Libyan Med J. 2025;17(3):321-326
https://doi.org/10.69667/lmj.2517303
Libyan Medical Journal
https://lmj.ly/index.php/ojs/index eISSN: 2079-1224

Original article

Role of Doppler Ultrasound in Diagnosis of Invasion of Placentation Tissue

Huda Khalif*, Laila Almahdi, Nasreen Osman, Amel Morgham

Department of Obstetrics and Gynecology, Faculty of Medicine, University of Tripoli, Tripoli, Libya
***Corresponding Email**. houdakhlif1972@gmail.com*

Keywords.
Doppler Ultrasound, Diagnosis, Invasion, Tissue.

Placenta previa is a severe complication of pregnancy and is the most common cause of postpartum hemorrhage, which often endangers the lives of pregnant women. In patients with malignant placenta previa and placenta accreta, ultrasound can display obvious blood flow changes, such as abnormal blood flow in the placental cavity, abundant blood flow signals, placenta accreta, a thinned echo zone between the uterus and placenta, an enlarged cervix, and thinned myometrium. Color Doppler ultrasound can accurately identify whether it is complete placenta previa. This study was conducted to assess the role of Doppler ultrasound in the diagnosis of invasion of the placental tissue. The study was a retrospective descriptive study conducted at Aljala Maternity Hospital in Tripoli during the years 2020-2021. Among 120 pregnant women were selected from medical files, and a predesigned questionnaire was formed to collect data from patients by simple random sampling methods. The data was coded and analyzed by using SPSS (Statistical Package for the Social Sciences) version 20. All variable results were considered statistically significant with a P value less than 0.05. Among 120 pregnant women who were diagnosed with placental invasion, the mean age group was 29.45 ± 5.345 SD, the minimum age was 18 years, and the maximum age was 45 years. Regarding the obstetric history, the mean gravidity was 3.37 ± 1.942 SD, the mean parity was 1.76 ± 1.559 SD, the mean miscarriage rate was 1.71 ± 0.454 SD, and the mean gestational age at time of diagnosis was 6.21 ± 2.111 SD. Regarding the prior experience with abnormal placentation in previous pregnancy, 66.3% had experienced it. Regarding the Doppler ultrasound approach, 73% of patients had abnormal Doppler findings on assessment. Regarding the prevalence of complications among participants who were diagnosed with placental invasion and the most commonly recognized complications were wound infection and thromboembolism, which both account for 63.5%. On assessing the placental invasion by Doppler ultrasound, this approach had a significant impact on evaluating pregnancy. Therefore, early utilization of Doppler is recommended, particularly in high-risk groups, to evaluate and detect serious health outcomes related to placental invasion.

Introduction

Placenta previa is a serious pregnancy complication and the leading cause of postpartum hemorrhage, often posing life-threatening risks to mothers [1]. Recent studies highlight the significant impact of placental positioning on pregnancy outcomes [1,2]. In clinical practice, obstetricians must consider not only the type of placenta previa (complete, partial, or marginal) but also the placental attachment site—such as the anterior or posterior uterine wall—and whether it overlaps a prior cesarean scar. Some experts propose classifying complete placenta previa with anterior wall attachment over a uterine scar as pernicious placenta previa. Additionally, research indicates that placenta previa frequently increases the risk of placenta accreta [2,3].

The term placenta accreta spectrum (PAS), introduced by FIGO in 2018 [4], encompasses abnormal placental adhesion and invasion, including accreta, increta, and percreta [5]. Both the ACOG and RCOG have issued evidence-based guidelines to improve PAS management [6,7]. In cases of malignant placenta previa with accreta, ultrasound reveals distinct hemodynamic changes, such as abnormal placental vasculature, increased blood flow signals, loss of the uteroplacental clear zone, cervical enlargement, and myometrial thinning. Color Doppler ultrasound effectively diagnoses complete placenta previa, with minimal discrepancies between preoperative assessments and postoperative pathology, consistent with findings from Yuwen et al. [8]. This study was conducted to assess the role of Doppler ultrasound in the diagnosis of invasion of the placental tissue.

Methods

Study design

This was a retrospective descriptive study conducted at Aljala Maternity Hospital in Tripoli between 2020 and 2021.

Copyright *Author (s) 2025. Distributed under Creative Commons CC-BY 4.0*
***Received**: 19-05-2025 - **Accepted**: 15-07-2025 - **Published**: 22-07-2025*

Libyan Med J. 2025;17(3):321-326
https://doi.org/10.69667/lmj.2517303
Libyan Medical Journal
https://lmj.ly/index.php/ojs/index eISSN: 2079-1224

Study Population
A total of 120 pregnant women diagnosed with placenta previa and placenta accreta spectrum (PAS) were selected through simple random sampling from medical records and a predesigned questionnaire.

Eligibility Criteria
We included pregnant women with a confirmed diagnosis of placenta previa and PAS. Patients who did not provide written consent were excluded

Data Management
Data were coded and analyzed using SPSS (Statistical Package for the Social Sciences) version 20. Descriptive statistics (frequency, percentage, mean, and standard deviation) were used to summarize variables. A p-value < 0.05 was considered statistically significant.

Ethical considerations
The study received ethical approval from the health authorities and Aljala Maternity Hospital. A standardized questionnaire was used to collect data from routine antenatal visits, ensuring anonymity and confidentiality throughout the study. The research objectives were designed to maximize clinical and scientific benefits while maintaining patient privacy.

Results

Demographic and socioeconomic data
Among 120 pregnant women who were diagnosed with placental invasion, the mean age group was 29.45 ± 5.345 SD, the minimum age was 18 years, and the maximum age was 45 years (Figure 1).

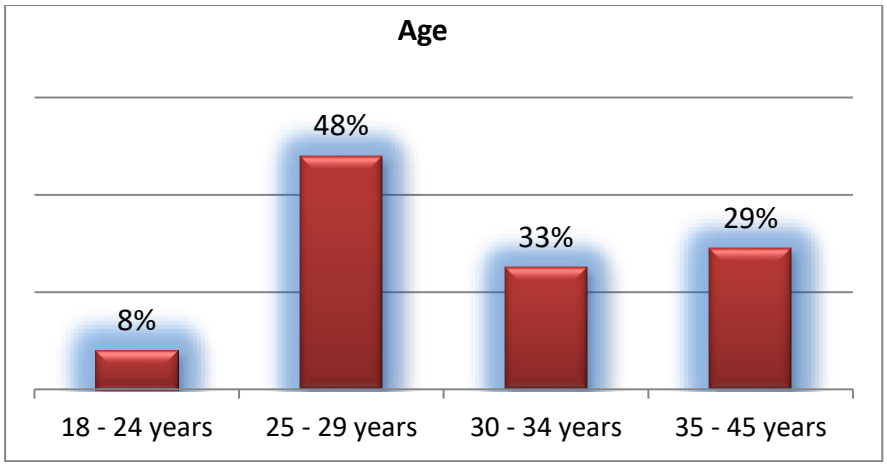

Figure 1. Illustration of the age of patients which diagnosed with placental invasion, Tripoli, Libya, 2020-2021

Regarding the obstetric history, the mean gravidity was 3.37 ± 1.942 SD, the mean parity was 1.76 ± 1.559 SD, the mean miscarriage rate was 1.71 ± 0.454 SD, and the mean gestational age at time of diagnosis was 6.21 ± 2.111 SD. Regarding the occupational status, 82.4% were housewives (non-workers) while 17.6% were workers, and on assessing the educational level, 45.1% had a higher educational level. On assessing the blood group (ABO and rhesus classification), nearly half of the participants were O Rh positive, which accounts for 48.4% (Table 1).

Table 1. Demonstration of the blood group (ABO and rhesus classification) for pregnant women who are diagnosed with placental invasion, Tripoli, Libya,2020- 2021

Variables (N= 120)	Percentage
A Rh+	28.6%
A Rh-	3.3%
B Rh+	11.0%
B Rh-	1.1%
AB Rh+	4.4%
AB Rh-	1.1%

Copyright *Author (s) 2025. Distributed under Creative Commons CC-BY 4.0*
Received*: 19-05-2025 -* ***Accepted****: 15-07-2025 -* ***Published****: 22-07-2025*

Libyan Med J. 2025;17(3):321-326
https://doi.org/10.69667/lmj.2517303
Libyan Medical Journal
https://lmj.ly/index.php/ojs/index *eISSN: 2079-1224*

O Rh+	48.4%
O Rh-	1.1%
Do not know	1.1%

Regarding the previous cesarean section, about 43.5% of them had a previous C/S (Table 2). On assessing the type of current cesarean section, 65% were delivered by emergency C/S (Figure 2).

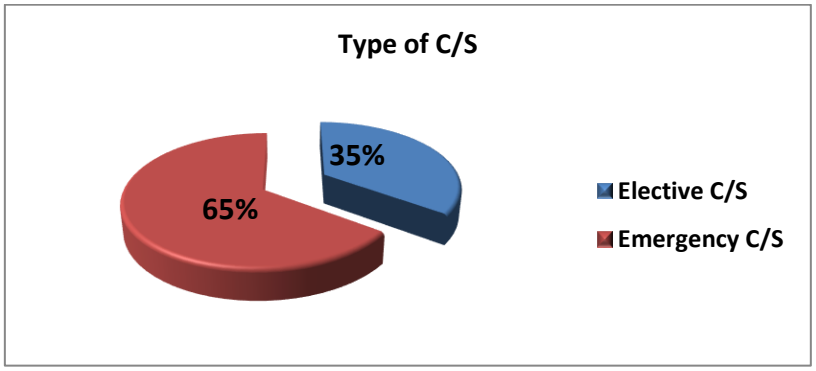

Figure 2. Distribution of type of C/S for pregnant women who are diagnosed with placental invasion, Tripoli, Libya, 2020-2021

Regarding the prior experience with abnormal placentation in previous pregnancy, 66.3% had experienced it. Regarding the Doppler ultrasound approach, 73% of patients had abnormal Doppler findings on assessment. Regarding the prevalence of complications among participants who were diagnosed with placental invasion, the following table demonstrates the list of them, and the most commonly recognized complications were wound infection and thromboembolism, which both account for 63.5%. On determining the neonatal condition, 66.4% were in good condition, and the mean fetal weight was 2.353 ± 0.719 SD within normal range (P-values were 0.034 and 0.671, respectively).

Table 2. Maternal Complications among Study Participants

Variables (N= 52)	Frequency	Percentage%	P – value
Uterine rupture	Yes – 20 No – 32	38.5% 61.5%	0.096
Coagulopathy	Yes – 20 No – 32	38.5% 61.5%	0.096
Complications of blood transfusion	Yes – 27 No – 25	51.9% 48.1%	0.782
Kidney injury	Yes – 23 No – 29	44.2% 55.8%	0.405
Bladder injury	Yes – 2 No – 50	3.8% 96.2%	0.000
Ureter injury	Yes – 1 No – 51	1.9% 98.1%	0.000
Bowel injury	Yes – 13 No – 39	25% 75%	0.000
Sepsis	Yes – 23 No - 29	44.2% 55.8%	0.405
Wound infection	Yes – 33 No - 19	63.5% 36.5%	0.052
Thromboembolism	Yes – 33 No - 19	63.5% 36.5%	0.052
Methotrexate complication	Yes – 7 No - 45	13.5% 86.5%	0.000

Copyright *Author (s) 2025. Distributed under Creative Commons CC-BY 4.0*
Received*: 19-05-2025 -* ***Accepted****: 15-07-2025 -* ***Published****: 22-07-2025*

Libyan Med J. 2025;17(3):321-326
https://doi.org/10.69667/lmj.2517303
Libyan Medical Journal
https://lmj.ly/index.php/ojs/index eISSN: 2079-1224

Discussion

Our study included 120 pregnant women diagnosed with placental invasion, with a mean age of 29.45 ± 5.345 years (range: 18–45 years). Complication rates in placenta previa cases were higher with anterior placental attachment compared to posterior attachment. Liu J et al. investigated the influence of placental positioning on maternal outcomes in placenta previa patients, noting that anterior implantation significantly increased bleeding and hysterectomy risks ($P < 0.05$) (9). Anterior placentation was linked to earlier gestational age, lower birth weight, reduced Apgar scores, increased antepartum and postpartum hemorrhage rates, extended hospital stays, and higher transfusion and hysterectomy needs compared to posterior placentation. Moreover, anterior attachment was identified as an independent risk factor for postpartum hemorrhage in placenta previa cases, as reported by Baba Y et al. (10).

Anterior placental attachment increases hemorrhage risk due to its proximity to the uterine incision site during cesarean delivery. Since the placenta cannot be entirely bypassed in such cases, manipulating or perforating it during delivery can trigger rapid, severe bleeding. Additionally, uterine muscle incision disrupts fiber integrity, impairing contractions and exacerbating blood loss. To avoid placental encroachment into the uterine cavity, the cesarean incision may sometimes be placed higher on the uterine body, where thicker tissue can contribute to greater bleeding. Furthermore, anterior placentation involves more blood vessels near the incision site, and their accidental laceration may result in significant hemorrhage (11). Thus, the higher vascular density near the incision in anterior placentation may further elevate postpartum bleeding risk. Compared to posterior attachment, anterior placement involves more vessels, increasing the likelihood of bleeding if these are damaged during surgery. Prior research supports that anterior placenta previa carries a greater hemorrhage risk, though the absence of detailed correlation analysis in our study limits our ability to exclude confounding factors (12–13).

In Zheng, Xiaoxiao et al.'s (2021) study, logistic regression analysis confirmed that anterior placentation is an independent risk factor for postpartum hemorrhage in placenta previa patients. This finding underscores the need for heightened caution when managing anteriorly attached placentas. Intraoperative reassessment is critical, particularly if dilated uterine vessels or placental visibility through the serosa are observed. In such cases, involving experienced obstetric surgeons is advisable. Whenever possible, the surgical incision should avoid the placenta's primary implantation site. Preoperative measures—including adequate blood preparation and close coordination with anesthesiologists and intensive care teams—are essential to prevent acute hemorrhagic shock, multi-organ dysfunction, and to minimize hysterectomy rates (13).

Neonatal outcomes in placenta previa are strongly influenced by bleeding severity. Antepartum vaginal hemorrhage can compromise fetal blood supply, leading to intrauterine growth restriction and fetal distress. In cases of severe bleeding, early pregnancy termination is often necessary to protect maternal and fetal lives, though this increases the risk of iatrogenic preterm birth. Yeniel et al (14) demonstrated that placenta previa significantly raises preterm delivery rates and reduces fetal weight, highlighting its adverse impact on fetal health. Our study found that anterior placentation was associated with higher rates of antepartum hemorrhage compared to lateral or posterior placental attachment. Such bleeding impairs placental perfusion, increasing the risk of fetal hypoxia. Additionally, recurrent vaginal bleeding elevates the likelihood of genital infections and further raises the probability of medically indicated preterm delivery—all of which negatively affect neonatal outcomes. Moreover, during cesarean delivery in anterior placentation cases, avoiding the placenta entirely is often impossible. Disruption of placental tissue can lead to rapid, substantial blood loss, which may also contribute to neonatal anemia. Consequently, infants with anterior placental attachment exhibit higher rates of respiratory distress syndrome and lower Apgar scores. To optimize perinatal outcomes, management should focus on prolonging gestation (using tocolytics when appropriate), promptly controlling antepartum hemorrhage, administering corticosteroids to enhance fetal lung maturity, and timely delivery planning to ensure maternal and neonatal safety.

A recent study indicates that for placenta previa patients with a history of C-sections, the placenta attaching to a previous incision site doesn't significantly impact overall pregnancy outcomes. However, these patients have a much higher chance of developing complete placenta previa and Placenta Accreta Spectrum (PAS) disorders compared to those whose placentas don't attach to the incision site. Research shows that women who have had a C-section are more likely to experience placenta previa. Pernicious placenta previa (PPP), a severe form first described by Japanese scholar Chattopadhyay et al., is characterized by significant bleeding and poor outcomes for both mother and baby. It typically occurs in patients with a history of C-sections. In China, the incidence of PPP is about 2.08 per 1,000 pregnancies.

Previous studies found that 92.3% of patients with placental attachment at the C-section incision site developed complete placenta previa, a much higher rate than in those without such attachment. This is likely due to issues like endometrial defects and chronic inflammation caused by the uterine scar, which can trigger placental implantation in the lower uterus. The scar tissue has insufficient blood supply for the

Copyright *Author (s) 2025. Distributed under Creative Commons CC-BY 4.0*
Received*: 19-05-2025 -* ***Accepted****: 15-07-2025 -* ***Published****: 22-07-2025*

Libyan Med J. 2025;17(3):321-326
https://doi.org/10.69667/lmj.2517303
Libyan Medical Journal
https://lmj.ly/index.php/ojs/index eISSN: 2079-1224

placenta, which encourages the placenta to expand into the lower uterus or even progress to central placenta previa. Furthermore, scar contracture alters the uterine cavity's shape, moving fertilized eggs closer to the cervix. The scar in the lower uterus also hinders the normal upward movement of the placenta in the third trimester, causing it to remain in the lower uterine segment. This can lead to abnormal placental adhesion and an increased risk of central placenta previa. In our study, 66.3% of participants had a history of abnormal placentation in a previous pregnancy.

Placental implantation, particularly when it occurs in a problematic way, is thought to be caused by abnormal development of the uterine lining (decidua) and excessive invasion by trophoblast cells (which form the placenta). A fertilized egg needs an environment rich in oxygen and collagen to implant. Since uterine scars from previous C-sections have these characteristics, embryos can easily implant there during subsequent pregnancies. This can lead to defects in the uterine lining and muscle. When the embryo implants at the incision site, the placental villi can easily invade the uterine muscle and even its outer layer, leading to abnormal placental implantation.

Furthermore, studies show that over half of women who have had C-sections have areas of thinning and discontinuity in their uteruses. These areas can have tiny cracks, poor inner lining growth, and weak muscle. If villi implant here, the decidua forms poorly, allowing trophoblast cells to invade the uterine muscle. This causes the villi to stick to the muscle, leading to embryo implantation and even penetration into the uterine wall. Fertilized eggs can implant into the uterine muscle through small holes in the scar, and the placenta can become implanted there in the third trimester. Some researchers believe that factors promoting blood vessel growth and substances secreted by invading trophoblast cells are key to this implantation. This study found that abnormal placental attachment disorders were much more common when the placenta was attached to a previous incision site compared to when it wasn't. Therefore, placental attachment to a prior uterine incision is an independent risk factor for abnormal placental implantation in patients with placenta previa.

Color Doppler ultrasound, used to assess placental issues, can be performed in two ways: transabdominal (through the abdomen) or transperineal (through the perineum). Transabdominal ultrasound is the most common and straightforward method. It can reveal signs of placenta accreta, such as the disappearance of the space behind the placenta, a thickened placenta, and a significantly thinned uterine muscle layer at the placental attachment site, aiding in diagnosis. However, its accuracy decreases in patients with a thick abdominal fat layer. In such cases, transperineal ultrasound, which involves multiple views from the perineum, can compensate by providing a clearer view of the cervix and lower uterus. This method is effective in determining the relationship between the placenta and the uterine muscle. Ultrasound images from transperineal exams often show swelling in the lower uterus, an enlarged cervix, placental coverage, and increased blood flow in the lower uterine segment. In our study, 73% of patients showed abnormal findings on Doppler ultrasound. A limitation of our study is its cross-sectional and retrospective design, which means there's a risk of missing data and inaccurate documentation.

Conclusion

On assessing the placental invasion by Doppler ultrasound, this approach had a significant impact on evaluating pregnancy. Therefore, early utilization of Doppler is recommended particularly in high-risk groups to evaluate and detect serious health outcomes related to placenta invasion.

Conflict of interest. Nil

References

1. Baumfeld Y, Herskovitz R, Niv ZB, Mastrolia SA, Weintraub AY. Placenta associated pregnancy complications in pregnancies complicated with placenta previa. Taiwan J Obstet Gynecol. 2017;56(3):331-5. PubMed PMID: 28600042.
2. Weiner E, Miremberg H, Grinstein E, Mizrachi Y, Schreiber L, Bar J, et al. The effect of placenta previa on fetal growth and pregnancy outcome, in correlation with placental pathology. J Perinatol. 2016;36(12):1073-8. PubMed PMID: 27654492.
3. Kollmann M, Gaulhofer J, Lang U, Klaritsch P. Placenta praevia: incidence, risk factors and outcome. J Matern Fetal Neonatal Med. 2013;29(9):1395-8. PubMed PMID: 23952619.
4. Jauniaux E, Bhide A, Kennedy A, Woodward P, Hubinont C, Collins S. FIGO consensus guidelines on placenta accreta spectrum disorders: Prenatal diagnosis and screening. Int J Gynaecol Obstet. 2018;140(3):281-90. PubMed PMID: 29352753.
5. Luke RK, Sharpe JW, Greene RR. Placenta accreta: the adherent or invasive placenta. Am J Obstet Gynecol. 1966;95(5):660-8. PubMed PMID: 5914492.

Copyright *Author (s) 2025. Distributed under Creative Commons CC-BY 4.0*
Received: *19-05-2025* - ***Accepted***: *15-07-2025* - ***Published***: *22-07-2025*

Libyan Med J. 2025;17(3):321-326
https://doi.org/10.69667/lmj.2517303
Libyan Medical Journal
https://lmj.ly/index.php/ojs/index eISSN: 2079-1224

6. Committee on Obstetric Practice. Committee opinion no. 529: placenta accreta. Obstet Gynecol. 2012;120(1):207-11. Royal College of Obstetricians and Gynaecologists. Placenta praevia, placenta praevia accreta and vasa praevia: diagnosis and management. Green-top guideline No. 27. London: RCOG; 2011.
7. Han Y, Zhang Y, Chen L, et al. Diagnostic effect of transabdominal ultrasound combined with magnetic resonance imaging on pernicious placenta previa and pregnancy outcome. Imaging Sci Photochem. 2020;38(4):657-62.
8. Liu J, Xie XQ. Influence of different attachment sites of placenta previa on maternal and child outcomes of re-pregnancy after cesarean section. China Mod Med. 2014;21(34):12-5.
9. Baba Y, Matsubara S, Ohkuchi A, Usui R, Kuwata T, Suzuki H, et al. Anterior placentation as a risk factor for massive hemorrhage during cesarean section in patients with placenta previa. J Obstet Gynaecol Res. 2014;40(5):1243-8. PubMed PMID: 24612183.
10. Matsubara S, Kuwata T, Usui R, Watanabe T, Izumi A, Ohkuchi A, et al. Important surgical measures and techniques at cesarean hysterectomy for placenta previa accreta. Acta Obstet Gynecol Scand. 2013;92(4):372-7. PubMed PMID: 23278243.
11. Fukushima K, Fujiwara A, Anami A, Fujita Y, Yumoto Y, Sakai A, et al. Cervical length predicts placental adherence and massive hemorrhage in placenta previa. J Obstet Gynaecol Res. 2012;38(1):192-7. PubMed PMID: 21917085.
12. Hasegawa J, Matsuoka R, Ichizuka K, Mimura T, Sekizawa A, Farina A, et al. Predisposing factors for massive hemorrhage during Cesarean section in patients with placenta previa. Ultrasound Obstet Gynecol. 2009;34(1):80-4. PubMed PMID: 19472327.
13. Yeniel AO, Ergenoglu AM, Itil IM, Askar N, Meseri R, et al. Effect of placenta previa on fetal growth restriction and stillbirth. Arch Gynecol Obstet. 2012;286(2):295-8.
14. Getahun D, Oyelese Y, Salihu HM, Ananth CV. Previous cesarean delivery and risks of placenta previa and placental abruption. Obstet Gynecol. 2006;107(4):771-8.
15. Chattopadhyay SK, Kharif H, Sherbeeni MM. Placenta praevia and accreta after previous caesarean section. Eur J Obstet Gynecol Reprod Biol. 1993;52(3):151-6. PubMed PMID: 8124998.
16. Yu L, Hu KJ, Yang HX. A retrospective analysis on the pernicious placenta previa from 2008 to 2014. Zhonghua Fu Chan Ke Za Zhi. 2016;51(3):169-73. PubMed PMID: 27030493.
17. Naji O, Wynants L, Smith A, Abdallah Y, Saso S, Stalder C, et al. Does the presence of a Caesarean section scar affect implantation site and early pregnancy outcome in women attending an early pregnancy assessment unit? Hum Reprod. 2013;28(6):1489-96. PubMed PMID: 23539610.
18. Jauniaux E, Jurkovic D. PAS disorders: pathogenesis of a 20th century iatrogenic uterine disease. Placenta. 2012;33(4):244-51. PubMed PMID: 22197624.
19. Sholapurkar SL. Increased incidence of placenta praevia and accreta with previous caesareans—a hypothesis for causation. J Obstet Gynaecol. 2013;33(8):806-9. PubMed PMID: 24127953.
20. Eshkoli T, Weintraub AY, Sergienko R, Sheiner E. Placenta accreta: risk factors, perinatal outcomes, and consequences for subsequent births. Am J Obstet Gynecol. 2013;208(3):219.e1-7. PubMed PMID: 23313723.
21. Garmi G, Goldman S, Shalev E, Salim R. The effects of decidual injury on the invasion potential of trophoblastic cells. Obstet Gynecol. 2011;117(1):55-9. PubMed PMID: 21173648.
22. Aggarwal R, Suneja A, Vaid NB, Yadav P, Sharma A, Mishra K. Morbidly Adherent Placenta: A Critical Review. J Obstet Gynaecol India. 2012;62(1):57-61. PubMed PMID: 23372293.
23. Suknikhom W, Tannirandorn Y. Previous uterine operation and placenta previa. J Med Assoc Thai. 2011;94(3):272-7. PubMed PMID: 21560835.
24. Fitzpatrick KE, Sellers S, Spark P, Kurinczuk JJ, Brocklehurst P, Knight M. Incidence and risk factors for placenta accreta/increta/percreta in the UK: a national case-control study. PLoS One. 2012;7(12):e52893. PubMed PMID: 23300807.
25. Ayaz A, Farooq MU. Risk of adverse maternal and peri-natal outcome in subjects with placenta previa with previous cesarean section. Kurume Med J. 2012;59(1-2):1-6. PubMed PMID: 23257596.
26. Roberge S, Boutin A, Chaillet N, Moore L, Jastrow N, Demers S, et al. Systematic review of cesarean scar assessment in the nonpregnant state: imaging techniques and uterine scar defect. Am J Perinatol. 2012;29(6):465-71. PubMed PMID: 22399214.
27. Tseng JJ, Chou MM. Differential expression of growth-, angiogenesis- and invasion-related factors in the development of placenta accreta. Taiwan J Obstet Gynecol. 2006;45(2):100-6. PubMed PMID: 17197348.
28. Jauniaux E, Bhide A, Kennedy A. FIGO consensus guidelines on placenta accreta spectrum disorders: Prenatal diagnosis and screening. Int J Gynaecol Obstet. 2018;140(3):274-80. PubMed PMID: 29352753.
29. Downes KL, Hinkle SN, Sjaarda LA. Previous prelabor or intrapartum cesarean delivery and risk of placenta previa. Am J Obstet Gynecol. 2015;212(5):669.e1-6.
30. Robinson KA, Kriegshauser JS, Dahiya N. Detection of transplant renal artery stenosis determining normal velocities at the renal artery anastomosis. Abdom Radiol (NY). 2017;42(1):254-9.

Copyright *Author (s) 2025. Distributed under Creative Commons CC-BY 4.0*
Received*: 19-05-2025 -* ***Accepted****: 15-07-2025 -* ***Published****: 22-07-2025*