagnostic Imaging.

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Introduction: Abnormal Placental Invasion (API) is defined as abnormal adherence of placenta to the uterine wall. It occurs due to defect in decidua basalis and is followed by invasion of uterine myometrium by placental chorionic villi. Based on degree of invasion of placenta into uterine myometrium, API is classified as Accreta vera, Increta and Percreta.[1] In placenta accrete vera (PA), the chorionic villi invade upto the surface of uterine myometrium. Placenta Increta (PI) occurs when the villi invade deep into myometrium sparing the serosa. In Placenta Percreta (PP) the severest variety, chorionic villi penetrate entire myometrium including serosa.[2] PP is the rarest and most severe form of API which can involve urinary bladder wall, rectum and sigmoid colon.[3,4]

The placenta is the primary biological link between the mother and the fetus, and any problems in the placenta will affect both the fetus and the mother. If API is not detected antenatally, it can be life-threatening to both mother and fetus.[5] Hence prenatal diagnosis is essential for planning and multidisciplinary management to reduce morbidity and mortality.[6]

API is associated with high morbidity and mortality during delivery, because the resulting hemorrhage can lead to multisystem organ failure, disseminated intravascular coagulation, emergency surgical intervention like hysterectomy, and even death.[7-9] API is reported to be the most common reason for both hysterectomy associated with caesarean delivery10, and peripartum hysterectomy.[11] It also is a rare but important contributor to maternal mortality worldwide.[12]

The incidence of API has increased globally primarily due to increasing rates of caesarean section delivery worldwide. Various reports suggest that API occurred in approximately 1 in 4000 deliveries in the 1970s, 1 in 2500 deliveries in the 1980s, and, more recently, it occurs in roughly 1 in 533 to 1 in 730 deliveries.[13]

There is no published data regarding the incidence of API in the Indian population. And therefore, identification and management of API is a big clinical and diagnostic challenge here which is now being encountered with increasing frequency.

The most relevant and reported clinical risk factors for API include prior caesarean delivery, placenta previa, advanced age at pregnancy, smoking, and history of uterine surgery.[14,15] Among them, prior caesarean delivery and placenta previa are universally accepted key risk factors.[16,17]

Our study aims to evaluate the role of ultrasonography (US) and magnetic resonance imaging (MRI) in antenatal diagnosis of abnormal placental invasion and to compare the accuracy of these two modalities in a high-risk subset of prior caesarean delivery patients with API.

Materials & Methods: Our study was designed as a prospective and collaborative study between the Departments of Radiology, Obstetrics and Gynecology and Pathology of a tertiary level referral centre located in western india. Institutional board approval and a written informed consent were obtained from all patients participating in our study for undergoing MRI. 26 females attending/referred to the Radiology department during the time period of February 2017 till December 2019 and fulfilling the inclusion criteria were enrolled in our study.

Following Were Inclusion Criteria For Our Study:

1. All pregnant females had positive history of atleast 1 prior C-section.
2. Abnormal placental invasion detected incidentally on antenatal growth scans.
3. Clinically suspicious cases of abnormal placental invasion based on past Obstetric history of previous caesarean sections and confirmed on imaging.

All these included patients underwent a detailed clinical examination and documentation of previous obstetric and surgical history. They underwent USG and non-contrast MRI. The USG examination and interpretation of MRI images was done by two separate radiologists with >5 years of experience in radiology, respectively. Both radiologists were blinded with the results of either of the imaging modality. There was no specific gestational age at which imaging was performed. Majority of the patients presented to us in the third trimester of their pregnancy.

Following Were The Exclusion Criteria In Our Study:

1. Patients with contraindication to MRI
2. Claustrophobic patients.

USG evaluation: All patients underwent obstetric USG evaluation via trans abdominal or trans vaginal scans using standard gray-scale and color Doppler settings. Ultrasound scans were performed on Samsung Accuvix XG machine having following probe details:

3. Convex probe: 2-6 MHz
4. Linear Probe: 5-13 MHz.

Patients were examined via transabdominal suprapubic approach with sufficient Urinary bladder distension. The ultrasound probe with convex transducer of 3.5 MHz and Linear transducer of 7.5 MHz was used. Gray-scale B-scan USG was performed first to screen the fetus and placental tissue, followed by color Doppler studies.

Findings Assessed Using Grey Scale USG And Color Doppler Studies Were

1. Placenta praevia
2. Loss of retroplacental clear space,
3. Myometrial thinning
4. Direct visualisation of placenta invading myometrium.
5. Abnormally raised vascularity of placenta and urinary bladder wall.

On ultrasound, based on degree of placental invasion, they were graded as

Placenta Accreta: Loss of retroplacental clear space with myometrial thinning.

Placenta Increta: Placenta invading the myometrium, however the clear echogenic line separating urinary bladder and placenta is preserved. Outer serosal margin of Uterus appears uninvaded.

Placenta Percreta: Placenta invades myometrium entirely with loss of echogenic serosa of uterus. Loss of echogenic line between placenta and urinary bladder. Increased vascularity of placental tissue within urinary bladder on colour doppler study was defined as urinary bladder involvement.

MRI Evaluation: All study patients underwent non-contrast MRI evaluation on 1.5 T MRI scanners (Achieva; Philips Medical System, Netherlands). To assess the placenta percreta, urinary bladder was partially filled. Gd contrast was not used in any of our patients. A phased array surface coil was used. T2-weighted TSE(turbo spin echo) (829ms/min repetition time, 90ms/echo time, with 300x224 matrix, 4mm slice thickness with 1mm slice gap, receiver bandwidth of 125kHz) was acquired in the axial, sagittal, and coronal planes. T1 weighted (TFE) sequence is acquired in coronal plane 10ms/min repetition time, 4.6ms/min echo time (TE), 78 TFE factor , flip angle 15 degree, matrix :332x346, slice thickness 4.5mm with 1mm slice gap, receiver bandwidth 125Khz. T2-weighted fat sat sequence (614ms/min repetition time,80ms/echo time, with 332x346 matrix, 4.5mm slice thickness with 1mm slice gap, receiver bandwidth of 125kHz) was acquired in coronal planes. T2 weighted VISTA repetition/echo times of 2000/200 ms, 94 TSE factor 152x101 data matrix, slice thickness 3.0 mm with no slice gap receiver bandwidth 125khz) in axial plane were also acquired.

All these sequences were acquired during maternal breath holding. If placenta accreta was suspected on preliminary survey, additional images in planes perpendicular to the placenta–myometrium or myometrium-bladder interface were obtained.

On T2W images, following signs of API were noted:

1. Placenta praevia.
2. Loss of normal inner hypointense myometrium with intermediate signal intensity placenta in myometrium.
3. Uterine bulge.
4. Placental bulge.
5. Heterogenous signal intensity of placenta.
6. Dark intraplacental bands.
7. Direct visualisation of placenta invading. or tenting the bladder wall.
8. Abnormal disorganized placental vascularity.
9. Focal interruptions in the myometrial wall.
10. Direct visualization of invasion of pelvic structures by the placental tissue.
11. Bladder wall nodularity.

The USG and MRI findings noted were then compared with the final diagnosis determined at delivery and/or pathologic examination.

Statistical Analysis: Since we didn't have normative obstetric database for comparison available for our hospital, we could not calculate detailed statistical values for API. However based on available data we were able to calculate sensitivity and positive predictive value (PPV) for both USG and MRI.

Result: We enrolled 26 patients satisfying the above stated criteria in our prospective study.

Table 1 Shows The Baseline Demographics Of These Patients.

No	Age (Years	Gravidity	Parity	Gestational age at diagnosis (weeks)	Presenting complaints	Placental Location	USG	MRI	Tissue Microscopy Findings	Outcome
1	30	3	2	32	Incidental	Left lateral	NEGETIVE	POSITIVE	Percreta	Uneventful
2	32	2	1	33	Incidental	Anterior, Grade IV Previa	POSITIVE	POSITIVE	Percreta	Baby died after birth
3	26	3	2	15	Incidental	Posterior	POSITIVE	POSITIVE	NEGETIVE for API	90 grams Abortus delivered
4	39	5	3	34	Incidental	Anterior towards maternal left	POSITIVE	POSITIVE	Accreta	Uneventful
5	23	2	1	32	Incidental	Anterior	POSITIVE	POSITIVE	Percreta	Uneventful
6	30	2	1	37	Incidental	Grade IV previa	POSITIVE	POSITIVE	Percreta	Uneventful
7	25	2	1	33	Incidental	Grade IV previa	POSITIVE	POSITIVE	Accreta	Uneventful
8	40	5	3	35	Incidental	Grade IV previa	POSITIVE	POSITIVE	Increta	Uneventful
9	24	4	2	35	Incidental	Grade IV previa	POSITIVE	POSITIVE	Percreta	Uneventful
10	24	2	1	33	Spotting PV	Anterior Grade IV Previa	POSITIVE	POSITIVE	Percreta	Patient and baby both died
11	32	3	2	33	Incidental	Grade IV previa	POSITIVE	POSITIVE	Increta	Uneventful
12	34	6	3	33	Incidental	Anterior, left lateral Grade IV Previa	POSITIVE	POSITIVE	Increta	Uneventful
13	28	3	2	32	Incidental	Anterior, left lateral Grade I Previa	POSITIVE	POSITIVE	Increta	Uneventful
14	33	6	5	33	Spotting PV	Anterior, left lateral Grade IV previa	POSITIVE	POSITIVE	Increta	Uneventful
15	28	3	2	32	Incidental	Anterior, right lateral Grade IV Previa	POSITIVE	POSITIVE	Increta	Uneventful
16	29	3	1	22	Incidental	Grade IV previa	POSITIVE	POSITIVE	Percreta	Patient and baby both died
17	28	2	1	25	Incidental	Grade IV previa	POSITIVE	POSITIVE	Percreta	Baby died after birth
18	24	3	1	38	Incidental	Grade IV previa	POSITIVE	POSITIVE	Accreta	Uneventful
19	38	3	2	36	Incidental	Grade IV previa	POSITIVE	POSITIVE	Accreta	Uneventful
20	25	3	2	34	Incidental	Posterior Grade IV Previa	NEGETIVE	POSITIVE	Increta	Uneventful
21	25	4	2	20	Incidental	Grade IV previa	POSITIVE	POSITIVE	Percreta	Uneventful
22	30	4	3	34	Incidental	Grade IV previa	POSITIVE	POSITIVE	Increta	Uneventful
23	30	2	1	25	Incidental	Posterior, anterior Grade IV Previa	POSITIVE	POSITIVE	Increta	Uneventful
24	28	3	2	34	Incidental	Anterior, Grade IV Previa	POSITIVE	POSITIVE	Increta	Uneventful
25	31	3	2	15	Incidental	Grade IV previa	NEGETIVE	POSITIVE	Accreta	Uneventful
26	31	3	2	32	Incidental	Grade IV previa	POSITIVE	POSITIVE	Percreta	Patient died.Baby survived.

Majority of the females in our study were in the age group of twenties (69%). The mean age of females in our study group was with 29.5 (SD + 4.64) years. The youngest female was of age 24 years and the eldest one was 40 years old. And nearly half of the patients were 3rd gravida and 2nd parous. Interestingly, 20 females (77%) in our study group were diagnosed in their third trimester of pregnancy.

Table 2 shows the relation of number of previous LSCS with present pregnancy abnormal placental invasion.

Table 2: Corelation with number of previous Caesarian deliveries.

Number of Previous Caesarean Section delivery	Number of Patient	Percentage (%)
Previous 1 CS	16	62
Previous 2 CS	6	23
More than 2 CS	4	15

62% of patients in our study had single previous LSCS, 23% cases had previous 2 LSCS and 15% cases had more than past 2 LSCS.

Table 3 shows correlation of previous Caesarian delivery indication with present placental invasion.

Table 3: Indication of prior Caesarian deliveries.

Indication of Previous CS	Number of Patients	Percentage (%)
Placenta Previa	13	50
Malpresentation	5	19
Delayed Labour	6	23
PIH and related disorders	1	4
Meconium aspiration syndrome	1	4

Nearly half of cases had previous LSCS done for Placenta Praevia followed by delayed labour in 23 % cases.

Figure 1

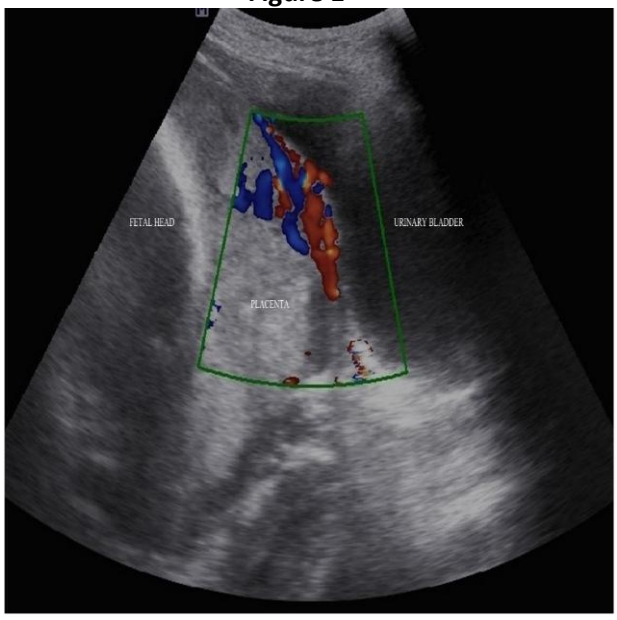


Figure 2

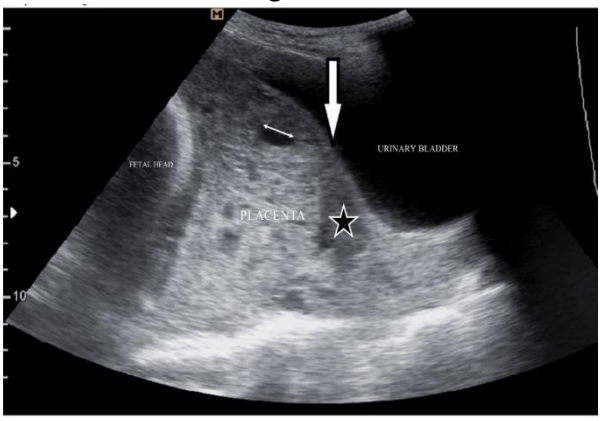


Figure 3

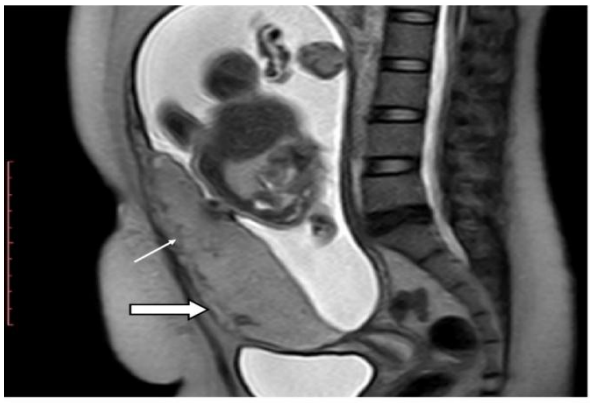
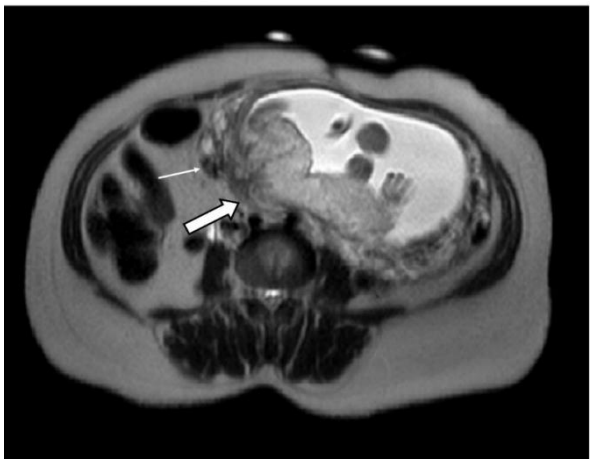


Figure 4



After analyzing the data we found out that USG had a sensitivity of 88% with a positive predictive value of 95.65% in our case series. While, MRI had a sensitivity of 100% with a positive predictive value of 96.15%. Since we did not screened normal healthy pregnant women with prior Caesarian deliveries we were unable to calculate specificity and negative predictive values for USG and MRI. USG and MRI were discordant in their diagnosis in 3 out of 26 cases. Among the discordant cases, MRI was found to be correctly leading to the diagnosis in all these 3 cases. In a single case both USG and MRI pointed

towards Placenta accreta but intra operative the case came out negative for it.

There were 3 maternal deaths during delivery time in our study. Figures 1-4 represent some of our study cases.

Discussion: Prior caesarian delivery is one of the relevant and universally reported risk factor for API. The association of API with past caesarian sections is believed to be secondary to malrepair of the endometrium and/or decidua basalis. With every subsequent pregnancy, the growing cytotrophoblasts invade decidualized endometrium where they fail to encounter the restrictive spongiosus layer and without getting normal physiological signal to stop they continue invading it to an abnormal degree.[18] This theory is supported by histopathologic evaluation of API specimens which shows trophoblastic invasion of the myometrium without evidence of a decidual layer in between.[19]

Other accepted pathophysiological theory for API is the theory of relative hypoxia of cesarean scar tissue (resulting from fibroblast-based repair and decreased vessel concentration) which recruits blastocytes preferentially in areas of scars.[20,21] This theory is supported by higher association of API with multiple caesarian sections.

Advance maternal age (>35 years) without previous history of C-section is also an important risk factor published in many studies.[24] In contrast to that, majority patients in our study group were young (<30 years). This difference could be attributed to diverse demographics of developing country like India, prevailing high illiteracy and low socioeconomic conditions leading to early marriages of women and multiple childbirths. Also, since our study was conducted at a tertiary care centre which serves poor community and a referral centre for high risk pregnancy cases, we ended up with a younger subset of women in our study.

API commonly occurs in multiparous women, more common in those with single prior cesarean delivery.[22] In our study all patients were also multiparous. Majority of them being 3rd gravida and 2 parous.

Higher the number of C-sections higher is the risk of API and placeta praevia.[23] Silver et al have estimated the risk of placenta accreta in women with a known placenta previa to be 3%, 11%, 40%, 61%, and 67% for first, second, third, fourth, and fifth or more cesarean deliveries, respectively.[24] In other words, the presence of a placenta previa should increase the clinician's suspicion for a possible API. We also had similar observation in our study group viz. Placenta Praevia was found to be the commonest indication for performing C- section in their past pregnancies.

Pre-delivery diagnosis of API enables multidisciplinary care and helps in improving the maternal and fetal outcomes.[25] Warshak et al. also observed that women with predelivery diagnosis of API had a better maternal outcome in terms of estimated blood loss and units of blood required.[26] The maternal mortality rate associated with API has been reported to around 7% in literature and in an Indian series, the maternal mortality has been reported as 30%.[27] Most of the deaths reported in the Indian studies were in women who were not diagnosed predelivery and those who were referred in a very poor condition. In our series the maternal mortality rate was relatively on lower side viz. 11.53% (3 mortalities in 26 cases). All 3 of them had Placenta Percreta, the severest form of API. Low maternal mortality in our Indian series can be attributed to prenatal diagnosis of abnormal placental invasion.

Imaging plays a pivotal role in diagnosing abnormal placental invasion disorders. Ultrasound and colour doppler studies have been the primary screening and diagnostic tool for placental evaluation.[28] The anomaly scan scheduled at 18-20 weeks of gestation gives the clinician an ideal opportunity to screen for this disorder.

Placenta previa, placental lacunae, abnormal color Doppler imaging patterns, loss of the retroplacental clear space, and reduced myometrial thickness have been described to aid in the diagnosis of API on ultrasound.[29] An irregular bladder wall also suggests the possibility of placenta percreta.30 Among all of them, placental lacunae has been reported to be the most sensitive and specific sign on ultrasound to diagnose API.[30,31] Many other Color Doppler features have been described to detect API like interface hypervascularity, abnormal blood vessels linking the placenta to the bladder with

high diastolic arterial blood flow, markedly dilated peripheral subplacental vascular channels with pulsatile venous-type flow over the uterine cervix, and absence of subplacental vascular signals in these areas lacking the peripheral subplacental hypoechoic zone.[32] All these ultrasound and color doppler diagnostic features were assessed in our study and were resonating with the reported evidence of API. Various studies have demonstrated that color Doppler imaging along with US has a high sensitivity (82–86%) and specificity (92–97%) in the diagnosis of placenta accrete.[33-35]

A major pitfall of US in the evaluation of API which we noted in our series was low reliability in cases with posteriorly located placenta. We were more confident of diagnosing API on imaging with MRI in such patients.

Recently MRI is gaining popularity in establishing accurate diagnosis of API in high risk pregancy cases and suspicious cases with US. The early MRI criteria for the diagnosis of API includes thinning and indistinctness of the myometrium, loss of thin T2 dark uteroplacental interface, and direct visualization of placental tissue within or outside the myometrium suggesting direct invasion of the placenta into the uterus.[36] These early signs on MRI are, however, nonspecific. Other MRI signs include irregular thick intraplacental T2 darkbands, marked placental heterogeneity, and bulging of the lower uterine segment.[37,38] Among all of them, Derman et al. postulated abnormal placental vascularity and intraplacental T2 dark bands were the most sensitive MR criteria for the diagnosis of API.[39]

Some authors have reported MRI to be a superior diagnostic imaging tool in posteriorly located placenta and more useful in patients with ambiguous USG findings. Others have suggested that MRI can better define areas of abnormal placentation, determine the levels of invasion, and ultimately change the surgical management.[40] We also agree on the above observation that MRI scores high over Ultrasound in such scenarios like posteriorly implanted placentas. Our study showed that USG and MRI both can diagnose API with adequate accuracy prenatally. Overall, we observed superiority of MRI over ultrasound in diagnosing API accurately in our series. Our results were similar to those of Dwyer et al.[35]They also reported that MRI was statistically better than USG in evaluation of depth of placental infiltration and more accurate in characterizing the topography of invasion.

The standard of care in a patient diagnosed with API is cesarean hysterectomy without attempting to separate the placenta.[2] In our study, all patients underwent a primary cesarean hysterectomy. Internal iliac ligation was also performed with cesarean hysterectomy in 30.76 % (8 out of 26 patients) of the patients secondary to intraoperative excessive ongoing hemorrhage.

Although many studies related to API are available in literature, only a handful of reports are available from the India.[28,36,41] The strength of our study are muiltifold viz. it is a real life prospective study, comparing the accuracy of USG and MRI in the same cohort of patients, separate and blinded radiologists performing and interpreting USG /MRI.

Today in practice it is believed that MRI has an upper hand over USG in diagnosing API. Our study was conducted to address the strengths and lacunae of diagnostic modalities. We intend to help radiologists understand and familiarize imaging modalities to diagnose API. Our study provides more realistic information about the diagnostic accuracy of these imaging modalities in a special subset group of patients who are at high risk for API. The major limitation of our study was its small sample size.

Conclusion: Both imaging modalities USG and MRI have good sensitivity to accurately diagnose API antenatally and can guide the obstretician for future course of treatment in these high-risk pregnancy cases. MRI scores over USG in cases with posteriorly implanted placentas and clinically suspicious patients with ambiguous USG findings.

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