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## Original Article

# Comparison Between the Roles of Trans-abdominal 3D Ultrasound Versus Transvaginal 2D Ultrasound in Evaluation of Placental Invasion in Cases of Placenta Previa with Previous Uterine Scar

Abdelhalim Hammouda Abdelhalim Hammouda\*<sup>[1]</sup>, Abd Elraouf Mohammad Oun <sup>[2]</sup>;  
 Mahmoud salah Mahmoud <sup>[2]</sup>; Hamada Aboelmaaty <sup>[2]</sup>

<sup>1</sup> Department of Obstetrics and Gynecology, Sherbin General Hospital, Ministry of Health, Egypt.

<sup>2</sup> Department of Obstetrics and Gynecology, Damietta Faculty of Medicine, Al-Azhar University, Egypt.

## ABSTRACT

### Article information

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\*Corresponding author

Email: [7aleem90@google.com](mailto:7aleem90@google.com)

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**Background:** The correct diagnosis of placenta previa is a crucial task to prevent associated complications. Ultrasound is considered the gold standard technique. However, the appropriate technique, with 100% sensitivity is not yet determined.

**The aim of the work:** The current study aimed to compare the transabdominal 3D versus transvaginal 2D ultrasound in the assessment of placental invasion in women with placenta previa with previous uterine scar.

**Patients and Methods:** The study included sixty patients with confirmed ultrasound placenta previa. Each patient was evaluated by the full history taking, clinical examination. Finally, ultrasound was performed for all women. The placenta was examined while the bladder is partially full [about 300 ml] for adequate visualization and precise localization. A complete US scan had been performed and included 2D vaginal ultrasound, and 3D abdominal ultrasound. At delivery, intraoperative definitive diagnosis of abnormally invasive placenta was made. Data compared to the previous ultrasound diagnosis.

**Results:** The hematocrit value was significantly decreased after the operation compared to preoperative values [ $27.16 \pm 2.51$  vs  $30.92 \pm 2.78$ , respectively,  $p = 0.024$ ]. The sensitivity of 3D transabdominal ultrasound was 53.3%, 65.0%, 88.3% and 73.3% for the detection of retroplacental clear zone, myometrial thinning, uterovesical vascularity and bladder wall interruption, successively. Otherwise, the 2D transvaginal ultrasound sensitivity was 75%, 71.6%, 83.3% and 7.7% for the same conditions. The 3D transabdominal US was 72.5% sensitive, 90% specific, 84.1% PPV, 60.9% NPV and 76.7% accuracy. The 2D transvaginal US revealed 87.4% sensitivity, 73.7% specificity, 93.3% PPV, 41.6% NPV and 89.3% accuracy.

**Conclusion:** 2D vaginal ultrasound is more sensitive compared to the 3-D abdominal sonography in detecting placenta previa. However, the 3D transabdominal US higher sensitivity in detecting some radiological signs of this lesions like uterovesical vascularity.

**Keywords:** Ultrasound; Transabdominal; Transvaginal; Three Dimensional; Cesarean Section Scar.



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## INTRODUCTION

Placenta previa [PP] describes abnormal implantation of placenta over or within two centimeters away from the internal os of the cervix. At the middle of the second trimester of pregnancy, the pp incidence is approximately

20%, based on ultrasonographic [US] diagnosis. Then, it reduced to 0.4-0.5% at the full-term. A definite PP diagnosis is crucial to share in prevention of maternofetal complications <sup>[1]</sup>.

The localization of the placenta by trans-abdominal sonography [TAS] is a standard

exercise for a long period of time. Despite its non-invasive nature and availability, the precision of TAS may be restricted by different conditions [e.g., posterior implantation of the placenta, the condition of bladder filling [under or over-filling], the existence of blood clots, fibroids, and obesity] [2]. However, TVS has been advised as the gold standard diagnostic test for PP by many researchers.

At primary care centers, expert obstetricians and suitable facilities may not be accessible to do TVS. This state is principally common in third-world countries where TAS is accessible in most medical facilities but access to TVS is restricted [3]. These restrictions are overcome by TVS, which offers an improved resolution by the use of a high frequency transducer, shorter distance from the internal cervical os to the TVS transducer, and is not affected by the condition of the bladder filling [4].

Most of previous studies compared TVS and TAS accuracy in the PP diagnosis. In 2007, one study reported that, TVS is more accurate in determination of the distance between placenta and internal os [5]. Another study compared TAS and TVS on 81 pregnant women with a potential diagnosis of pp in the third trimester. The confirmation of diagnosis was done at delivery. PP was confirmed among 85.0% of women. The sensitivity of TAS and TVS were 86% and 95%, respectively]. The specificity of both methods was 93% and the overall accuracy of TAS and TVS was 89% and 94%, respectively [6].

Another research conducted to assess the accuracy of TAS and TV gray-scale and color Doppler in PP accreta diagnosis in patients with previous cesarean sections. Seven of 21 women had US indicators of placenta accreta and all were confirmed intraoperatively to have PP accreta. The positive findings on gray-scale ultrasound were present in six of the seven women [7].

There are a few studies that discussed the accuracy of both trans-abdominal three-dimensional [3D] US versus transvaginal two-dimensional [2D] US in the evaluation of placental invasion in cases of PP with previous uterine scar. Hence, this study was conducted to assess the sensitivity and specificity of both

diagnostic measures in diagnosis of placental invasion.

## THE AIM OF THE WORK

The current work aimed to compare the transabdominal 3D versus transvaginal 2D ultrasound in the placental invasion assessment in women with placenta previa and previous uterine scar.

## PATIENTS AND METHODS

The study was conducted in Obstetrics and Gynecology Department- Al-Azhar University [New Damietta] during the period from June 2019 to March 2021. Sixty patients were selected to participate in the study to deal with comparison between the roles of trans-abdominal 3D ultrasound versus trans-vaginal 2D ultrasound in the evaluation of placental invasion in cases of placenta previa with previous uterine scar.

The inclusion criteria were patients age 18-45 years old, with singleton pregnancy, had confirmed persistent PP anterior wall after 28 weeks of gestation, history of previous caesarian section and/or any other type of uterine surgery [myomectomy, hysterotomy]. On the extreme side, the exclusion criteria were PP posterior wall, multiple pregnancies, and chronic illness [e.g., renal, cardiac, liver, diabetes mellitus, etc.]

**Ethical considerations:** The study protocol had been submitted, evaluated and accepted by the local research and ethics committee of Damietta Faculty of Medicine, Al-Azhar University [IRB number: IRB 00012367-19-04-003]. All women signed an informed consent to participate in the study; their privacy and withdrawal right at any time without any harm were guaranteed. Data used for the purpose of research and all data are available on request.

Each patient was assessed through full history taking, general physical and obstetric examination. Finally, ultrasound was performed for all participating women. The placenta was investigated with partial filling of the bladder [about 300 ml] for satisfactory visualization and accurate localization. A complete US scan had been performed and included 2D vaginal

ultrasound, and 3D abdominal ultrasound. All ultrasound examinations were performed by the same investigator. The ultrasound collected data included the following:

- **Loss of ‘clear zone’:** The hypoechoic myometrial plane below the placental bed [clear zone] was lost or irregular.
- **Bladder wall interruption:** The bright wall of the bladder was lost or interrupted [the line between uterine serosa and bladder showed hyperechoic band].
- **Myometrial thinning:** The myometrium over the placenta was thinned to <1 mm or even undetectable.
- **Uterovesical hypervascularity:** Striking amount of color Doppler signal seen between myometrium and posterior bladder wall; this sign perhaps specifies numerous, closely packed, tortuous vessels in this area.

At delivery, intraoperative final diagnosis of abnormal placental invasion was made when the myometrium invasion by the placenta was confirmed. Data compared to the previous ultrasound diagnosis

#### Statistical analysis and interpretation:

Data were coded and fed to the computer and analyzed using SPSS version 22.0 [IBM® SPSS® Inc., USA]. Qualitative data were presented in frequencies and percentages. Quantitative data were expressed as median for non-parametric data and mean± standard deviation for parametric data after testing normality by Kolmogorov-Smirnov test. The statistical significance of the obtained results was considered at p value < [0.05].

The *Chi-Square* or *Fischer Exact* tests were used for comparison of qualitative groups. On the other side, independent samples, Student “*t*”-test or *Mann-Whitney “U”* were used to compare the two quantitative groups. The diagnostic performance of a test, or the accuracy of a test to discriminate the categorical outcome was assessed using sensitivity and specificity, positive predictive value [PPV], negative predictive value [NPV] and overall accuracy.

## RESULTS

The mean age of the participating women was  $27.27 \pm 5.17$  years with a range between 19 and 40 years. The mean GA at presentation was  $28.35 \pm 3.03$  weeks with a range between 19 and 35 weeks. The median number of gravidities was 3 with a range between 1 and 6 while the median number of parities was 2 with a range between 1 and 4. The mean duration since the last delivery was  $2.45 \pm 1.45$  years with 1 year as minimum period and 6 years as the maximum period. The mean GA at delivery was  $35.63 \pm 1.35$  weeks with a range between 34 and 38 weeks.

The mean preoperative hematocrit value was  $30.92 \pm 2.78\%$  while it decreased postoperatively to  $27.16 \pm 2.51\%$  with a statistically significant difference between the two groups [p = 0.024].

Table [1] describes the operative data. The significant blood loss was detected in 28 patients, 38 women required blood transfusion. Difficult placental separation was reported in 37 patients, 29 women required internal iliac artery ligation and 8 patients had intraoperative bladder injury. The placenta invaded the bladder of three patients and invaded other organs of two patients. In addition, 34 patients required administration of uterotonics and 19 women needed emergency hysterectomy.

As shown in table [2], 3D-transabdominal US detected retroplacental clear zones correctly in 32 patients [53.3%] while 2D-transvaginal US detected correct findings in 45 women [75%]. 3D- transabdominal US detected myometrial thinning correctly in 39 patients [65%] while 2D- transvaginal US detected correct findings in 43 patients [71.6%]. 3D-transabdominal US detected utero-vesical vascularity correctly in 53 patients [88.3%] while 2D-transvaginal US detected correct findings in 50 women [83.3%]. 3D-transabdominal US detected bladder wall interruption correctly in 44 women [73.3%] while 2D-transvaginal US detected correct findings in 46 women [76.7%].

Regarding the diagnostic accuracy of 3D-transabdominal US revealed 72.5% sensitivity and 90% specificity, 84.1% PPV, 60.9% NPV

and 76.7% accuracy. Regarding the diagnostic accuracy of 2D-transvaginal US revealed 87.4%

sensitivity and 73.7% specificity, 93.3% PPV, 41.6% NPV and 89.3% accuracy [Table 3].

**Table [1]:** Analysis of operative data in the cases of the study.

Variable	Study subjects [n=60]	
	Yes	No
<b>A Significant blood loss</b>	28 [46.7%]	32 [53.3%]
<b>Blood transfusion</b>	38 [63.3%]	22 [36.7%]
<b>Easy placental separation</b>	23 [38.3%]	37 [61.7%]
<b>Internal iliac artery ligation</b>	29 [48.3%]	31 [51.7%]
<b>Intraoperative bladder injury</b>	8 [13.3%]	52 [86.7%]
<b>Administration of uterotonics</b>	34 [56.7%]	26 [43.3%]
<b>Bladder invasion by the placenta</b>	3 [5%]	57 [95%]
<b>Other organs invasion</b>	2 [3.3%]	58 [96.7%]
<b>Emergency hysterotomy</b>	19 [31.7%]	41 [68.3%]

**Table [2]:** Comparison of the accuracy between 3D TAS and 2D TVS in the different findings.

Findings	3D Transabdominal US [N=60]		2D Transvaginal US [N=60]		MCN	P
	Correct	Incorrect	Correct	Incorrect		
<b>Retroplacental clear zone</b>	32 [53.3%]	28[46.7%]	45[75%]	15[25%]	3.98	= 0.005*
<b>Myometrial thinning</b>	39[65%]	21[35%]	43[71.6%]	17[58.4%]	1.047	0.274
<b>Utero-vesical vascularity</b>	53[88.3%]	7[11.7%]	50[83.3%]	10[16.7%]	0.946	0.337
<b>Bladder wall interruption</b>	44[73.3%]	16[26.7%]	46[76.7%]	14[23.3%]	0.825	0.458

MCN: Monte-carlo test; P: probability; \*: statistically significant [ $p < 0.05$ ]

**Table [3]:** Comparison between the overall accuracy of 3D TAS vs 2D TVS.

	Sensitivity [%]	Specificity [%]	PPV [%]	NPV [%]	Accuracy [%]
<b>3D TAS</b>	72.5	90	84.1	60.9	76.7
<b>2D TVS</b>	87.4	73.7	93.3	41.6	89.3

PPV= positive predictive value, NPV= negative predictive value.

## DISCUSSION

There is a shortage in studies that reveal the diagnostic ability of ultrasound in the detection of antenatal abnormal placentation in cases of placenta previa and previous cesarean scar. Thus, the current study was conducted to compare between transabdominal 3D-ultrasound and transvaginal 2D-ultrasound in evaluation of placental invasion in PP with previous uterine scar. To the best of researcher's knowledge, no previous studies have compared the sensitivity of the two modalities regarding their sensitivity and specificity in the detection of abnormal placental invasion. This study included 60 pregnant women with persistent PP after 28 weeks' gestation who were assessed using the both modalities and followed up until delivery to correlate the results of ultrasonography with the pathological findings.

As in the current work, the study conducted by Sachan and his colleagues [8], revealed significant association between placental invasion and the number of previous cesarean

sections, with previous two lower-segment cesarean sections [LSCSs] [75.4%] and three LSCSs [78.6%] increasing chances of invasion, respectively [ $P = 0.001$ ]. It reflected the role of cesarean section scar in the pathogenesis of placental invasion. The chances of placental invasion increased as the number of cesarean sections increased.

One researcher stated that a number of prior cesarean deliveries were significantly linked to the risk of placental invasion. The risk of PP accreta was 11%, 40%, and >60% in women with one, two, and three prior cesarean sections with PP, respectively. It has been also found that there were increased odds of having PP accreta, increta, and percreta in women who had a history of prior uterine surgery and myomectomy [9].

In the current study, we have reported that a significant blood loss was detected in 46.7% and 63.3% of women required blood transfusion. Wright *et al.* [10] reported that 41.7% of women with an identified placental invasion [accreta] had lost  $\geq 5000$  mL of blood. However, there

was no significant association between parity, previous cesarean section deliveries, degree of invasion of the placenta, and blood loss. Thus, their results partially agree with the current work regarding blood loss, but contradicts the current results regarding the association between previous cesarean deliveries and placental invasion. This could be attributed to the difference inclusion criteria and different study design. They conducted a retrospective analysis and included only women underwent peripartum hysterectomy, with massive blood loss [ $> 5$  L] and transfusion of large volume of the blood [ $> 10$  units]

In the current study, placenta invaded the bladder in 5% and invaded other organs in 3.3%. This agrees with Japaraj *et al.* [7] who showed that all of their confirmed cases of pp accreta had at least one positive indicator on color Doppler US. All women had manifestations of interphase hypovascularity with abnormal vessels links between the placenta and the bladder. However, it is crucial to note that this appearance can be mistaken with bladder varices originating from neovascularized vessels from prior cesarean sections [11].

In the current work, 31.7% of women required emergency hysterectomy and 48.3% required internal iliac artery ligation [BIIAL]. Comparable results were shown by Abdel Moniem *et al.* [12] who reported that BIIAL was required in 28% of women, intrauterine compression balloon with placental bed stitches were required in 6% of women, and hysterectomy was done in 22% of women. Warshak *et al.* [13] assessed 99 women with placenta accreta confirmed by histopathological examination. They reach to the conclusion that the antenatal recognition and diagnosis of PP accreta was linked to a significant reduction in maternal blood loss. In addition, Tikkanen *et al.* [14] confirmed that the placenta accreta diagnosis may significantly decrease peripartum blood loss, and Chantraine *et al.* [15] showed that, the prenatal diagnosis of abnormally invasive placenta [AIP] decreases the morbidity.

The undiagnosed AIP led to more emergent hysterectomies. Eller *et al.* [16] demonstrated that planned hysterectomy and preoperative ureteric stents were associated with decreased maternal

morbidity.

Regarding the loss of the retroplacental clear zone, 3D TAS detected retroplacental clear zone correctly in 53.3% while 2D TVS detected correct findings in 75%. This agreed with Sedek *et al.* [17] who showed sensitivity 51.2%, specificity 71.4%, PPV 91.7%, NPV 19.2%, and accuracy 54.0% by TAS. Sensitivity 74.4%, specificity 85.7%, PPV 97.0%, NPV 35.3%, accuracy 76.0% were by TVS. Cali *et al.* [18] showed that the loss of retroplacental clear zone had sensitivity 90%, specificity 81%, PPV 57%, NPV 97%. However, Romeo *et al.* [19] stated that the loss of the retroplacental clear zone responsible for the majority of false positive results and the criterion should not be used by itself to make the diagnosis. Bhide *et al.* [20] found the absence of a clear space in 65% of women without PP accreta and in 100% of women with it. However, it is sensitive but not specific. The primary use of the clear space seems to effectively excludes PP accreta as it had a high negative predictive value [NPV].

In the current study, 3D TAS detected myometrial thinning correctly in 65% while 2D TVS detected correct findings in 71.6%. As reported in the study by Sachan *et al.* [8], minimum sagittal myometrial thickness  $< 1$  mm had a significant association with placental invasion [69.8%]. On the other hand, 33.3% of patients with myometrial thickness of  $> 3$  mm presented with invasion.

Values  $< 1$  mm for the smallest thickness of myometrium or the presence of large intraplacental lakes was 100% sensitive in predicting the prediction of PP accreta spectrum as observed on color Doppler ultrasound flow mapping when placenta implanted in proximity to the prior uterine scar [21]. Another study reported that a value  $< 1$  mm of myometrial thickness recognized in the third trimester of pregnancy, and the risk of AIP was 100% sensitive and 72% specific with a positive predictive value and negative predictive value of 72% and 100%, respectively [22].

In the current study, 3D TAS detected uterovascular vascularity correctly in 88.3% while 2D TVS detected correct findings in 83.3%. Sachan *et al.* [8] showed that there was no significant

association between placental invasion with bridging vessels was found in their study. One study reported that the occurrence of linking [bridging] vessels recognized with color Doppler was the most predictive parameter of PP accreta [9]. Japaraj *et al.* [7] found that the gray-scale prominent sign for diagnosis of PP accreta was dilated vessels extending from the placenta to myometrium, and the most prominent color Doppler sign for diagnosis of placenta accreta was abnormal vessels communicating the placenta to the bladder. In addition, Shi *et al.* [23] reported that the most specific gray-scale sign for diagnosis of placenta accreta was dilated vessels extending from the placenta to the myometrium, and the most prominent color Doppler diagnostic sign was the presence of abnormal vessels connecting the placenta to the bladder. Shi *et al.* [24] found that many vessels detected by the 3D-power Doppler was the best sole diagnostic sign of PP accreta, with 97% sensitivity, and they concluded that the 3D power Doppler is a valuable method for the diagnosis of morbidly adherent placenta [MAP].

In the current study, 3D TAS detected bladder wall interruption correctly in 73.3% while 2D TVS detected correct findings in 76.7%. This agrees with Sedek *et al.* [17] who showed that the bladder wall invasion, TVS had sensitivity 4.7%, specificity 100.0%, PPV 100.0%, NPV 14.6%, accuracy 18.0% by TAS and sensitivity 9.3%, specificity 100%, PPV 100%, NPV 15.2%, accuracy 22.0% by TVS. This came in accordance with Comstock and Bronsteen [25] where this finding had sensitivity 20%, PPV 75% and Bhide *et al.* [20] sensitivity 11%, specificity of 100% was unlike Cali *et al.* [18] where this criterion showed sensitivity 70%, specificity 100%, PPV 100%, NPV 100% [25]. The low sensitivity reported in Comstock & Bronsteen [25], and Bhide *et al.* [20] studies may be due to the use of non-specific conditions for all women at transvaginal ultrasound as used by Cali *et al.* [18]. In a larger study, the researchers first set 300 ml in the bladder to result with the best uterine-bladder interface visualization. Chou *et al.* [11] found that color Doppler yielded 82.4% sensitivity, 96.8% specificity, 87.5% and 95.3% positive and negative predictive values. Chou *et al.* [26] in another study, reported

a strong association between bladder invasion in morbidly adherent placenta and 3D power Doppler results, mainly hypervascularization of the uterine serosa-bladder interface and large rosette of varicosities in the base of the bladder. They concluded that 3DUS can be set as an adjunctive instrument with 2D US to recognize the invasion extent in MAP [26].

Color Doppler US has also been established to be a valuable diagnostic method in PP accreta. Many researchers found high sensitivity and specificity of color Doppler imaging for the diagnosis of PP accreta [11-13]

The diagnostic accuracy of 3D TAS revealed 72.5% sensitivity, 90% specificity, 84.1% PPV, 60.9% NPV and 76.7% accuracy. The diagnostic accuracy of 2D TVS revealed 87.4% sensitivity and 73.7% specificity, 93.3% PPV, 41.6% NPV and 89.3% accuracy. In a recent Egyptian study, the sensitivity was 69.8%, specificity 100%, PPV 100%, NPV 35.0%, accuracy 74.0% by TAS and sensitivity 71.2%, specificity 100%, PPV 100%, NPV 36.8%, accuracy 76.0% by TVS [17]. This was also confirmed by Cali *et al.* [18].

Although no previous studies performed direct comparison as in the current work in this specific population, TVS permits for a complete assessment of the lower uterine segment and is currently the recommended standard of care [27]. Finberg and Williams [28] assessed the ultrasound role in the prenatal diagnosis of placental invasion [PP accreta] in women with one or more previous caesarean deliveries. By using gray scale US as the sole diagnostic method, they reported that US had a 93.0% sensitivity and 79.0% specificity in the diagnosis of PP accreta. Japaraj *et al.* [7] also reported that gray scale US had sensitivity of 85% and 100% specificity in the PP accreta diagnosis. The main feature on the gray scale, which was reported in 85.7% of confirmed accreta cases, was the existence of multiple lakes in the placenta. Moniem *et al.* [12] revealed that the best 2D gray-scale US characters for the discovery of difficult placental separation and significant intra-operative blood loss were abnormal lacunae of the placenta [73.9% sensitivity], exophytic mass invading the urinary bladder [100% specificity and 100% PPV], and disappearance of the



sonolucent zone behind the placenta [74.2% NPV]. In addition, the best 2D gray-scale US manifestations for the recognition of emergency cesarean hysterectomy in the women were the interruption of the hyperechoic uterine serosa-bladder interface [81.8% sensitivity] and exophytic mass invading the urinary bladder [94.9% specificity, 66.7% PPV, and 84.1% NPV]. Levine *et al.* [29] reported similar results with gray scale US, and they concluded that gray scale US was adequate for the assessment of most PP accreta. The worth of the grayscale US in diagnosis or ruling out PP accreta has many applications in the underdeveloped and developing republics, where most of the readily available machines only have gray scale abilities.

The strength point of this study is the utilization of 3D transabdominal ultrasonography instead of the 2D ultrasound. The advantages of 3DUS are: 1. Multiplanar image display at the same time and 2. Viewing planes of vasculature can be used to recognize vessels invading the bladder [26].

In addition, Cali *et al.* [18] found that irregular tortuous vessels are harmful to the whole placenta and the uterine serosa-bladder interface was the most prominent diagnostic sign of MAP detected by the 3D power Doppler.

Despite the obtained results, the current study had some limitations. The main limitations are the small sample size and it is a single center study that decreases the power of results, and prevents its globalization.

### Conclusion:

Two-dimensional vaginal ultrasound is more sensitive than the 3-D abdominal sonography in detecting placenta previa. However, the 3D transabdominal US had higher sensitivity in detecting some radiological signs of these lesions like uterovesical vascularity.

### Financial and Non-financial Relationships and Activities of Interest

None

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