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Role of Three-Dimensional Multi-Slice Color Flow Doppler in Diagnosis of Morbid Adherent Placenta

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ABSTRACT

Background: The most common causes of morbid adherent placenta (MAP) include hysterectomies, excessive blood loss, and bladder injuries. Placental trophoblasts that penetrate the endometrium past the Nitabuch layer of decidua basalis cause placenta accreta, while placental trophoblasts that penetrate the myometrium cause placenta increta.

Objectives: To evaluate the role of the multislice 3D color flow Doppler in the diagnosis of MAP in relation to intrapartum findings and the mean value of placental volume vascularization index (VI) and flow index (FI) and vascularization flow index (VFI).

Patients and Methods: This was a prospective study that included 41 pregnant women at Department of Obstetrics and Gynecology in Menoufia University Hospital, from December 2021 till March 2023.

Results: Cutoff point of placental **(**VI**)** as a marker in prediction of placental invasion among cases was 23.760, with sensitivity of 94.1%, specificity of 95.8% at AUC of 0.771. Cutoff point of placenta (FI) as a marker in prediction of placental invasion among cases was 32.405, with sensitivity of 88.2%, specificity of 83.3% at AUC of 0.513. Cutoff point of placental **(**VFI) as a marker in prediction of placental invasion among cases was 9.305, with sensitivity of 94.1%, specificity of 95.8% at AUC of 0.749.

Conclusion: among the 3D color flow Doppler indices, VI had the best index in prediction of placental invasion, followed by VFI while FI had the lowest. Additionally, loss of sonolucency was the most 3D multislice color flow Doppler in the diagnosis of MAP with accuracy 92.3%, followed by placental lacunae with accuracy 84.5%, then abnormal uterine serosa bladder line by 80.55% of accuracy.

Keywords: Morbid Adherent Placenta, 3D Multislice color flow Doppler ultrasound, Caesarean section.

INTRODUCTION

The usage of caesarean section (CS), which can save the lives of both the mother and the child, has grown significantly in the past ten years. Similar to worldwide patterns, Egypt's CS rates have been rising rapidly; they now account for 67% of all deliveries, which is a more than 100% rise since 2005 **[1].**

Worldwide, a number of variables have been linked to CS, including early amniotic membrane rupture, cephalo-pelvic disproportion, fetal distress, multiple pregnancies, breech presentation, place of birth (public or private hospital), maternal preference, birth weight, parity, maternal height, and use of antenatal care **[2].** Whereas placental trophoblasts that penetrate the endometrium past the Nitabuch layer of decidua basalis cause placenta accreta, placental trophoblasts that invade the myometrium cause placenta increta, and placental trophoblasts that infiltrate the serosa cause placenta percreta **[3].**

Morbidly adherent placenta can be diagnosed prenatally by different modalities although there is limitation of prenatal diagnosis as it is not histopathological diagnosis, but 2D ultrasound, 3D multislice Doppler, and MRI have a major role to diagnose morbidly adherent placenta **[4].**

In the previous fifty years, there has been a notable rise in the prevalence of MAP. The risk factors for MAP include a history of caesarean birth, placenta previa, and damage to the decidua basalis' Nitabuch layer as a result of an intrauterine infection or scarring. There is a direct correlation between rising rates of caesarean sections and rising incidence of MAP **[5]**. Pregnant women without a history of placenta previa or caesarean delivery have a 3.3% incidence of MAP, but those with a history of placenta previa and two caesarean sections have a 40% rate **[6]**. The best window of time for a scheduled birth if MAP was identified or suspected before to delivery is about 34–35 weeks, after a course of corticosteroids and a multidisciplinary team approach to treatment **[7]**.

Based on abnormal vascular patterns, a number of studies that employed 3D colour Doppler methods to diagnose MAP found sensitivity values ranging from 39% to 100% **[8].**

This work's objective was to evaluate the role of the multislice 3D color flow Dopplerin the diagnosis of MAP in relation to intrapartum findings and the mean value ofplacenta volume VI and FI and VFI.

PATIENTS AND METHODS

This was a prospective study that included 41 pregnant women at Department of Obstetrics and Gynecology in Menoufia University Hospital, from December 2021 till March 2023.

Patients' criteria:

The inclusion criteria included singleton pregnancy, pregnant women at ≥28 weeks of gestation, women with placenta previa with 2D ultrasound with history of previous CS or hysterotomy. However,

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pregnant women with normally situated placenta were excluded from the current study.

Sample size:

Sample size was determined using PASS 11.0 and based on a previous evaluation of study by **Chou *et al.*** [9], who discovered a substantial relationship between bladder invasion in MAP and 3D multislice colour flow Doppler results, with 82.4% sensitivity and 96.8% specificity for diagnosing MAP. The sample size was obtained using the following equation: n-(X2 x P x Q)/D2 at CT 95%. Assuming = 0.05 (standard value of 1.96), we computed that 41 women would be required to show a significant difference after accounting for a 5% drop-out rate in order to obtain 80% power (0.8).

All patients received the following procedures:

History taking, general examination, abdominal examination, and investigations (laboratory and ultrasound). All participated women had been examined by 2D ultrasound showing low lie placentaor placenta previa to be included in the study. For each patient, the whole placenta was scanned in a methodical manner utilising 2D greyscale, 3D scan applied, 3D multislice color flow Doppler modality and Virtual Organ Computer-aided Analysis (VOCAL) of placenta volume. If the patients who were thought to have progressed invasive morbid placentation, the placenta was scanned with a bladder volume that allowed the serosa bladder interface to be seen clearly.

In the 2nd and 3rd trimesters, loss of the retroplacental sonolucent zone, loss of placental homogeneity, which is replaced by multiple intra-placental lacunae (venous lakes or placental lacunae) adjacent to the involved myometrium, and loss or thinning of the normal hypoechoic area behind the placenta (referred to as the clear space) are sonographic findings suggestive of placenta accreta. <1 mm of retroplacental myometrial thickness, the placenta protruding into the bladder's posterior wall, the presence of isolated exophytic masses invading the urinary bladder, and the loss or disruption of the typically continuous white line that represents the interface between the bladder wall and uterine serosa (referred to as the bladder line).

3D Multi-slice color flow Doppler was used to detect if those patients were suspected of having advanced invasive morbid placenta. The placenta was scanned with a bladder volume that allowed the serosa bladder interface to be seen clearly.

Difficulty in separating and removing the placenta, uncontrollably bleeding after placental separation in a well-contracted uterus as moderate blood loss of 1000 to 2000 cc or massive blood loss exceeding 2000 cc, thinning of the lower uterine segment, and abnormal vasculature over the lower uterine segment were all considered signs of placental invasion during the surgical procedure [9].

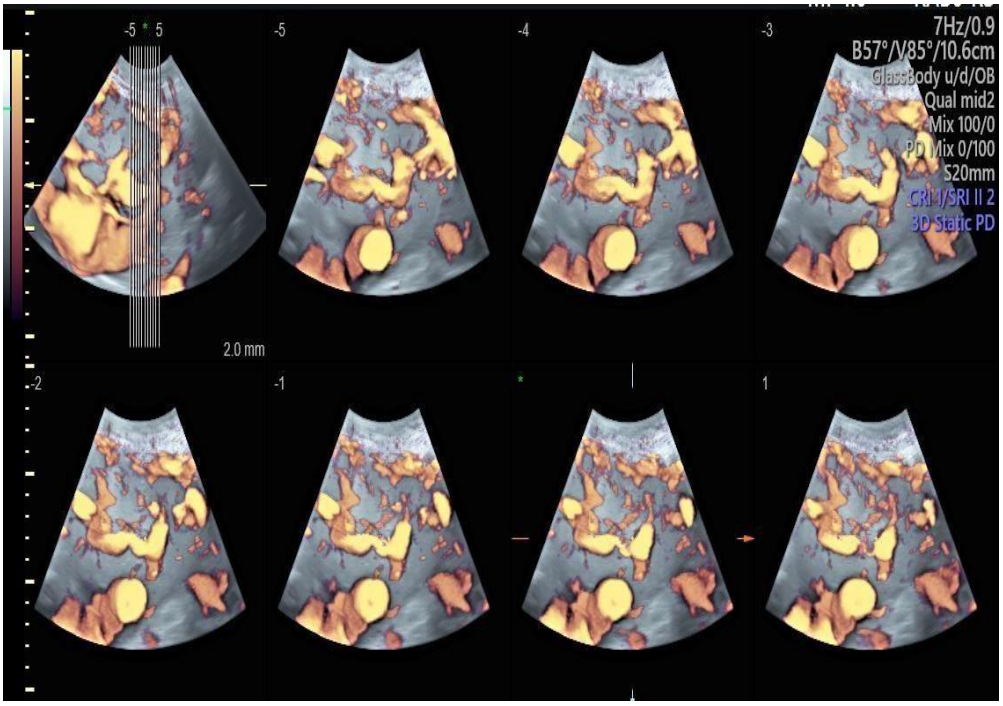

Figure (1): 3D multislice color flow Doppler showing hypervascularization of theserosa bladder interface.

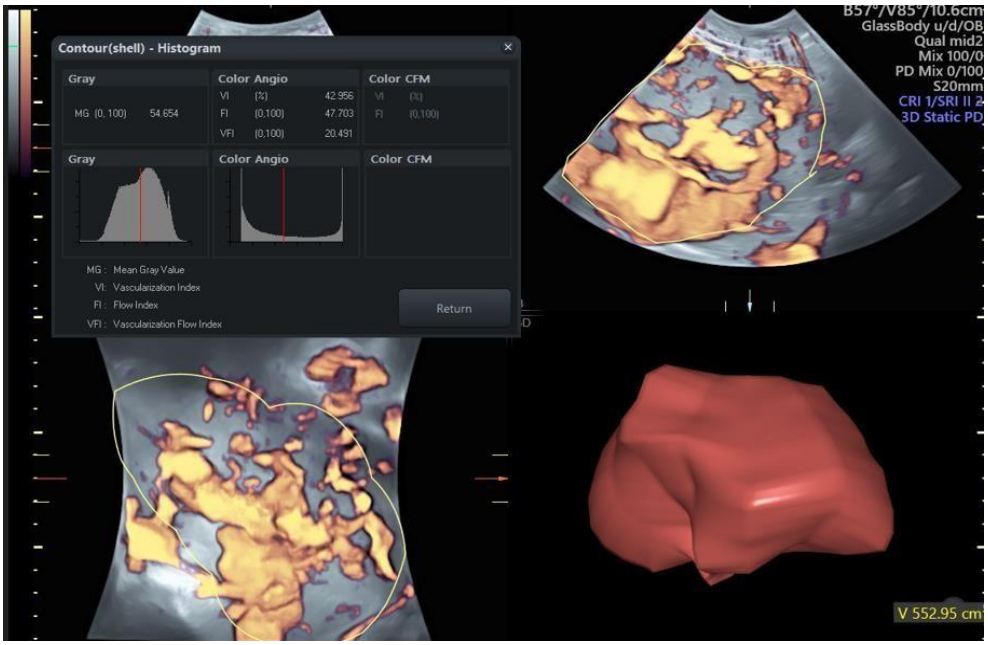

Figure (2): VI, FI, VFI usingmanual tracing to ROI histogram by VOCAL.

Operative Details:

The treatment involved either extreme surgery, such as a caesarean hysterectomy, or conservative surgery, such as lower segment repair and placenta removal with adherent myometrium. When the baby was born, the obstetricians provided the operational results of the invasive morbid placentation. It was difficult to separate and remove the placenta, which raised suspicions about intraoperative symptoms of placental invasion. In a uterus that is well-contracted, uncontrollably bleeding upon placental separation, lower uterine segment thinning, abnormal blood loss of more than 2000 cc, and abnormal vasculature of the lower uterine segment **[6].**

According to the placenta invasion, all studied pregnant women were classified to:

Type 1: The anterior segment was markedly thinner, and the placenta reached the serous surface; no newly produced placental vesical or vesico-uterine vessels were recognised; and there was a lax separating plane between the posterior bladder wall and the anterior surface of the uterine segment.

Type 2: The lower uterine segment and bladder's posterior wall were considerably thinner, there was no flexible plane between both organs and a fibrous scar joined them, and no newly developed placental vesical or vesico-uterine veins were visible.

Type 3: Characterised by a thinner uterine segment, vesical wall of varied thickness, the existence of placental-vesical and vesico-uterine neovascular circulation, and the vesico-uterine plane with or without fibrous adhesion.

Ethical approval:

The study was authorised by Menoufia University's Faculty of Medicine Ethics Committee. Each participant received a full summary of the study's aims prior to completing an informed consent form. The Helsinki Declaration was observed at all stages of the study.

Statistical analysis

The acquired data was coded, tabulated, and statistically analysed with SPSS version 26.0. Data was analysed using the Shapiro-Wilk test for normality, followed by independent and paired t-tests. Qualitative data were expressed in terms of numbers and percentages, and variables with tiny predicted numbers were compared using the Chi-square test and Fisher's exact test. P-values < 0.050 were considered significant; otherwise, they were non-significant. A significant level was defined as a P value of less than 0.05.

RESULTS

Of the 63 women diagnosed with MAP at Menoufia University Hospital, 22 were excluded from the study (9 declined consent and 13 did not meet the inclusion criteria), while 41 women agreed to participate and were divided into three groups: type 1 (n=20), type 2 (n=4), and type 3 (n=17) (Figure 3).

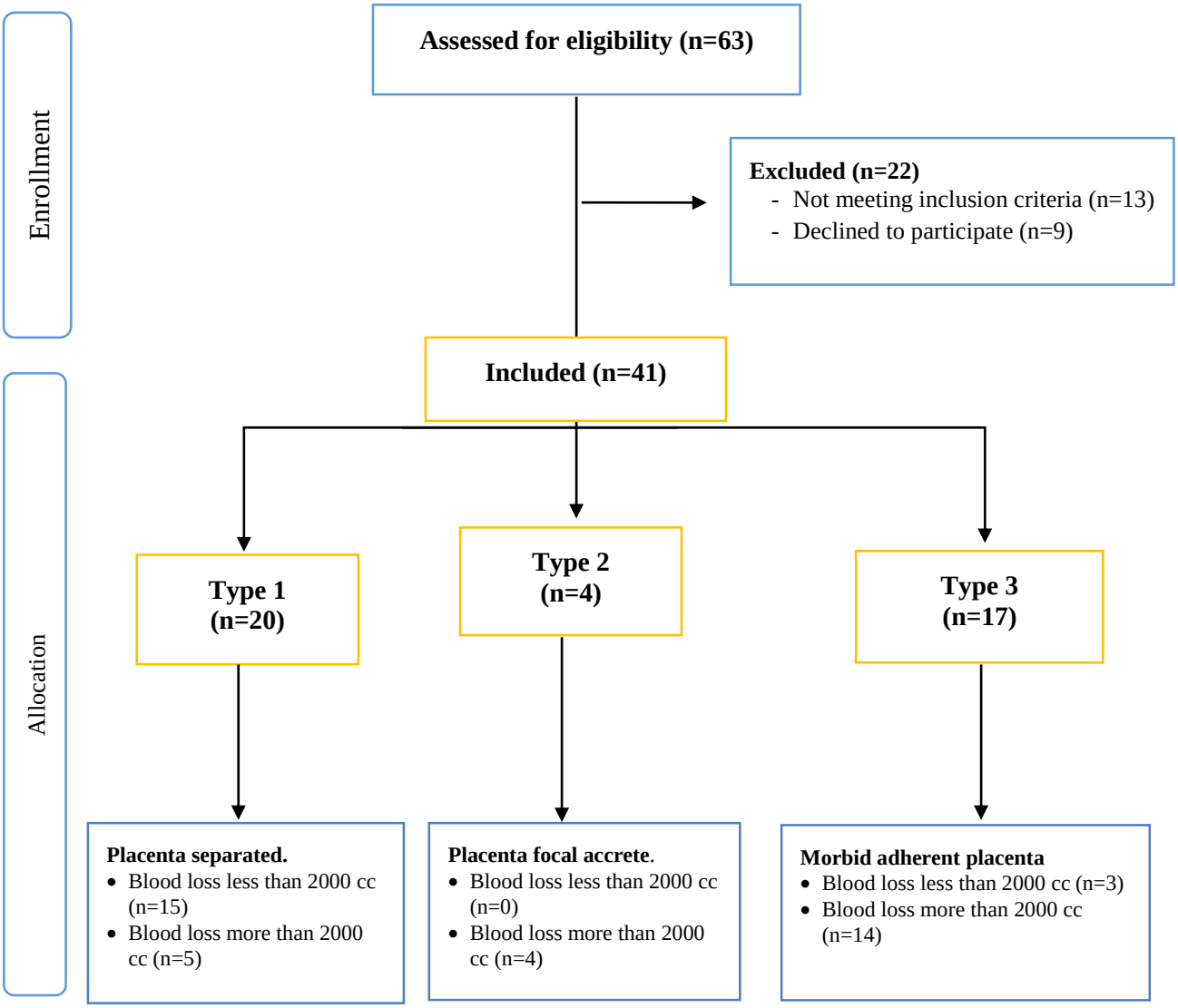

Figure (3): Flowchart of the studied patients.

In our study, there was no significant difference among the studied groups regarding age, height, weight, and placental location **(Table 1).**

Table (1): Demographic data among the studied groups (n=41).

Variable	Type 1 (n=20)	Type 2 (n=4)	Type 3 (n=17)	F	P value
Age (years)					
Mean± SD	28.40±6.18	32.50±4.36	29.82±5.34	0.942	0.399
Range	22.00-39.00	29.00-38.00	22.00-39.00		
Height (cm)					
Mean± SD	164.85±4.96	163.00±2.45	168.41±6.55	2.604	0.087
Range	157.00-170.00	160.00-165.00	150.00-175.00		
Weight (Kg)					
Mean± SD	93.90±7.04	94.25±8.06	95.29±12.41	0.096	0.909
Range	85.00-108.00	85.00-101.00	80.00-121.00		
Placental location					
PP complete centralis	9 (45%)	3 (75%)	14 (82.3%)	X^2= 3.820	0.701
PP incomplete centralis	2 (10%)	2 (50%)	3 (17.6%)		
PP marginalis	2 (10%)	2 (50%)	1 (5.88%)		
PP lateralis	1 (5%)	1 (25%)	1 (5.88%)		

F: One-way ANOVA test,

In our study, there was significant difference among the studied groups regarding blood loss less than 2000 cc, blood loss more than 2000 cc, vesico-uterine plane, and vesico-uterine neovascularization. On the other hand, there was no significant difference among the studied groups regarding thin anterior uterine segment and placenta reach serous surface **(Table 2).**

Table (2): Intraoperative findings among the studied groups.

Variable	Type 1 (n=20)		Type 2 (n=4)		Type 3 (n=17)		X^2	P value
	N	%	N	%	N	%		
Blood loss less than 2000CC	15	75.0	1	25.0	3	17.6	15.742	**<0.001***
Blood loss more than2000cc	5	25.0	4	100.0	14	82.4	15.742	**<0.001***
Thin anterior uterine segment	20	100.0	4	100.0	17	100.0	0.000	1.000
Placenta reach serous surface	20	100.0	4	100.0	17	100.0	0.000	1.000
Vesico-uterine plane	19	95.0	1	25.0	1	5.88	34.196	**<0.001***
Vesico-uterine neovascularization	1	5.0	2	50.0	16	94.1	33.118	**<0.001***

*Significant

The current study indicated that, there was a significant difference between the studied groups of women regarding placenta separation, focal accretion, preserve uterus, and CS hysterectomy **(Table 3).**

Table (3): Operative outcome among the studied groups.

Variable	Type 1 (n=20)		Type 2 (n=4)		Type 3 (n=17)		X^2	^{mc}P value
	N	%	N	%	N	%		
Placenta separation	19	95	1	25.0	1	5.88	30.43	<0.001*
Focal accretion	1	5.0	3	75	2	11.8	13.26	0.005*
Uterus preservation	19	95	3	75	1	5.88	30.28	<0.001*
CS Hysterectomy	1	5.0	1	25.0	16	94	30.28	<0.001*

*Significant

In the present study, loss of sonolucency was the most 3D multislice color flow Doppler in the diagnosis of MAP with accuracy 92.3%, followed by placental lacunae with accuracy 84.5%, then abnormal uterine serosa bladder line by 80.55% of accuracy **(Table 4).**

Table (4): Diagnostic characteristics of 3D multislice color flow Doppler in the diagnosis of MAP.

Test Result Variable(s)	Std. Error	Sig.	Ses.	Spac.	Accuracy	95% C I	
						Lower	Upper
Placental lacunae 3D	0.067	<0.001*	94.1	29.2	84.5	0.69	0.96
Loss of sonolucency 3D	0.057	<0.001*	94.1	16.7	92.3	0.78	1.00
Abnormal uterine serosa bladder line	0.079	0.004*	70.6	16.7	80.55	0.61	0.92

CI: Confidence Interval, **Std. Error** stander error, **Sig.:** Significance, **Ses. :** Sensitivity, **Spac**: specifity. *: Significant,

In our study, placental VI and VFI were significantly increased among type 3 than type 2 and type 1 respectively **(Table 5).**

Table (5): 3D color flow Doppler analysis of placental volume by "VOCAL" among the studied groups (n=41).

Variable	Type 1 (n=20)	Type 2 (n=4)	Type 3 (n=17)	K	P value
Placental volume vascularization index 3D				11.681	0.003*
Mean± SD	43.14±17.54	57.73±24.46	61.73±16.41		
Range	26.30-64.87	21.22-71.60	21.22-79.45		
Post Hoc	P1= 0.141, **P2=0.003*,** P3=0.687				
Placental volume flow index 3D				1.005	0.605
Mean± SD	34.97±5.87	36.02±4.01	37.96±4.95		
Range	21.50-38.98	32.40-41.76	32.40-47.00		
Placental volume VFI 3D					
Mean± SD	15.49±6.47	20.11±7.68	22.83±4.96	9.119	0.010*
Range	9.75-23.68	8.86-25.03	8.86-30.60		
Post Hoc	P1= 0.168, **P2=0.001*,** P3=0.419				

*Significant

P1: Type 1 Vs type 2, **P2:** Type 1 Vs type 3, **P1:** Type 2 Vs type 3.

In the current study, the cutoff points of placental VI 3D, FI 3D, and VFI 3D as markers in prediction of placental invasion among cases were 23.760, 32.405, and 9.305 respectively. Finally, among the 3D Doppler indices, VI had the best index in prediction of placental invasion, followed by VFI while FI had the lowest **(Table 6 and Figure 4).**

Table (6): Validity (AUC, sensitivity, specificity) for analysis of placental volume by "VOCAL" in prediction of placental invasion (morbid adherent placenta).

Test Result Variable(s)	AUC	Std. Error	Sig.	Ses.	Spac.	Cutoff value	95% C I	
							Lower	Upper
Placental volume vascularization index 3D	0.771	0.080	0.003*	94.1	95.8	23.760	0.61	0.93
Placental volume flow index 3D	0.513	0.102	0.884	88.2	83.3	32.405	0.31	0.71
Placental volume VFI 3D	0.749	0.080	0.007*	94.1	95.8	9.305	0.59	0.91

CI: Confidence Interval, *: Significant

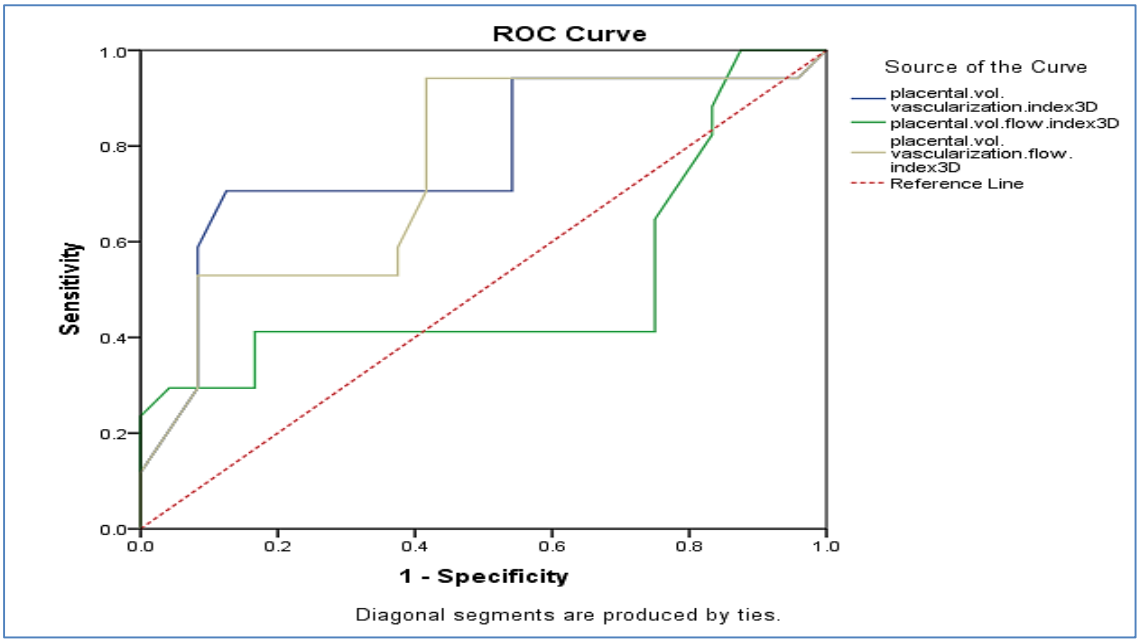

Figure (4): ROC curve for analysis of placental volume by "VOCAL" in prediction of placental invasion.

Data in table 7 indicated that, based on intraoperative diagnosis, 3D multislice color flow Doppler could predict MAP in 20 out of 21 patients diagnosed intraoperative (true positives). It did not detect MAP pathology in 19 patients (true negatives). There were 1 false negative and 1false positive results. So, we found that 3D multislice Doppler had overall sensitivity, specificity, and diagnostic accuracy of 95%, 92% and 89% respectively **(Table 7).**

Table (7): Accuracy measures of 3D multislice color flow Doppler in prediction of MAP in relation to intraoperative diagnosis.

		Intraoperative diagnosis					Sensitivity	Specificity	PPV	NPV	Accuracy
		Negative (Free)		Positive (MAP)		Total					
		No.	%	No.	%						
3D Multi-slice Doppler	**Negative**	19	46.3%	1	2.43%	20	95%	92%	90%	93%	89%
	Positive	1	2.43%	20	48.7%	21					
	Total	20	46.3%	21	48.7%	41 (95%)					

Regression analysis indicated that presence of placental lacunae was the major predictive value for MAP, followed by VFI, and VI was the third significant predictive factor. While other parameters didn't show any significant effect in the present cohort of MAP patients **(Table 8).**

Table (8): Regression analysis for the parameters associated with MAP among studied women.

Parameters	B	S.E.	Wald	P-value	Odds ratio (OR)	95%CI	
						Lower limit	Upper limit
3D Loss of sonolucency	0.341	0.135	0.180	0.018*	1.77	0.064	0.618
Abnormal uterine serosa bladder line	-0.025-	0.072	-0.013-	0.728	0.13	-0.173-	0.122
Vesico-uterine plane	0.141	0.094	0.075	0.145	0.88	-0.052-	0.335
Vesico-uterine neovascularization	-0.038-	0.117	-0.020-	0.747	0.165	-0.279-	0.203
3D-abnormal placental lacunae	0.291	0.099	0.153	0.006*	2.66	0.090	0.492
3D: VI	0.954	0.016	0.830	**0.045***	1.055	1.016	1.096
3D: FI	0.004	0.008	0.022	0.623	0.108	-0.012-	0.020
3D: VFI	1.150	0.023	1.850	**0.024***	1.194	1.061	1.342

CI: Confidence Interval, *: Significant.

DISCUSSION

Although there are limitations to prenatal diagnosis since it is not a histological diagnosis, 2D ultrasound, 3D multislice Doppler, and MRI play a significant role in the prenatal diagnosis of morbidly adherent placentas [4]. The fast-evolving 3D multislice Doppler imaging method has a lot of potential applications in obstetrics and gynecology. In addition to being used to map and define uterine lesions like fibroids, adenomyosis, and intrauterine synechia, as well as to assess artefacts in fetal heart scanning during the second trimester, its reported sensitivity and specificity for diagnosing congenital uterine anomalies are nearly 100%, comparable to those of MRI and laparoscopy [10].

In the current study, there was no significant difference among the studied placental invasion types regarding age, height, weight. In same line with our study **Khalil *et al.*** [11] demonstrated that there were no statistically significant variations in age, BMI, and GA based on placental invasion (invasion = 21 and no invasion = 29). When it came to parity, there was a big disparity. **Fathy *et al.*** [12] concurred with the current study in these matched investigations, stating that there was no significant difference in age, BMI, or GA, but disagreed with it regarding parity, stating that there was no significant difference in parity. In comparison to anterior placenta adhesion, which had a GA of 36 weeks (range 33–39), **Abotorabi *et al.*** [13] found that the median GA at delivery in lateral and posterior placenta adhesion was 34 weeks (range 29–39). This finding is similar to another study that found that women with placenta accreta had a GA of 37 weeks [14].

In our study, most cases (63.41%) had placenta previa complete centralis, 17.07% of them had placenta previa incomplete centralis and 12.19% of them had placenta previa marginalis, then 7.3% had placenta previa lateralis. However, placental location didn't have a significant difference among the placental invasion types. In the same trend, **Abotorabi *et al.*** [13] examined the impact of placenta position on issues associated to placental adhesion, as well as its risk factors and outcomes. After reviewing seventy cases, they discovered that the distribution of placenta placement was as follows: 27% posterior, 16% lateral, and 57% anterior. Severity of invasion accreta/increta placenta were more common at anterior placenta (56.6%) compared to posterior placenta (26.4%) and lateral placenta (16.9%). While percreta placenta was found in 58.8% of patients at anterior placenta followed by posterior placenta (29.4%) then lateral placenta (11.7%). However, there were no significant differences between anterior, posterior, and lateral placenta locations with severity of invasion.

An excessively deep placental anchoring villi and trophoblast invasion can occur at the scar location due to a deficiency in the endometrium-myometrium interface, which prevents normal decidualization surrounding a uterine scar [15]. The placental villi adhere to smooth muscle fibres rather than decidual cells when there is a uterine scar that prevents the decidua and thus Nitabuch's layer from developing. The anti-invasive substances that the decidua ordinarily release are insufficient as a result of diminished decidualization [16].

In current investigation, placental volume vascularization index and VFI were significantly increased among type 3 than type 2 and type 1, respectively. While placental volume FI 3D was not significant among the types. The study of **De Paula *et al.*** [17] indicated that, in spite of the notable increase in placental volume, the placental vascular indices determined by 3D-Doppler ultrasonography had a consistent distribution throughout gestation. This finding implies that placental vascularization, or the quantity of arteries and blood flow, may rise in proportion to the amount of the organs, helping to keep the placental vascular indices consistent throughout the course of pregnancy, as shown by the 3D-Doppler histograms.

In line with our study, **Soliman *et al.*** [18] reported considerably higher VI and VFI in preeclampsia placentae compared to normal pregnancies, although there was no significant correlation. As regard to **Ali *et al.*** [19] found lower values for all three indices in pregnancies affected by preeclampsia, which is unsurprising given defective placental circulation leading in hypoperfusion of the placenta. Furthermore, **Mercé *et al.* [20]** demonstrated increased levels of all indices related with gestational age.

In contrast of our study, **Haggag *et al.*** [21] assessed the relationship between the degree of preeclampsia and the placental vascularization determined during the third trimester of pregnancy. The non-severe group had considerably higher values for all indices (VI, FI, and VFI) than the severe group did. Furthermore, **Chen *et al.*** [10] revealed a significant decrease in all indices in severe preeclampsia when compared to the control group, indicating the limited usefulness of 3D Doppler indices in predicting the severity of preeclampsia.

Our research revealed, there were notable differences between the groups under investigation in terms of 3D sonolucency loss, abnormal uterine serosa bladder line, multislice Doppler suspect MAP 3D, placenta invasion, placenta separation, focal accretion, preserve uterus, CS hysterectomy, vesico-uterine plane and vesico-uterine neovascularization. Loss of sonolucency 3D was found in 4 (100%) of women of type 2 and 16 (94.1%) of type 3. Also, abnormal uterine

serosa bladder line was found in 4 (100%) of women of type 2 and 12 (70.4%) of type 3. On the other hand, no significant difference among the studied groups regarding disruption of the hyperechoic serosa bladder interface, irregular or loss of retroplacental sonolucent zone, thin anterior uterine segment and placenta reach serous surface. Consistent with our research, **Moniem *et al.*** [22] discovered that women who experienced challenging placental delivery, severe intraoperative blood loss, or emergency hysterectomy for bleeding management had a notably higher frequency of prior caesarean procedures. In contrast **Wright *et al.*** [23] came to the conclusion that there was no meaningful correlation between substantial blood loss, parity, the number of prior caesarean births, and the degree of placental invasion. Further research conducted by **Warshak *et al.*** [24] found a substantial correlation between prenatal identification of placenta accreta and a reduction in maternal hemorrhage.

Furthermore, **Japaraj *et al.*** [25] research, using a different approach from the current study, discovered that the most notable colour Doppler diagnostic sign was the existence of aberrant arteries linking the placenta to the bladder. Clogged vasculature across the peripheral sub-placental zone had the greatest diagnostic qualities among multislice 3D Doppler signals in the diagnosis of placental invasion, with sensitivity and specificity of 95.2% and 93.1%, respectively, in terms of agreement between multislice 3D Doppler and placental invasion. Very low agreement was found between multislice 3D Doppler and placental invasion and aberrant placental lacunae, but very high agreement was found between the two regarding disruption of the serosa-bladder interface.

In our study, there was a significant relation between types of placenta invasion with blood loss less than 2000 CC, blood loss more than 2000 cc. blood loss more than 2000 cc was significantly higher with type 3 than type 1 and 2. In the study, by **Abotorabi *et al.*** [13]**,** in anterior PAS, 200–4500 ml in posterior PAS, and 200–5000 ml in lateral PAS, the average blood loss was recorded. Blood loss beyond 3500 to 5500 ml has been linked to placenta accreta or increta (lower grades), according to **Schwickert *et al.*** [26]. According to research, in placenta percreta (higher grades), blood loss above 3500 ml typically happens when the placenta invades other organs; in contrast, blood loss is typically less when there is no placental invasion into other organs. The mean estimated blood loss for patients with PAS in this research varied from 2000 to 7800 ml. A median of five units of pRBC were given to each patient, and many patients needed many blood transfusions [26].

Studies have indicated that patients with PAS who had a median blood loss of 2500–3000 ml at the time of surgery are at high risk for catastrophic hemorrhage [27,28]. But all placenta location groups had the same set of credible indicators of life-threatening blood loss in PAS [23]. The lateral placenta position in previa and PAS patients has also been shown to influence perinatal outcomes like blood loss [29]. Additionally, in placenta previa, the non-lateral placenta had a greater amount of blood loss compared to the placenta located in the lateral uterine wall. This difference in blood loss may be caused by the placenta's central portion receiving blood from both uterine arteries rather than just one [30].

In our study, the cutoff point of placental volume vascularization index 3D as a marker in prediction of placental invasion among cases was 23.760, with sensitivity of 94.1%, specificity of 95.8% at AUC of 0.771. Cutoff point of placental volume FI 3D as a marker in prediction of placental invasion among cases was 32.405, with sensitivity of 88.2%, specificity of 83.3% at AUC of 0.513. Cutoff point of placental volume VFI 3D as a marker in prediction of placental invasion among cases was 9.305, with sensitivity of 94.1%, specificity of 95.8% at AUC of 0.749 and among the 3D Doppler indices, VI had the best index in prediction of placental invasion, followed by VFI while FI had the lowest. Much more like our study, in line with our findings, **Moniem *et al.*'s** [22] investigation found that the 3D MSV Doppler may be used as an additional, helpful technique in addition to the 3D power or colour Doppler to help with MAP diagnostic refinement. The 3D MSV Doppler improved the diagnostic criteria of MAP in terms of accuracy and predictive values. When utilising the 3D power Doppler to identify difficult placental separation and significant intraoperative blood loss in cases of MAP, the NPV (79.6% and 82.2%, respectively) of congested vessels across the peripheral sub-placental zone was enhanced to 82.6% and 84%, respectively, when employing the 3D MSV Doppler. Furthermore, the 3D MSV Doppler improved the sensitivity, specificity, and PPV (90.9%, 68.8%, and 47%, respectively) of the disruption of the uterine serosa-bladder interface for the purpose of identifying emergency hysterectomy in cases of MAP, compared to the 3D power Doppler's 100%, 71.8%, and 50%, respectively.

Additionally, **Chen *et al.*** [31] showed that the VI, which measures the proportion of vascularized tissues, is one of the three indicators or factors measuring placental perfusion and vascularization. The relative quantity of moving blood in the tissues that were collected is measured by the VFI. The placental sample's blood movement amplitude is measured by FI. In contrast with our study, **Moran *et al.*** [32] who found that whereas FI was shown to increase with pregnant age, VI and VFI were not affected by pregnancy. Within the range of 24 to 30 weeks, all three indices were below the usual levels.

In our study, placental lacunae by 3D as a marker in prediction of placental invasion among cases had sensitivity of 94.1%, specificity of 29.2% at AUC of 0.825. Loss of sonolucency 3D as a marker in prediction of placental invasion among cases had sensitivity of 94.1%, specificity of 16.7% at AUC of 0.887.and

abnormal uterine serosa bladder line as a marker in prediction of placental invasion among cases had sensitivity of 70.6%, specificity of 16.7% at AUC of 0.770. Loss of sonolucency was the most 3D multislice color flow doppler in the diagnosis of MAP with accuracy 92.3%, followed by placental lacunae with accuracy 84.5%, then abnormal uterine serosa bladder line by 80.55% of accuracy. Study by **Comstock *et al.* [33]** found in another research that obliteration of the retro-placental region is not a reliable indication for the diagnosis of placenta accrete, and many vascular gaps inside the placenta (placental lacunae) was the most prominent diagnostic sign for placenta accreta with high PPV. Furthermore, they also discovered that while the gap between the placenta and myometrium may often be missing in the absence of MAP, its absence is not a diagnostic indicator of the condition. For the purpose of identifying placental sinuses that penetrate the uterine wall and enter the bladder, they suggested using a colour Doppler.

CONCLUSION

In conclusion, among the 3D Doppler indices, VI had the best index in prediction of placental invasion, followed by VFI while FI had the lowest. Additionally, loss of sonolucency was the most 3D multislice color flow Doppler in the diagnosis of MAP with accuracy 92.3%, followed by placental lacunae with accuracy 84.5%, then abnormal uterine serosa bladder line by 80.55% of accuracy. Finally, combined VI with signs of 3D multislice color flow Doppler as (loss of sonolucency, placental lacunae) were the best diagnostic tools for placental invasion.

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