
Evaluation of the diagnostic accuracy of designed ultrasound- based scoring system for prenatal diagnosis and differentiation of Morbidly Adherent Placenta (MAP).

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Abstract

Background: Accurate diagnosis of morbidly adherent placenta (MAP) and differentiation between its variants accreta, increta and percreta, allows preparation of life saving measures, and enables planning for alternative surgical procedures saving the future fertility according to the severity of the case.

Objective: Evaluate the accuracy of 2D, color Doppler, 3D and 3D power Doppler in the assessment of Morbidly Adherent Placenta (MAP) and the introduction of designed ultrasound-history based scoring system for prenatal diagnosis of (MAP), and differentiation between its variants in patients with previous cesarean section (CS) scar/s in correlation with the intraoperative findings.

Materials and Methods: Ninety five pregnant women with persistent placenta previa (after 28 weeks' gestation) and previous history of uterine CS scar/s with mean 2 (1-6) cesarean deliveries were enrolled into the study, with mean age 30.08 ± 7.01 years, gravidity 3.9 ± 1.1 and parity 2.4 ± 1.5 . All patients were evaluated with 2D, then color Doppler, Finally 3D and 3D power Doppler ,each US finding suggestive for Morbidly Adherent Placenta (MAP) take a score; the cumulative score compared with the intraoperative final diagnosis. The diagnostic accuracy was evaluated by receiver operating characteristic (ROC) analysis.

Results: 2D had sensitivity (87.4%), specificity (92%), PPV (97.6%) and NPV (65.7%) for diagnosis of Morbidly Adherent Placenta (MAP), while color Doppler had sensitivity (94.7%), specificity (92%), PPV (97.8%) and NPV (82.1%) , 3D power Doppler had sensitivity (93.7%) ,specificity (100%), PPV (100%) and NPV (80.6%) , finally 3D section of the bladder interface had sensitivity (62.1%), specificity (100%), PPV (100%) and NPV (41%). The diagnostic accuracy of the scoring system by using degree of agreement (ROC curve) was (0.049) for 3D power Doppler, (0.049) for 2D US and (0.053) for color Doppler in diagnosis of MAP. The area under the ROC curve was significantly equivalent to all tools of diagnosis (for 3D power Doppler 1.000, 2D US 0.975, color Doppler 0.967 and for overall scoring 0.979).

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Conclusion: 3D power Doppler as an additional tool for diagnosis of MAP had the best sensitivity (93.7%), specificity (100%), PPV (100%) and NPV (80.6%) followed by color Doppler with sensitivity (94.7%), specificity (92%), PPV (97.8%) and NPV (82.1%) and lastly 2D US with sensitivity (87.4%), specificity (92%), PPV (97.6%) and NPV (65.7%), and the introduction of the scoring system facilitates the diagnosis and differentiation between MAP variants with scores (8-12 for accreta, 13-18 for increta, 19-25 for focal percreta and > 25 for diffuse percreta), so life saving and fertility preservation procedures could be probably planned

Key words: placenta ,ultrasound ,scoring , morbidly.

INTRODUCTION

Morbidly adherent placenta (MAP) is a term used to describe the clinical condition when part or the entire placenta invades and becomes inseparable from the uterine wall (1).

In normal pregnancy; the Decidua prevents the placenta from invading the uterine wall, while in MAP, the Decidua (Nitabuch's layer) is thin or deficient due to scar defect from prior CS scar/s (2). Therefore in MAP, placenta acts like an invading tumor and how deeply the placenta attaches determines the severity of the case , and so MAP may develop and worsen as pregnancy progresses (3).

Placenta previa with previous cesarean section/s are the main risk factors for MAP, and what is more important, factors related to the closure technique, development of the lower uterine segment, location of the incision and the wound healing which may have an impact in the incidence of placenta accreta (4-6). If no prior cesarean scar with placenta previa the risk of MAP is 5%, while with one prior cesarean scar the risk increases to 24%, with two prior cesarean scars the risk 40% and with four prior cesarean scars the risk reaches 67%, and if the caesarean rates continue to rise as they have in recent years,

there will be an additional increase in MAP rates (6). So accurate diagnosis of MAP and differentiation between its variants allows preparations for a possible obstetric emergencies (7) or the use of alternative surgical procedures saving the future fertility according to the severity of the case (8).

PATIENTS AND METHODS

This retrospective study was carried out in Mansoura University Hospital, Obstetric and Gynecological Department together with women imaging center of Professor / Magda Shady between May 2013 to May 2017. Ninety five pregnant women with persistent placenta previa (in third trimester) and previous history of uterine CS scar/s with mean 2 (1-6) cesarean deliveries were enrolled into the study, with mean age 30.08 ± 7.01 years, gravidity 3.9 ± 1.1 and parity 2.4 ± 1.5 (table 1). All patients were subjected by the same operator to 2D, color Doppler, then 3D and 3D power Doppler using (Voluson E8 expert), the sonographic data of all patients were reviewed, calculating their sensitivity, specificity and predictive values, while images interpretations were guided by parameters listed in tables (2, 3, 4, 5, 6), then a score was given to each criteria for diagnosis of MAP and the cumulative score was calculated compared with the scoring system listed in table (7). The scoring results were compared with operative findings and the results were statistically analyzed using SPSS software, Chi-square, T-test, Monte Carlo test, Kruskal-walis test and ROC Curve.

RESULTS

Among this study patients were divided in to four groups: accreta, increta, focal percreta, and diffuse percreta.

MAP and its variants were confirmed in 95 patients at the time of Cesarean delivery (intraoperative), in which placenta accreta (n= 13, 14% %), placenta increta (n=24,

25%) percreta focal (n=20, 21%) and diffuse percreta (n=38, 40%).

According to the history (table 1) the number of CS scars had significant difference between groups ($P = 0.001$), but past history of placenta previa had no significant difference ($P = 0.3$), each historical criteria take a score then the sum of them give score (3-5) for MAP.

In order to test the accuracy of sonographic criteria for the diagnosis of all types MAP (accreta, increta, percreta), 2D sonographic data (table 2, 3) revealed that: Type of the placenta had significant difference between groups ($P = 0.001$), as more severe cases associated with anterior placenta previa complete centralis.

Myometrial thinning had sensitivity (47.4%), specificity (100%), PPV (100%) and NPV (33.3%), when the myometrium partially lost or completely absent or had placental bulge / exophytic mass it had specificity (100%), PPV (100%) with sensitivity (20, 87.4, 16.8% respectively) and NPV (24.8, 67.6, 23.8% respectively).

As regarded lacunae, suggested cut off value for Lacunar number (5 lacunae) had sensitivity (38.9%), specificity (92%), PPV (94.9%) and NPV (28.4%), and cut off value of lacunar size (2 cm) had sensitivity (61.1%), specificity (72%), PPV (89.2%) and NPV (32.7%), these cut off values help in decreasing bias, as regarded lacunar shape, branching ones were found to be associated with severe cases of MAP ($P=0.001$), and when both lacunae eye of typhoon and lacunae continuous with bladder wall added to the lacunar evaluation specificity and PPV increase to (100%) but with low specificity (5.2, 6.3 respectively).

Disrupted bladder had specificity and PPV (100%), but with lower specificity (11.6%) and NPV (22.9%).

The overall sensitivity of 2D US (87.4%), specificity (92%), PPV (97.6%) and NPV

(65.7%) for diagnosis of MAP, each criteria described above take a score then the sum of them give score to each MAP variant (accreta=5-8, increta=9-12, focal percreta=13-18, diffuse percreta= >18).

As regarded color Doppler criteria for diagnosis of MAP (table 4):- Hypervascularity was found to have sensitivity (95.8%), specificity (68%), PPV (91.9%) and NPV (81%), and with its classification to mild, moderate and marked there was significant difference between groups ($P=0.000$), within the hypervascularity the presence of gap had sensitivity (61.1%), specificity (88%), PPV (95.1%) and NPV (37.3%), and The blood flow PVS more than 15 cm had sensitivity (50.5%), specificity (96%), PPV (98%) and NPV (33.8%).

With over all sensitivity of the color Doppler (94.7%), specificity (92%), PPV (97.8%) and NPV (82.1%). For diagnosis of MAP, each criteria described above take a score, the sum of them give score to each MAP variant (accreta=2-4, increta=5-7, percreta>7).

With 3D power Doppler (table 5), we had to examine two views:-

(A) Basal (sagittal) view: - Numerous coherent vessels including the bladder interphase and the placental base had sensitivity (64.2%), specificity (100%), PPV (100%) and NPV (42.4%). Lacunar aneurysm had sensitivity (26.3%), specificity (100%), PPV (100%) and NPV (26.3%).

(B) Lateral (coronal) view:- The presence of blood vessels passing perpendicular to the uterus had sensitivity (75.8%), specificity (96%), PPV (98.6%) and NPV (51.1%). **Chaotic branching & detour vessels** at the bladder interphase, **had sensitivity** (82.1%), specificity (96%), PPV (98.7%) and NPV (58.8%). The resistance index (RI) was measured at 3 different points on bladder wall then the lowest value was used to be our referral to identify high risk cases, with cut off value less than 0.4, with sensitivity (98.9%),

specificity (64%), PPV (91.3%) and NPV (94.1%).

With over all sensitivity of the 3D power Doppler (93.7%) and specificity (100%), PPV (100%) and NPV (80.6%) for diagnosis of MAP, each criteria described above take a score and the sum of them give score to each MAP variant (≤ 4 =Focal percreta and > 4 =Diffuse percreta).

Finally 3D US section at the bladder interface shows (table 5):- interrupted bladder mucosa which had sensitivity (62.1%), specificity (100%), PPV (100%) and NPV (41%) ,the presence of this criteria take score 3 in case of placenta percreta only ,to be added to the previous scores.

A total score made by the sum of previous scores for diagnosis and differentiation of MAP and its variant (accreta=8-12, increta=13-18, focal percreta=19-25, diffuse percreta= > 25).

Based on the criteria described above (preoperative) when compared with intraoperative findings, 3D power Doppler as an additional tool for diagnosis of MAP had the best sensitivity (93.7%), specificity (100%), PPV (100%) and NPV (80.6%) followed by color Doppler with sensitivity (94.7%), specificity (92%), PPV (97.8%) and NPV (82.1%) and lastly 2D US with sensitivity (87.4%), specificity (92%), PPV (97.6%) and NPV (65.7%) (table 6).

The diagnostic accuracy of the scoring system by using degree of agreement (ROC curve) was (0.049) for 3D power Doppler, (0.049) for 2D US and (0.053) for color Doppler in diagnosis of MAP. The area under the ROC curve was significantly equivalent to all tools of diagnosis (for 3D power Doppler 1.000, 2D US 0.975, color Doppler 0.967 and for overall scoring 0.979) (figure 7).

DISCUSSION

The main core of prenatal diagnosis of MAP and its variants in cases of placenta previa

with previous cesarean scar /s is to reduce maternal and fetal morbidity and mortality due to lack of adequate preparation at time of delivery (1).

The introduction of clinical and ultrasound scoring system for the diagnosis of MAP and its variants (accreta, increta, percreta), could be helpful for improvement of the diagnostic performance and management.

In the current study diagnosis of MAP and its variants (accreta, increta and percreta) was confirmed in 95 patients, placenta accreta represented (n= 13, 14%), placenta increta (n=24, 25%) focal percreta (n=20, 21%) and diffuse percreta (n=38, 40 %).

Cases with placenta accreta had less number of previous CS scars and no past history of placenta previa, by sonographic evaluation they associated with anterior placenta centralis (n=6), anterior placenta marginalis (n=5) and posterior placenta centralis (n=2), they had thinmyometrium and serrated bladder interface without abnormal vascularity, no lacunae or lacunae ≤ 5 in number, < 2 cm in size with regular shape and no vascularity.

While cases with placenta increta were associated with increasing number of previous CS scars and no past history of placenta previa ,the sonographic evaluation revealed that the majority of the cases had anterior placenta centralis (n=22), the myometrium may be thin , partially lost or even completely lost and disrupted bladder wall with hypervascularity and blood vessels passing parallel to the bladder wall having low RI < 0.4 , also had no lacunae or lacunaer number ≥ 5 with size ≥ 2 cm with irregular shape and with abnormal blood flow had PSV > 15 cm.

In cases with placenta percreta they had increasing number of previous CS scars with past history of placenta previa, the sonographic evaluation showed that the majority of the cases had anterior placenta centralis (n=56), and only few cases (n=2) seen with

posterior placenta centralis, they had complete myometrial loss with placental bulge / exophytic mass and hypervascularity with gap in, that differentiate cases of focal percreta from cases of diffuse percreta which have severe hypervascularity with no gap, and the bladder interface seen disrupted which may be focal or diffuse with blood vessel/s passing perpendicular to the uterus and according to their number we can differentiate between percreta types, by 3D power doppler they had hypervascularity with low RI < 0.4 , forming coherent, chaotic branching and detour vessels, they may have no lacunae or lacunae number ≥ 5 with size ≥ 2 cm with irregular shape or even branching ones open at bladder wall with abnormal blood flow had PSV > 15 cm, they may form lacunae aneurysm when their vascularity fuse with the vascularity of the bladder wall in cases of diffuse percreta, lastly by 3D section diagnosis of interrupted bladder mucosa which might be focal or diffuse.

The overall performance of 2D US for diagnosis of MAP had sensitivity (87.4%), specificity (92%), PPV (97.6%) and NPV (65.7%), so by 2D grayscale abdominal ultrasound we have an idea about cases highly suspected to be MAP and even we can localize the site of the myometrium defect which could have more vascularity and need more evaluation by Doppler US, and that was in agreement with Fatemeh Rahimi et al (9), who revealed ultrasound sensitivity and specificity reached to 71.4% and 88.5%: consecutively with accuracy of 87%, and the study carried out by Dwyer BK et al (10) who detected 2D US sensitivity 93% and specificity 71%.

Adding color Doppler the accuracy of diagnosis increases to sensitivity (94.7%), specificity (92%), PPV (97.8%) and NPV (82.1%), similar to our study, Levine D - et al (11) that showed color Doppler imaging with a sensitivity of (86%) and a specificity of (92%), while Shweel MAG et al (12) results with color doppler was (90%) for sensitivity

and (70%) for specificity, with the current study the high false positive (PPV 97.8%) results were observed because the majority of the cases had more than one previous CS with the formation of bladder varices and neovascularized vessels mistaken as abnormal bladder-uterine serosa interface hypervascularity which was assumed to be MAP and that was in agreement with Bonnie KD et al (13) and Cali G et al. (14,15), While the false-negative cases (NPV 82.1%) was mostly in cases evaluated early at 29-32 weeks and delivered later after 35 weeks, because MAP is a progressive condition that increase with increasing the period of pregnancy (16,17), also depending on more than one criteria increases the accuracy of diagnosis and differentiation of MAP and that agree with Shih et al (18).

Adding 3D power Doppler increases the accuracy of diagnosis and decreases the false negative and false positive results, and it was carried in two views (table 5):- Basal view:-the presence of numerous coherent vessels and lacunar aneurysm both had specificity (100%) and PPV (100%), they were found with more severe cases of MAP (diffuse percreta).

lateral view :-the presence of blood vessels passing perpendicular to the uterus, Chaotic branching & detour vessels had specificity (96%) and PPV around (98%), so they could be used not only for differentiation between placenta increta and percreta but also between percreta variants, and that was in agreement with the study carried out by Cali G et al (14,15) and Chou M-M et al (19), and with the addition of RI value as done by the study of Shih et al (18) the sensitivity increase to (98.9%), but also the NPV had increased to (94.1%), because of neovascularity of the previous CS scars (13,14).

3D US section (table 5) at the bladder wall, interrupted mucosa due to abnormal placental invasion could be identified, with specificity (100%), PPV (100%) and low NPV (41%), that criteria was associated with all cases of diffuse percreta and all most all

cases of focal percreta, and that was to lesser extent in agreement with Chou M-M-etal (19), so that criteria could add an additional tool in the differentiation between placenta increta and percreta and also between percreta variants according to the part of mucosa involved (focal or diffuse), also 3D US section at the bladder interphase can differentiate between focal percreta and cases of placenta increta with outer varicosity, so decreasing the false positive results.

Each of the previous diagnostic criteria in each tool of diagnosis had taken a score according to its severity and its ability of differentiation between different types of MAP, and the sum of scores was evaluated for each tool in one hand and the total score of all tools in the other hand, and it was found that the 3D power doppler criteria alone was as accurate as the total score in diagnosis and decreasing the false positive results (table 6, figure 7), this scoring system may help in standardization of diagnosis for MAP and differentiation between its variants, our results were to lesser extent in agreement with that of Nelson T et al (20), that introduces placenta accreta index (PAI), which is a scoring system based on history of previous cesarean delivery (s), placental location, placental lacunae, lower uterine segment thickness, and the presence or absence of bridging vessels, with score of > 4 predicted abnormal placenta invasion in patients with at least 1 prior CD, while Rac MWF et al (21) had published scoring system parameters include loss of retroplacental clear zone, irregularity and width of uterine-bladder interface, smallest myometrial thickness, presence of lacunar spaces, and bridging vessels, together with number of cesarean deliveries and anterior placental location, each parameter was weighted to create a 9-point scale in which a score of 9 provided a probability of invasion, with sensitivity 61%, specificity 93%, positive predictive value 87%, and negative predictive value 82%,

Close to the current study Woodring TC et al (22) study, who developed a mathematical model using antenatal clinical signs to identify patients with PA, suggesting that combining antenatal factors (placenta previa, numbers of previous caesarean deliveries) with ultrasound suspicion of PA had better positive predictive value than ultrasound suspicion of PA alone. From previously discussed, the current study scoring system had the advantage of diagnosis MAP cases and differentiation between its variants while other scoring systems gave an idea of cases more liable to be MAP, and that had an important effect on childbirth timing and management, as the mean gestational age of delivery in the current study was 37 weeks and in many cases it could reach 39 weeks, and that agreed with many studies that had planned CS between the 36th and 38th week, after fetal pulmonary maturity (23), and disagreed with other studies that had scheduled CS at 34- weeks after course of corticosteroids to avoid emergent CS (1,24).

Conclusion

3D power Doppler as an additional tool for diagnosis of MAP had the best sensitivity (93.7%), specificity (100%), PPV (100%) and NPV (80.6%) followed by color Doppler with sensitivity (94.7%), specificity (92%), PPV (97.8%) and NPV (82.1%) and lastly 2D US with sensitivity (87.4%), specificity (92%), PPV (97.6%) and NPV (65.7%), together with the introduction of the scoring system, that had better accuracy in diagnosis of, and differentiation between MAP variants with (1.000) for 3D power Doppler, (0.975) for 2D US and (0.967) for color Doppler, with score (8-12 for accreta, 13-18 for increta, 19-25 for focal and > 25 for diffuse percreta), so life saving and fertility preservation procedures could be probably planned

Case presentation (Diagnostic performance):

Case (1):

27 years old, G3P2 pregnant ± 30 weeks, had previous 2 CS scars with no past history of placenta previa in the previous pregnancy, history score = 3 (MAP).

2D US shows anterior placenta complete centralis, thinning of the myometrium, lacunae (≤ 5 in number, small ≤ 2 cm in size and irregular), the score = 8 (accreta).

Color Doppler shows mild myometrial hypervascularity with PSV > 15 cm, the score = 3 (accreta).

3D power Doppler in the lateral view shows blood vessels passing parallel to the bladder wall with the lowest RI < 0.4 , the score = 2 (focal percreta).

Total score sum = 16, which correspond to placenta increta according to our scoring system, and was confirmed operatively.

Case (2):

33 years old, G4P2 pregnant ± 32 weeks, had previous 3 CS scars, no past history of placenta previa in the previous pregnancy, the score = 3 (MAP)

2D US shows anterior placenta complete centralis, absent myometrium/retroplacental space, lacunae (≤ 5 in number, small ≤ 2 cm in size) and disrupted bladder wall, the score = 10 (increta).

Color Doppler shows moderate hypervascularity, the score = 2 (accreta).

3D power Doppler in the lateral view shows blood vessels passing perpendicular to the uterus, chaotic branching & detour vessels with the lowest RI ≤ 0.4 , the score = 7 (diffuse percreta).

Total score sum = 22, which correspond to focal percreta according to our scoring system, and was confirmed operatively.

Case3 (3):

35 years old, G4P3 pregnant ± 31 weeks, had previous 3 CS scars, no past history of placenta previa in the previous pregnancy, history score = 3 (MAP).

2D US shows anterior placenta complete centralis, partially lost myometrium/retroplacental space, lacunae (≥ 5 in number, large ≥ 2 cm in size, irregular), and disrupted bladder wall, the score = 14 (focal percreta).

Color Doppler shows marked hypervascularity with gap, blood flow PSV > 15 cm, the score = 8 (percreta).

3D power Doppler in the basal view shows numerous coherent vessels, the lateral view shows blood vessels passing perpendicular across the bladder wall, chaotic branching & detour vessels with the lowest RI < 0.4 , the score = 10 (diffuse percreta).

3D at the bladder interface identify interrupted bladder mucosa, score = 3 (percreta).

Total score = 38, which correspond to diffuse percreta according to our scoring system, and was confirmed operatively.

Case (4):

40 years old, G3P2 pregnant ± 36 weeks, had previous 2 CS scars, no past history of placenta previa in the previous pregnancy, history score = 3 (MAP).

2D US shows anterior placenta complete centralis, partially lost myometrium/retroplacental space with placental bulge and lacunae (≤ 5 in number, large ≤ 2 cm in size, irregular), and disrupted bladder wall which, the score = 15 (focal percreta).

Color Doppler shows marked hypervascularity with gap and blood flow PSV > 15 cm, the score = 8 (percreta).

3D power Doppler in the basal view shows numerous coherent vessels, the lateral view shows blood vessels passing perpendicular

across the bladder wall, chaotic branching & detour vessels with the lowest RI < 0.4, the score = 10 (diffuse percreta).

3D at the bladder interface identify interrupted bladder mucosa, score = 3 (percreta).

Total score = 39, which correspond to diffuse percreta according to our scoring system, and was confirmed operatively.

Case (5):

31 years old, G5P3A1 pregnant \pm 35 weeks, had previous 3 CS scars, with past history of placenta previa in the previous pregnancy, history score = 5 (MAP).

2D US shows anterior placenta complete centralis, absent myometrium /retroplacental space, lacunae (≥ 5 in number, large ≥ 2 cm in size, irregular/branching and lacunae continuous with bladder wall), and disrupted bladder wall which, the score = 18 (focal percreta).

Color Doppler shows marked hypervascularity with gap and blood flow PSV > 15 cm, the score = 8 (percreta).

3D power Doppler in the basal view shows numerous coherent vessels, the lateral view shows blood vessels passing perpendicular across the bladder wall, chaotic branching & detour vessels and lacunar aneurysm with the lowest RI < 0.4, the score = 13 (diffuse percreta).

3D at the bladder interface identify interrupted bladder mucosa, score = 3 (percreta).

Total score = 47, which correspond to diffuse percreta according to our scoring system, and was confirmed operatively.

Case (6):

28 years old, G4P2A1 pregnant \pm 34 weeks, had previous 2 CS scars, no past history of placenta previa in the previous pregnancy, the score = 3 (MAP).

2D US shows anterior placenta complete centralis, absent myometrium

/retroplacental space and placental bulge/exophytic mass, lacunae (≥ 5 in number, large ≥ 2 cm in size, irregular/branching) with lacuna continuous with the disrupted bladder wall, the score = 21 (diffuse percreta).

Color Doppler shows moderate hypervascularity with gap, PSV > 15 cm, the score = 7 (in-creta).

3D power Doppler in the basal view shows numerous coherent vessels and in the lateral view shows blood vessels passing perpendicular to the uterus, chaotic branching & detour vessels and lacunar aneurysm with the lowest RI ≤ 0.4 , the score = 13 (diffuse percreta).

3D at the bladder interface identifies interrupted bladder mucosa, score = 3 (diffuse percreta). Total score sum = 47, which correspond to diffuse percreta according to our scoring system, and was confirmed operatively.

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Table (1): History risk factors of MAP.

	Accreta n = 13	Increta n =24	percreta focal n =24	percreta diffuse n =34	Significance test
Age in years mean \pm SD	31.5 \pm 3.6	30.08 \pm 5.01	32.1 \pm 4.6	30.1 \pm 4.5	MCT,P = 0.1
Gravidity mean \pm SD	4.5 \pm 2.02	3.9 \pm 1.1	4.2 \pm 0.87	4.1 \pm 1.5	F= 0.5,P = 0.8
Parity mean \pm SD	2.4 \pm 1.5	2.5 \pm 1	2.5 \pm 0.8	2.7 \pm 1	F = 1.4,P= 0.2
Number of scars	2(1-4)	2(1-5)	2(1-4)	2(1-6)	Kruskal-walis testP = 0.001
History of placenta previa	0 (0)	1 (4.2%)	3 (35%)	3 (8.8%)	MCT P = 0.3

Table (2):-Type of placenta previa.

Type of placenta	Accrete n = 13	Increta n =24	percret a focal n =24	percreta diffuse n =34	Significan t test
	No (%)	No (%)	No (%)	No (%)	
Anterior placenta (centralis)	6(46.2)	22(91.7)	23(95)	33(97.1)	MCT P \leq 0.001
Anterior placenta (marginalis)	5(38.5)	1(4.2)	0 (0)	0 (0)	
posterior placenta (centralis)	2(15.4)	1(4.2)	1(5)	1(2.9)	

MCT= Monte Carlo test P \leq 0.05 statistically significant

Table (3):- Preoperative diagnosis by 2D US.

2D US	MAP* N=95	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
The myometrium					
Thinning	45	47.4	100	100	33.3
Partially lost	19	20	100	100	24.8
Absent myometrium/retroplacental space	83	87.4	100	100	67.6
Placental bulge/ exophytic mass	15	16.8	100	100	23.8
Lacunae					
Number	37	38.9	92	94.9	28.4
Size	58	61.1	72	89.2	32.7
Lacunae continuous with bladder wall	6	6.3	100	100	21.9
Lacunae eye of Typhon	5	5.2	100	100	20.9
Urinary bladder interface					
Disrupted	95	93.7	100	100	79.3
Over all diagnosis of 2D US	83	87.4	92	97.6	65.7

Table (4):- preoperative diagnosis by color Doppler.

Color Doppler	MAP* n= (95)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Hypervascularity	85	89.5	68	91.4	63
+ve gap	58	61.1	88	95.1	37.3
Blood flow with PVS >15 cm	48	50.5	96	98	33.8
Lacunae eye of typhoon	5	5.2	96	80	20.9
Bladder interface hypervascularity	58	95.8	68	91.9	81
Over all diagnosis of color Doppler	90	94.7	92	97.8	82.1

*Or its variants, placenta increta and placenta percreta. NPV, negative predictive value; PPV, positive predictive value

Table (5): Preoperative diagnosis by 3D color power Doppler.

	MAP n=(95)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
(Basal view)					
Numerous coherent vessels	61	64.2	100	100	42.2
Lacunar aneurysm	25	26.3	100	100	26.3
(Lateral view)					
blood vessels passing perpendicular to the bladder wall	73	75.8	96	98.6	51.1
Chaotic branching & detour vessels	79	82.1	96	98.7	58.5
Lowest RI	95	98.9	64	91.3	94.1
3D section					
Interrupted bladder mucosa	60	62.1	100	100	41
Over all evaluation	89	93.7	100	100	80.6

Table (6): Comparison between diagnosis tools.

Over all evaluation	MAP n= (95)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
3Dpower Doppler	89	93.7	100	100	80.6
Color Doppler	90	94.7	92	97.8	82.1
2D US	83	87.4	92	97.6	65.7

Table (7): Scoring system for diagnosis of MAP.

Item	Score	Type of placenta
History:		
Number of previous scars ≤ 2		
Number of previous scars > 2	1	≤ 2 =no accreta
No history of placenta previa	2	3-5=MAP
History of placenta previa	1	
2D US:	3	
Anterior placenta	2	≤ 4 =no accreta
Other types of placenta	1	5-8=accreta
Thinning myometrium	1	10-12=increta
myometrium Partially lost	2	13-18=focal percreta
Absent myometrium.	3	> 18 = diffuse percreta
Placental bulge/exophytic mass	3	
Lacunar number ≤ 5	1	
Lacunar number > 5	2	
Lacunar size < 2 cm	1	
Lacunar size ≥ 2 cm	2	
Irregular/ branching lacunae	3	
Lacunae continuous with bladder wall.	3	
Disrupted bladder wall	3	
Color Doppler:		
Blood flow with PSV > 15 cm	2	< 2 = no accreta
Lacunae eye of Typhon	3	2-4=accreta
Hypervascularity: mild/moderate/severe	1/2/3	4-6=increta
+ve gap	3	> 6 =percreta
3D power Doppler :		
The presence of blood vessels passing perpendicular to the uterus	2	≤ 4 =Focal percreta
Lowest RI < 0.4	2	> 4 =Diffuse percreta
Numerous coherent vessels	3	
Chaotic branching & detour vessels	3	
Lacunaer aneurysm	3	
3D section at bladder wall:		
Interrupted bladder mucosa	3	3=percreta
Total score:		
No accreta	≤ 8	
Accreta	8-12	
Increta	13-18	
Focal percreta	19-25	
Diffuse percreta	> 25	

Figure (1):- Case (1) diagnosis:



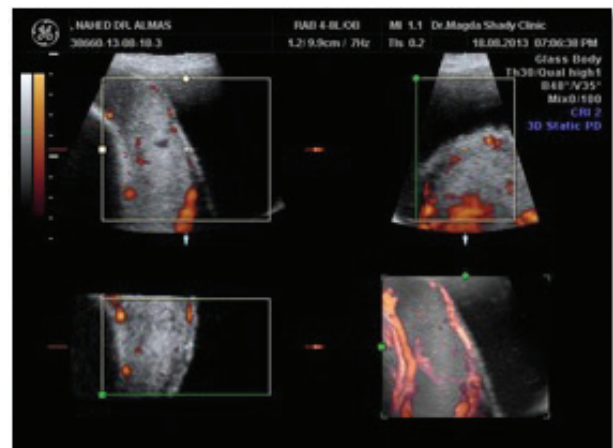
A: Thinning of the myometrium by 2D US.



C: lost retroplacental space and disrupted bladder wall.



B: lacunae (≤ 5 , small ≤ 2 cm in size and irregular)

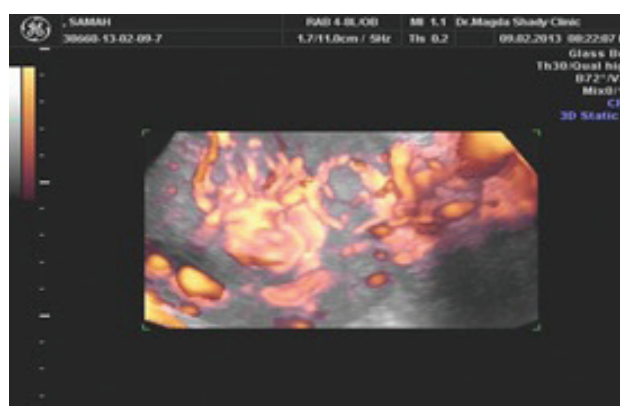


D: blood vessels passing parallel to the bladder wall by 3D power Doppler.

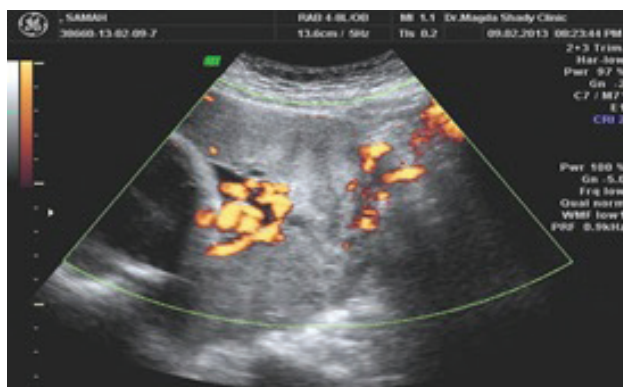
Case (2) diagnosis:



(A):-Absent myometrium/retroplacental space and no significant lacunae by 2D US.

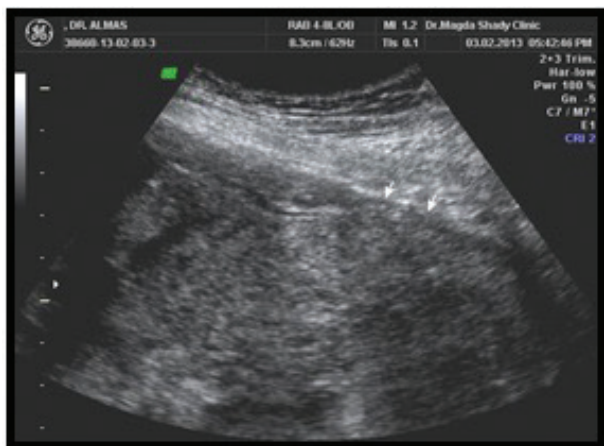


(C):- Chaotic branching & detour vessels by 3D power Doppler.

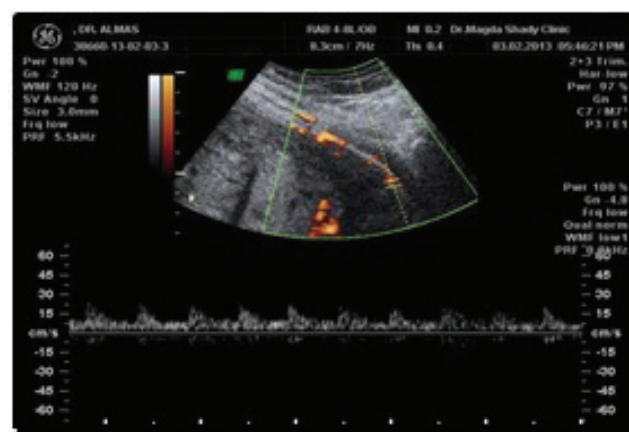


(B):-Moderate hypervascularity at bladder wall by Doppler.

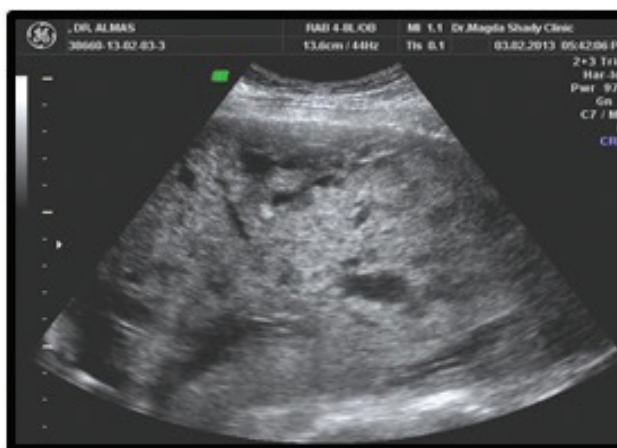
Figure (3):- Case (3) diagnosis:-



(A):-Partially lost myometrium by 2D US.



(C)-Presence of gap within bladder interface hypervascularity. With PSV >15 cm by Doppler.



B: Lacunae ≥ 5 in number, ≥ 2 cm in size, and irregular by 2D US.(B):-



(D):-Coherent, Chaotic branching & detour vessels by 3D power Doppler.

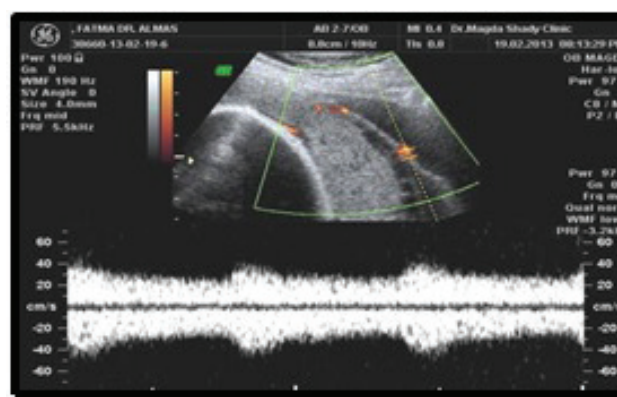
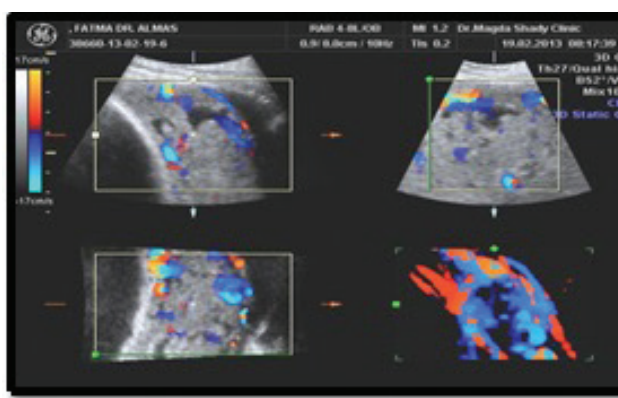
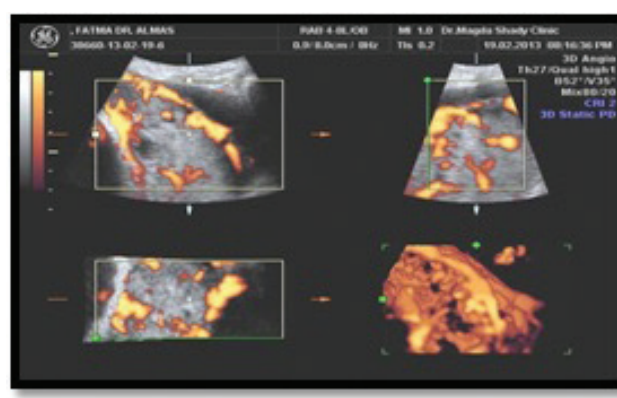
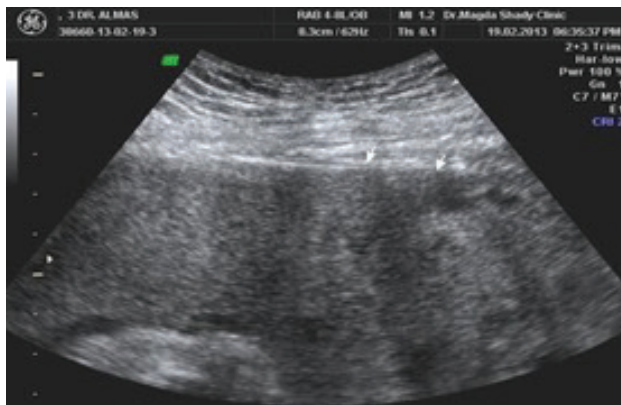
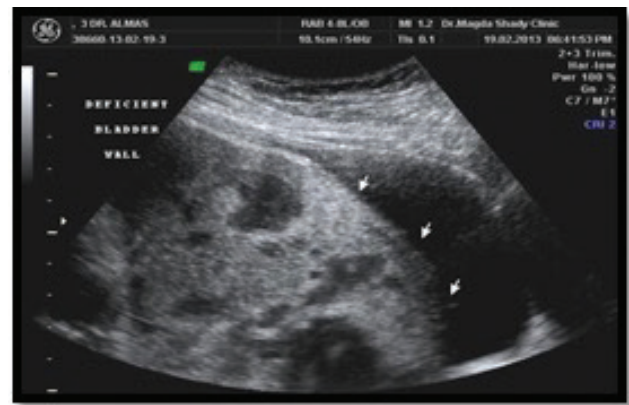
Figure (4):- Case (4) diagnosis:**(A):-partially lost myometrium with placental bulge and lacunae (≤ 5 in number, small ≤ 2 cm in size and irregular) by 2D US.****(D):-PSV > 15 cm by Doppler.****(B):-Severe bladder wall hypervascularity with gap by color Doppler.****(E):- Numerous coherent vessels by 3D power Doppler.**

Figure (5):- Case (5) diagnosis:



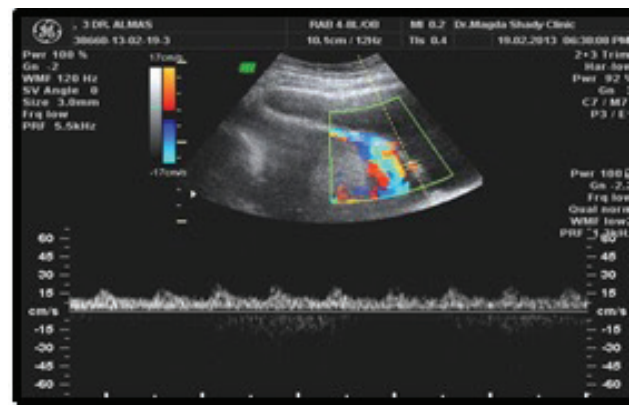
(A):-Absent myometrium/retroplacental space by 2D US.



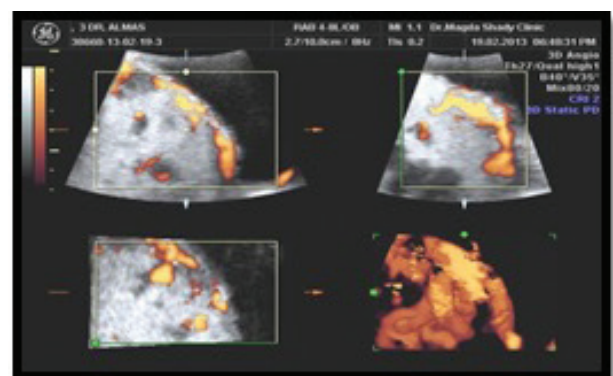
(C):-Disrupted bladder wall with large branching lacunae continuous with it.



(B):-lacunae (≥ 5 in number, small ≥ 2 cm in size and irregular/branching)

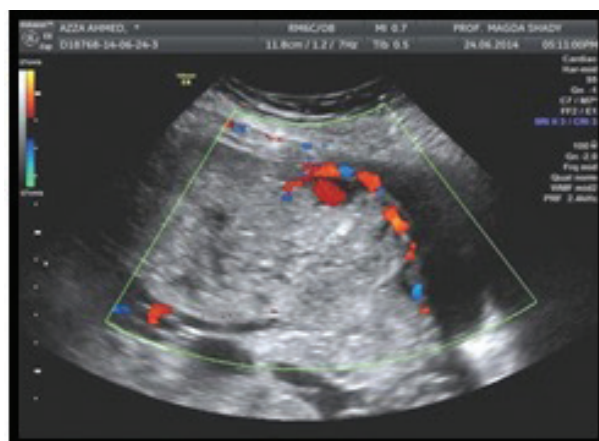
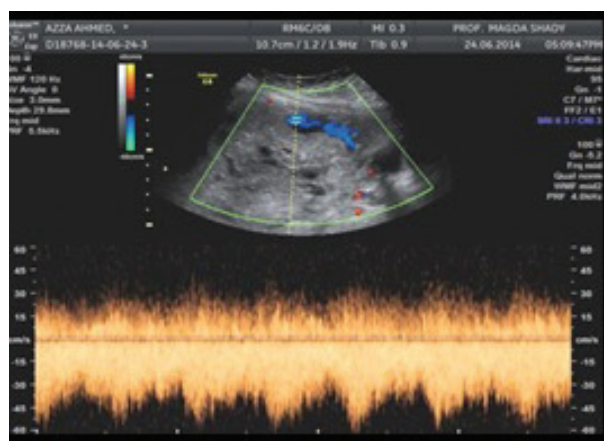
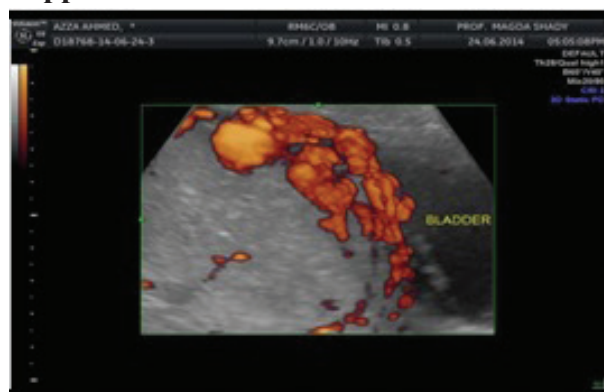


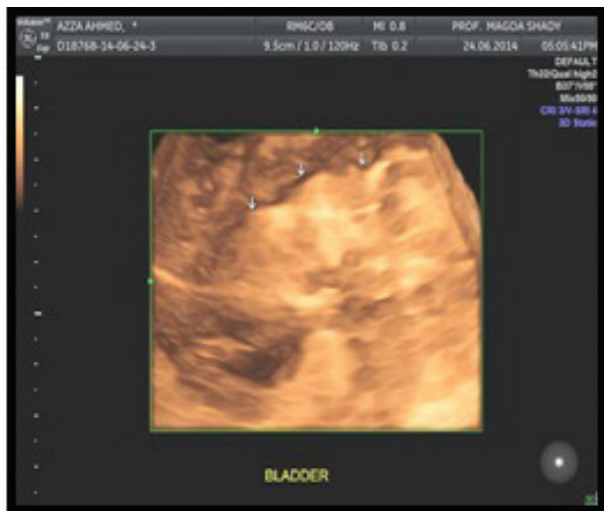
(D):-Marked bladder wall hypervascularity with PSV >15 cm by doppler.



(E):- Chaotic branching & detour vessels by 3D power Doppler.

Fig. (6): ROC curve analysis of serum β hCG and Kiss-1 as predictors for getting EPL

Figure (6):- Case (6) diagnosis: -**(A):-Absent myometrium/retroplacental space by 2D US.****(B):- lacunae (≥ 5 in number, large ≥ 2 cm in size and irregular/ branching) with large branching lacunae continuous with the bladder wall by 2D US.****(C):-Disrupted bladder wall with placental bulge/exophytic mass.****(D):- Moderate bladder wall hypervascularity with gap, by Doppler.****(E):- Blood flow with PSV >15 cm by color doppler.****(F):-Coherent vessels, chaotic branching & detour vessels by 3D power Doppler.**



(G):- Interrupted bladder mucosa by 3D section at the bladder wall.

Figure (7):-ROC curve for scoring system accuracy.

