

Research

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Outcomes and Accuracy of 2D Gray-Scale Ultrasound Scan in Prenatal Diagnosis of Morbid Adherent Placenta

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ABSTRACT

Objective: This study designed to evaluate outcomes and accuracy of 2D gray-scale ultrasound scan in prenatal diagnosis of Morbid Adherent Placenta (MAP).

Patients and methods: Fifty pregnant women ≥ 28 weeks gestation with suspected MAP studied. 2D trans-abdominal gray-scale ultrasound scan done for studied women to confirm; placental location and findings suggestive of MAP. Intra-operative findings at delivery compared with pre-operative sonographer findings to evaluate outcomes and accuracy of 2D gray-scale ultrasound scan in prenatal diagnosis of MAP.

Results: 56%(28/50) of studied women had difficult placental separation, considerable intraoperative blood loss. Bilateral internal iliac artery ligation done to control bleeding in 28%(14/50), intrauterine compression balloon with placenta bed sutures done in 6%(3/50) and cesarean hysterectomy done in 22%(11/50) of studied women. Best 2D gray-scale ultrasound parameters for detection of difficult placental separation and considerable intraoperative blood loss in studied cases were; abnormal placental lacunae (73.9% sensitivity) and exophytic mass invading bladder (100% specificity & 100% PPV).

Best 2D gray-scale ultrasound parameters for detection of emergency hysterectomy were; disruption of uterine serosa-bladder interface (81.8% sensitivity) and exophytic mass invading bladder (94.9% specificity, 66.7% PPV and 84.1% NPV).

Conclusion: Antenatal diagnosis of MAP is crucial for; proper counseling for possible surgical complications, multidisciplinary team care and recruitment. Best 2D gray-scale ultrasound parameters for detection of difficult placental separation in studied cases were; exophytic mass invading bladder, while, best 2D gray-scale ultrasound parameters for detection of emergency hysterectomy were; disruption of uterine serosa-bladder interface and exophytic mass invading bladder.

KEYWORDS: Outcomes; 2D gray-scale ultrasound; Morbid adherent placenta.

ABBREVIATIONS: MAP: Morbid Adherent Placenta; cEBL: calculated Estimated Blood Loss; RBCs: Red Blood Cells; SPSS: Statistical Package for Social Sciences; LMP: Last Menstrual Period.

INTRODUCTION

Placenta accreta occurs when placental trophoblasts invade endometrium beyond the

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Nitabuch's layer of decidua basalis, while placenta increta occurs when placental trophoblasts invade myometrium and placenta percreta occurs when trophoblasts invade serosa.^{1,2}

MAP (morbid adherent placenta) is usually associated with excess blood loss, bladder injuries and hysterectomies.^{3,4} Incidence of MAP has increased significantly over the past 50 years.^{5,6}

Previous cesarean delivery, placenta previa and damage of Nitabuch's layer of decidua basalis following intrauterine infection or scarring are risk factors of MAP.^{1,7-9} Incidence of MAP is increased concomitantly with increased cesarean section rates.^{1,7-9}

Incidence of MAP is 3.3% in pregnant women with no prior cesarean delivery and placenta previa and is 40% in pregnant women with previous two cesarean sections and placenta previa.⁴ If MAP was diagnosed or suspected before delivery, the optimum time for planned delivery is around 34-35 weeks following a course of corticosteroid and multidisciplinary care team approach.^{2,10,11}

Accurate diagnosis of MAP is essential to prepare both patient and health providers for possible complications during delivery. Authors reported that ultrasound is a useful tool to diagnose MAP with 77-93% sensitivity and 71-98% specificity and MRI should be reserved for cases with inconclusive sonographic findings.¹²⁻¹⁷

Prenatal diagnosis of MAP allows development multidisciplinary care team approach during delivery.¹⁴ This study aimed to detect outcomes and accuracy of 2D gray-scale ultrasound scans in prenatal diagnosis of morbid adherent placenta (MAP).

PATIENTS AND METHODS

From February 2011 to February 2015, pregnant women ≥ 28 weeks gestation with placenta previa anterior covering scar of previous cesarean section scar by trans-abdominal gray-scale ultrasound scan were included in this study conducted in Ain Shams University Maternity Hospital, Cairo, Egypt, after approval of ethical committee. Thorough history and examination of all studied women was followed by 2D trans-abdominal gray-scale ultrasound scan to confirm; gestational age, placental location, findings suggestive of MAP. Findings suggestive of MAP by 2D gray-scale ultrasound scan were;

1. Obliteration of clear space between uterus and placenta, (Figure 1).
2. Visualization of placental lacunae (irregular vascular spaces), moth-eaten appearance placenta (Figure 1).
3. Interruption of posterior uterine serosa-bladder interface.

4. Exophytic mass invading bladder.^{11,18}

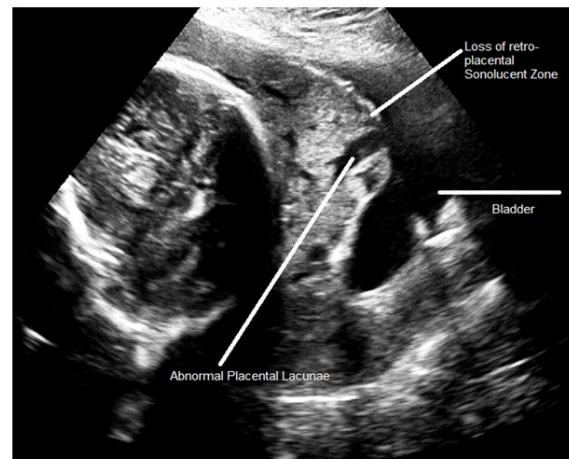


Figure 1: 2D gray scale ultrasound scan shows loss of retro-placental sonolucent zone and abnormal placental lacunae in morbid adherent placenta.

All scans were done for all studied women in supine position with sufficient and comfortably bladder volume to allow optimal visualization of uterine serosa-bladder interface. Ultrasound scans were done by sonographer who was blinded to patient's criteria using Medison machine (Sonoace X8, Medison Co, South Korea) with 4-7 Mhz (Megahertz) multi-frequency convex probe. Gestational age was calculated from first day of Last Menstrual Period (LMP) and confirmed by early ultrasound done at 20th weeks gestation.

According to Ain Shams University Maternity Hospital protocol, all studied women were hospitalized at 32 weeks and delivered at 35 weeks, following a course of corticosteroids. Emergency cesarean section was done if significant bleeding developed before time of planned cesarean section. All deliveries were conducted in attendance of obstetrics and anesthetic consultants on duty and urologist on duty was informed in case bladder injury or reconstruction was needed.²⁻¹⁰ A written consent was taken from all studied women explaining; possible intra-operative complications (blood transfusion, hysterectomy, internal iliac ligation) and postoperative complications (deep venous thrombosis, prolonged hospital stay and intensive care unit admission). Women included in this study were also, cross matched with fresh frozen plasma and packed RBCs (Red Blood Cells). Intra-operative findings including; difficulty in placental separation, degree of placental invasion (superficial myometrial invasion or deep myometrial invasion to uterine serosa), bleeding from placental site, amount of blood loss, intraoperative blood transfusion recorded. Also, need for internal iliac ligation or emergency hysterectomy to control bleeding and histopathology results of removed uteri in cases managed by emergency hysterectomy recorded.¹⁹ cEBL (calculated Estimated Blood Loss) was evaluated using Stafford, et al. formula.²⁰ Intra-operative findings (Figure 2) were compared with pre-operative sonographer findings to evaluate accuracy of 2D gray-scale ultrasound scans in prenatal diagnosis of MAP.

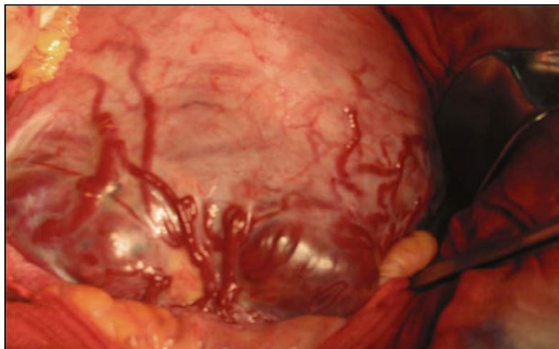


Figure 2: Intraoperative findings of a case of MAP with numerous vessels over uterine serosa and confirmed as placenta percreta after hysterectomy.

SAMPLE SIZE AND STATISTICAL ANALYSIS

Using data from previous studies and EpiInfo® version 6.0, a sample size of 50 women was needed to produce a significant difference. Data were collected and statistically analyzed using SPSS (Statistical Package for Social Sciences); computer software version 18 (Chicago, IL, USA). Mean and SD (standard deviation) were used to represent numerical variables, while, number and percentage were used to represent categorical variables. Student’s t and Mann-Whitney’s tests were used for analysis of quantitative data, Chi-square (X²) test for analysis of qualitative data and regression analysis to predict outcomes of categorical dependent variables. P value <0.05 was considered significant, also, sensitivity, specificity and predictive values of ultrasound diagnostic criteria of MAP were calculated.

RESULTS

Demographic data of 50 studied women with suspected MAP were represented in Table 1.

56%(28/50) of studied women had difficult placental separation, considerable blood loss (≥1500 cc) and received blood transfusion. Bilateral internal iliac artery ligation done to control bleeding in 28%(14/50) of studied women, intrauterine compression balloon with placenta bed sutures done in 6% (3/50) of studied women and cesarean hysterectomy done in 22%(11/50) of studied women. Histopathological examination of surgically removed uteri showed; placenta accreta in 10%(5/50) cases, placenta increta in 8%(4/50) cases and placenta percreta in 4%(2/50 cases). 10%(5/50) cases of bladder injury were recorded during this study. (Table 1)

Number of cesarean deliveries (median 3 (1-4 range) versus 1 (1-2 range); respectively) and parity (median 4 (1-6 range) versus 1 (1-2 range): respectively) were high among women, who had difficult placental delivery, women who had considerable intraoperative blood loss and women required emergency hysterectomy to control bleeding. (Table 2)

All 2D gray scale ultrasound parameters (except abnormal placental lacunae) were significantly high in women who

had difficult placental separation and considerable intraoperative blood loss and emergency hysterectomy compared with women who did not have difficult placental separation or considerable blood loss. (Tables 3 and 4)

Variables	Total Number of studied women=50
Age (years)	31.22±4.82*
Duration from last cesarean section (years)	3.4±2.39*
Gestational age at scan (weeks)	30.6±3.17*
Gestational age at delivery (weeks)	34.7±1.2*
Preoperative hematocrit	30.8±3.3*
48-hours postoperative hematocrit	27.3±4.1*
Postoperative hematocrit drop	3.4 ± 2.4*
Considerable intraoperative blood loss (≥1500 cc)	28(56%)**
Intraoperative blood transfusion	28(56%)**
Easy placental separation	22(44%)**
Difficult placental separation	28(56%)**
No need for additional surgical steps	22(44%)**
Bilateral Internal Iliac Ligation	14(28%)**
Emergency hysterectomy	11(22%)**
Intrauterine compression balloon and placental bed sutures	3(6%)**
<u>Histopathology results of surgically removed uteri</u>	
Placenta accrete	5(10%)**
Placenta increta	4(8%)**
Placenta percreta	2(4%)**
Intraoperative bladder injury	5(10%)**

*Data represented as Mean±SD. **Data represented as Number and percentage.

Table 1: Preoperative and intraoperative data of studied women with suspected morbid adherent placenta.

Variables	Women who had difficult placental delivery and considerable intraoperative blood loss and required emergency hysterectomy	Women who did not have difficult placental delivery or considerable intraoperative blood loss or required emergency hysterectomy	P value Significance
Age (years) Mean±SD	30.3±5.2	30.9±4.1	0.13* (NS)
Body Mass Index (BMI), (Kg/m ²) Mean±SD	25.3±3.2	24.7±2.9	0.32* (NS)
Parity Median (Range)	4(1-6)	1(1-2)	0.02** (S)
Number of previous cesarean section Median (Range)	3(1-4)	1(1-2)	0.04** (S)
Gestational age at delivery (weeks) Mean±SD	35.9±1.7	36.2±1.4	0.18* (NS)

*Analysis using independent student’s t-test. **Analysis using Mann-Whitney’s U-test. NS: Non-Significant; S: Significant

Table 2: Women who had difficult placental delivery, considerable intraoperative blood loss and required emergency hysterectomy to stop bleeding compared with women who did not have difficult placental delivery or considerable blood loss or required emergency hysterectomy to stop bleeding.

Regression analysis showed that; the risk of difficult placental separation and considerable intraoperative blood loss increased; 3 times (95% CI; 1.7-8.5) with irregular retro-placental sonolucent areas, 7 times (95% CI; 1.8-27.2) with disruption

Variables	Women who had difficult placenta separation and considerable intraoperative blood loss (number=28)	Women who did not have difficult placenta separation or considerable intraoperative blood loss (number=22)	P value Significance RR (95% CI)
2D gray-scale parameters			
Loss of retro-placental sonolucent space	26(92.8%)	7(31.8%)	0.03(S), 2.9(1.5-5.4)
Irregular retro-placental sonolucent area	25(89.3%)	5(22.7%)	0.01(S), 3.0(1.7-8.5)
Disruption of uterine serosa-bladder interface	18(64.3%)	2(9.1%)	0.006(S), 7.0(1.8-27.2)
Exophytic mass invading bladder	8(28.6%)	0(0%)	0.003(S), 1.34(0.8-22.1)
Abnormal placental lacunae	21(75%)	14(63.6%)	0.7(NS), 0.39(0.1-0.8)

Data represented as number and percentage. Analysis using Chi-square (X2) test. NS: Non-Significant; S: Significant; 2D: Two Dimensional; RR: Relative Risk; CI: Confidence Interval

Table 3: 2D gray-scale parameters in women who had difficult placental separation and considerable intraoperative blood loss compared with women who did not have difficult placental separation or considerable intraoperative blood loss.

Variables	Women who required emergency hysterectomy (number=11)	Women who did not require hysterectomy (number=39)	P value Significance
2D gray-scale parameters			
Loss of retro-placental sonolucent space	11(100%)	13(33.3%)	0.03(S), 3(1.9-4.6)
Irregular retro-placental sonolucent area	11(100%)	12(30.8%)	0.02(S), 3.2(1.9-4.6)
Disruption of uterine serosa-bladder interface	9(81.8%)	7(17.9%)	0.01(S), 4.5(2.2-33.7)
Exophytic mass invading bladder	4(36.4%)	2(5.1%)	0.02(S), 7.1(1.4-33.7)
Abnormal placental lacunae	8(72.7%)	26(66.7%)	0.8(NS), 1.1(0.7-1.6)

Data represented as number and percentage. Analysis using Chi-square (X2) test. NS: Non-Significant; S: Significant; 2D: Two Dimensional; RR: Relative Risk; CI: Confidence Interval

Table 4: 2D gray-scale parameters in women who required emergency hysterectomy to stop bleeding compared with women who did not require hysterectomy.

of uterine serosa-bladder interface and 13.4 times (95% CI; 0.8-22.1) with Exophytic mass invading bladder by 2D gray scale ultrasound scan. (Table 3)

Regression analysis also showed that; the risk of emergency hysterectomy to control bleeding in studied cases of MAP increased; 3.2 times (95% CI; 2-5.2) with irregular retro-placental sonolucent areas, 4.5 times (95% CI; 2.2-9.4) with disruption of uterine serosa-bladder interface and 7.1 times (95% CI; 1.4-33.7) with Exophytic mass invading bladder by 2D gray scale ultrasound scan. (Table 4)

Best 2D gray-scale ultrasound parameters for detection of difficult placental separation and considerable intraoperative blood loss in studied cases were; abnormal placental lacunae (73.9% sensitivity) and exophytic mass invading bladder (100% specificity & 100% PPV). (Table 5)

Best 2D gray-scale ultrasound parameters for detection of emergency hysterectomy were; disruption of uterine serosa-bladder interface (81.8% sensitivity) and exophytic mass invading bladder (94.9% specificity, 66.7% PPV and 84.1% NPV). (Table 5)

DISCUSSION

Hemorrhagic and surgical complications associated of MAP depend on depth of placental invasion and involvement of adjacent structures.²¹ MAP with bladder invasion is a serious, which necessitate proper antenatal diagnosis and appropriate management strategy.²² Previous cesarean delivery and increased

parity are the two known risk factors to MAP and incidence of MAP is increased concomitantly with increased cesarean section rates.^{3,23-25}

Antenatal diagnosis of MAP is crucial for; proper counseling for possible surgical complications, multidisciplinary team care and recruitment.³ Despite its cost and unavailability in many centers, MRI should be reserved for cases with inconclusive sonographic findings.^{13,15,17}

Fifty pregnant women ≥ 28 weeks' gestation with expected MAP were studied (only 28 had MAP). 2D trans-abdominal gray-scale ultrasound scan done for studied women to confirm; placental location and findings suggestive of MAP. Intra-operative findings and histopathology results of removed uteri compared with pre-operative sonographer findings to detect accuracy of 2D gray-scale ultrasound scans in prenatal diagnosis of MAP. Forty-six of studied women were delivered at 35 weeks by planned cesarean section, while, 4 women were delivered at 33 weeks because of ante-partum hemorrhage. 56%(28/50) of studied women had difficult placental separation, considerable intraoperative blood loss and received intraoperative blood transfusion. In this study; parity, number of previous cesarean sections were significantly high among women, who had difficult placental delivery, women who had considerable intraoperative blood loss and women who required emergency hysterectomy to control bleeding. Wright et al found that; 41.7% of women with a known placenta accreta had a blood loss of ≥ 5000 (ml).²⁶

Although, Wright et al, concluded that there was no

Variables	Sensitivity	Specificity	PPV	NPV
<u>Accuracy of 2D gray-scale parameters in prediction of difficult placental separation, considerable intraoperative blood loss</u>				
Loss of retro-placental sonolucent space	70%	59.3%	64.4%	74.2%
Irregular retro-placental sonolucent area	72.6%	63%	65.5%	71%
Disruption of uterine serosa-bladder interface	43.5%	88.9%	76.9%	64.9%
Exophytic mass invading bladder	26.1%	100%	100%	61.4%
Abnormal placental lacunae	73.9%	37%	50%	62.5%
<u>Accuracy of 2D Gray-Scale ultrasound parameters in prediction of emergency hysterectomy</u>				
Loss of retro-placental sonolucent space	70%	48.7%	35.5%	70%
Irregular retro-placental sonolucent area	70%	53.8%	37.9%	70%
Disruption of uterine serosa-bladder interface	81.8%	82.1%	56.3%	84.1%
Exophytic mass invading bladder	63.4%	94.9%	66.7%	84.1%
Abnormal placental lacunae	72.7%	33.3%	23.5%	81.3%

Data represented as percentage. PPV: Positive Predictive Value; NPV: Negative Predictive Value. 2D: Two-Dimensional.

Table 5: Accuracy of 2D gray-scale ultrasound parameters in prediction of difficult placental separation, considerable intraoperative blood loss and emergency hysterectomy.

significant relation between parity, number of previous cesarean deliveries, degree of placental invasion and massive blood loss, Tikkanen, et al. found that; the risk factors of placenta accreta include parity, cesarean section and placenta previa.^{26,27}

Also, Guleria, et al. concluded that; risk factors of AIP (abnormal invasive placentation) were placenta previa and previous cesarean delivery, and Thia, et al. concluded that depth of invasion in MAP is increased with multiple previous surgery or excessive curettage or infection causing defective decidua basalis.^{28,29}

D’Antonio, et al. concluded that; incidence of AIP increased in past decades due to increasing caesarean section rates and ultrasound has 91% sensitivity and 97% specificity for prediction of all forms of AIP.¹⁶

Bilateral internal iliac artery ligation needed in 28%(14/50) of studied women, intrauterine compression balloon with placenta bed sutures needed in 6%(3/50) women and cesarean hysterectomy done in 22%(11/50) women. Histopathological examination of surgically removed uteri showed; placenta accreta in 10%(5/50) cases, increta in 8%(4/50) cases and percreta in 4%(2/50) cases. 10%(5/50) cases of bladder injury recorded during this study. Warshak et al, reviewed 99 women with pathologically confirmed placenta accreta.³⁰ Warshak, et al. concluded that; antenatal detection of placenta accreta was associated with significant decrease in maternal hemorrhage, also Tikkanen, et al. concluded that; antenatal diagnosis of placenta accreta may significantly reduce peripartum blood loss and Chantraine et al, concluded that; antenatal diagnosis of AIP reduces morbidity and undiagnosed cases of AIP led to more emergency hysterectomies.^{27,30,31}

Eller, et al. concluded that; planned cesarean hysterectomy and pre-operative ureteric stents were associated with reduced maternal morbidity in MAP.³²

In this study; best 2D gray-scale ultrasound parameters for detection of difficult placental separation and considerable intra-operative blood loss were; abnormal placental lacunae (73.9% sensitivity), exophytic mass invading bladder (100% specificity & 100% PPV) and loss of retro-placental sonolucent zone (74.2% NPV). Also, best 2D gray-scale ultrasound parameters for detection of emergency hysterectomy in studied cases were; disruption of hyperechoic uterine serosa-bladder interface (81.8% sensitivity) and exophytic mass invading bladder (94.9% specificity, 66.7% PPV and 84.1% NPV).

Dwyer, et al. studied 32 women to compare accuracy of trans-abdominal ultrasound and MRI for diagnosis of placenta accrete. They found that ultrasound identified placenta accreta with 93% sensitivity and ruled out placenta accreta with 71% specificity, while, MRI correctly identified placenta accreta with 80% sensitivity and ruled out placenta accreta with 65% specificity.¹⁵

Warshak, et al. found that ultrasound accurately diagnosed MAP with 77% sensitivity and ruled out MAP with 96% specificity, and, concluded that MRI may be helpful in diagnosis of MAP in cases with equivocal or inconclusive ultrasound findings.¹³

See comment in PubMed Commons bel Comstock and colleagues, to detect accuracy of ultrasound in detection of placenta accreta in high-risk patients, conducted large prospective study.³³ They, concluded that; multiple vascular spaces inside placenta (placental lacunae) was the most diagnostic sign for placenta accrete with high PPV and obliteration of retro-placental is not reliable sign for diagnosis of placenta accreta. Comstock and colleagues, found that absence of retro-placental space is not diagnostic sign to MAP, since the spaces may be normally absent without MAP and they recommended use of color Doppler to identify placental sinuses crossing the uterine wall to bladder.³³

Wong, et al. concluded that loss of placental-uterine interface and presence of abnormal vessels crossing this interface were the most specific criteria to diagnose the MAP using 2D gray-ultrasound scan.

Wong, et al. found that the major risk of placenta accreta is severe hemorrhage when the placenta separated at delivery. They concluded that the extent of myometrial involvement and the vascularity could be assessed by the observation of the extent of placental – uterine wall interface disruption and the vessels crossing the interface disruption sites. In addition, they concluded that such assessment results in strategic planning of management of the placenta at delivery with favourable pregnancy outcomes.³⁴

Japaraj, et al. found that the prominent gray scale ultrasound sign to diagnose the placenta accreta was dilated vessels extending from placenta to myometrium, also, Shi et al found that; the most prominent gray scale sign to diagnose the placenta accreta was dilated vessels extending from placenta to myometrium.^{35,36}

CONCLUSION

Antenatal diagnosis of MAP is crucial for; proper counseling for possible surgical complications, multidisciplinary team care and recruitment. Best 2D gray-scale ultrasound parameters for detection of difficult placental separation in studied cases were; exophytic mass invading bladder, while, best 2D gray-scale ultrasound parameters for detection of emergency hysterectomy were; disruption of uterine serosa-bladder interface and exophytic mass invading bladder.

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CONFLICTS OF INTEREST

No conflict of interest exists in relation to this manuscript.

DISCLOSURE

All authors were contributed significantly and are responsible for the content of this manuscript.

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