Role of transabdominal ultrasound for prediction of invasion in placenta accreta spectrum

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Abstract

Background: Abnormal placentation has been classified into accreta, increta, and percreta on the basis of depth of myometrial invasion. The aim of the study was to evaluate the role of transabdominal ultrasonography (USG) for prediction of placental invasion in the placenta accreta spectrum.

Materials and Methods: This was a prospective cohort study carried out over 1 year in the Department of Obstetrics and Gynecology in collaboration with the Department of Radiodiagnosis at King George’s Medical University, Lucknow, Uttar Pradesh, India. A total of 110 patients were recruited for the study, of these 20 patients were lost to follow-up. After informed consent and ethical clearance, 90 pregnant women with gestation age of 34 weeks or above (late pregnancy) with previous cesarean section with complaints of bleeding per vaginum or diagnosed on USG as a case of placenta previa with or without accreta were enrolled for the study. Women not giving consent for participation in the study or not having any of above risk factors were excluded from the study.

Results: Placental invasion was found in 61.1% (55) on USG. Women with previous two cesarean sections had a placental invasion rate of 74.5%. Women with previous three cesarean sections had the highest placental invasion rate (78.6%), and this association of placental invasion with the number of prior cesarean sections was significant. On transabdominal ultrasound, 68 patients had Grade 3 lacunae, of which 67.6% (46) had invasion. Maximum number of cases \((n = 63)\) had the smallest sagittal myometrial thickness of \(<1\) mm, and invasion was found in 69.8% (44). Out of 90 cases, placental invasion was found in 61.1% (55) by transabdominal USG, and 80% (72) of placental invasion was observed on histopathological examination.

Conclusion: In the present study, Grade-3 lacunae, smallest sagittal myometrial thickness of \(<1\) mm and more than 1 prior cesarean delivery were associated with placental invasion on USG.

Keywords: Lacuna, placenta accreta spectrum, placental invasion, ultrasound

INTRODUCTION

Abnormal placentation has been classified into accreta, increta, and percreta on the basis of depth of myometrial invasion. When depth of invasion increases, risk of hemorrhage and maternal morbidity also increases.\(^{1,2}\) It is very important to diagnose placenta accreta spectrum...
during the antenatal period to avoid intrapartum and postpartum hemorrhage. Ultrasound is a very important tool for diagnosis of placenta accreta spectrum.

Surgical procedure on the uterus or uterine cavity, including uterine curettage, hysteroscopic surgery, endometrial ablation, uterine artery embolization, and myomectomy, has been associated with the subsequent development of placenta accreta.[2] However, the most important risk factor for the development of placenta accreta is a prior cesarean section.[3] Increasing trend of cesarean section is a troublesome issue worldwide, responsible for increasing rates of placenta accreta spectrum. Placenta accreta spectrum has now become a major cause of mortality and morbidity in pregnant women.

Transabdominal ultrasound is a reliable tool for diagnosis of abnormal placentation, and Doppler is helpful in diagnosis of invasion. Various parameters of ultrasound have been documented to assess the higher risk of placenta accreta spectrum, including the presence of placental lacunae (irregular vascular spaces resulting in a “Swiss cheese” appearance), smallest myometrial thickness (<1 mm), loss of the normal hypoechoic retroplacental zone, and anomalies of the bladder–myometrium interface.[4] Eighty-six percent of patients had abnormal findings between 15 and 20 weeks, which suggests that the diagnosis can be made at an early gestation by proper USG evaluation.

The measurement of <1 mm for the smallest myometrial thickness or the presence of large intraplacental lakes was 100% sensitive in predicting placenta accreta spectrum as observed on color Doppler ultrasound flow mapping when placenta implanted in proximity to the prior hysterotomy scar.[5,6]

Transvaginal ultrasound is a good tool for more detailed assessment of a placental invasiveness, and it improves diagnostic accuracy in invasive placentation.[7] Rae et al. reported three parameters, including absence of clear retroplacental zone, irregularity, and decrease in width of the bladder–uterine interface as significant variables in the placenta accreta spectrum prediction, when they used linear logistic regression and multiparametric analyses.[8]

The results are presented in frequencies, percentages, and mean ± standard deviation. The Chi-square test was used to compare the categorical variables. The one-way analysis of variance was used to compare the continuous variables. A P value of < 0.05 was considered statistically significant.

MATERIALS AND METHODS

This was a prospective cohort study carried out over a period of 1 year in the Department of Obstetrics and Gynecology in collaboration with the Department of Radiodiagnosis at King George’s Medical University, Lucknow, Uttar Pradesh, India. A total of 110 patients were recruited for the study, of these 20 patients were lost to follow-up. After obtaining informed consent and ethical clearance, 90 pregnant women with gestation age of 34 weeks or above (late pregnancy) with history of previous cesarean section and with complaints of bleeding per vaginum or diagnosed on USG as a case of placenta previa with or without accreta were enrolled for the study. Women not giving consent for participation in the study or not having any of above risk factors were excluded from the study.

Transabdominal ultrasound was done by PHILLIPS AFFINITY 70 G Model (Yorba Linda, CA, USA). Two-dimensional gray-scale high-resolution (1–5 MHz) and color Doppler imaging was done for assessment of abnormal vasculature. If any portion of the placenta covered the anterior lower uterine segment, then the placenta was considered to be anterior.

The diagnosis of placenta previa was based on the presence of placental tissue covering the internal cervical os. Low-lying placenta was diagnosed when the placenta was within 2 cm from the internal cervical os but did not cover it.

This was a single-center study. Sonographic parameters observed were the location of placenta, loss of clear retroplacental zone, irregularity and thickness of uterine–bladder interface, the smallest myometrial thickness in sagittal and transverse plane, presence of lacunar spaces and bridging vessels. Lacunar spaces were graded according to Finberg and Williams (11R AJOG) as follows: Grade 0 :: none seen, Grade 1 :: 1–3 lacunar spaces present and generally small, Grade 2 :: 4–6 lacunar spaces present and tending to be larger and more irregular, Grade 3 :: many lacunar spaces throughout the placenta and appearing large and bizarre. Confirmation of the placenta accreta spectrum was based on histopathologic evidence of placental invasion.

Three-dimensional Doppler ultrasound has the ability to differentiate between the degrees of placental invasion.[9] Thus, this study was planned to evaluate diagnostic accuracy of transabdominal ultrasonography (USG) for prediction of placental invasion in the placenta accreta spectrum.
All the analyses were carried out on SPSS 16.0 version (Inc., Chicago, IL., USA).

RESULTS

In the present study, although the invasion was high in women with urban background and literate group, statistically both groups (Placental invasive group and group without placental invasion) were almost matched in terms of religion, residence, rural or urban, and literacy. Placental invasion was found in 61.1% (55) on USG, and in rest of the cases, no invasion was observed [Table 1].

There was a significant association between placental invasion and a number of prior cesarean sections. For women with previous one cesarean section, the invasion rate was 5.3% only, while for women with previous two cesarean invasions, it was 74.5%. Women with previous three cesarean sections had the highest placental invasion rate of 78.6%, and this association of placental invasion with a number of prior cesarean sections was significant. Anterior placenta previa was reported in 77 (85.5%) cases and invasion was found in 62.3%, while of 90 cases, only 13 women had no anterior placenta previa, but still invasion was found in the same group (53.8%). Hence, no significant association was observed between placental invasion and anterior placenta previa location [Table 2].

On transabdominal ultrasound, 68 patients had Grade-3 lacunae, of which 67.6% (46) had invasion. Maximum number of cases (n = 63) had the smallest sagittal myometrial thickness of <1 mm, and invasion was found in 69.8% (44). It was observed that increase in myometrial thickness was associated with a decrease in placental invasion. Of 90 cases, bridging vessels were found in these 49 cases, and its association with placental invasion was observed in 63.3% (31) [Table 3].

Of 90 enrolled subjects, 72 (80%) cases had histopathologically documented invasion. Placenta accrete was observed in 31.9% (23), placenta increta in 43% (31), placenta percreta in 25% (18) on histopathological examination [Table 4].

DISCUSSION

In our study, of 90 cases, placental invasion was found in 61.1% (55) by transabdominal USG, and 80% (72) of placental invasion was observed on histopathological examination. Transabdominal ultrasound is a reliable tool for diagnosis of abnormal placentation, and Doppler is helpful in diagnosis of invasion. It is the primary tool for antenatal diagnosis of placenta accreta spectrum. Various parameters of ultrasound have been documented to assess the higher risk of placenta accreta spectrum. This is a significant obstetric challenge; previously, it was a rare diagnosis, but nowadays, it complicates as many as 1 per 500–533 patients. In our study, the mean age of patients with placental invasion was 29.86 ± 3.17 years. In our study, no association was found between age and placental invasion (P = 0.19) in women with previous cesarean section. However, another author reported in

| Religion | Number of patients | Placental invasion, n (%) | No placental invasion, n (%) | OR (95% CI) | P* |
|----------|------------------|--------------------------|----------------------------|-------------|-----|
| Hindu    | 61               | 37 (60.7)                | 24 (39.3)                  | 0.94 (0.38-2.33) | 0.89 |
| Muslim   | 29               | 18 (62.1)                | 11 (37.9)                  | 1.00 (reference) |     |

| Residence | Number of patients | Placental invasion, n (%) | No placental invasion, n (%) | OR (95% CI) | P* |
|-----------|------------------|--------------------------|----------------------------|-------------|-----|
| Rural     | 34               | 24 (70.6)                | 10 (29.4)                  | 1.93 (0.78-4.79) | 0.15 |
| Urban     | 56               | 31 (55.4)                | 25 (44.6)                  | 1.00 (reference) |     |

| Literacy | Number of patients | Placental invasion, n (%) | No placental invasion, n (%) | OR (95% CI) | P* |
|----------|------------------|--------------------------|----------------------------|-------------|-----|
| Illiterate | 40              | 21 (52.5)                | 19 (47.5)                  | 0.52 (0.22-1.22) | 0.13 |
| Literate | 50               | 34 (68.0)                | 16 (32.0)                  | 1.00 (reference) |     |

| Prevalence of placental invasion on ultrasonography | Number of patients | Placental invasion, n (%) | No placental invasion, n (%) | OR (95% CI) | P* |
|-----------------------------------------------------|------------------|--------------------------|----------------------------|-------------|-----|
| 1         | 90               | 55 (61.1)                | 35 (38.9)                  | -            | -   |

OR: Odds ratio, CI: Confidence interval

| Number of previous LSCS | Number of patients | Placental invasion, n (%) | No placental invasion, n (%) | OR (95% CI) | P* |
|-------------------------|------------------|--------------------------|----------------------------|-------------|-----|
| One                     | 19               | 1 (5.3)                  | 18 (94.7)                  | 0.01 (0.001-0.16) | 0.001* |
| Two                     | 57               | 43 (75.4)                | 14 (24.6)                  | 0.83 (0.20-3.43) | 0.80 |
| Three                   | 14               | 11 (78.6)                | 3 (21.4)                   | 1.00 (reference) |     |

| Anterior placenta previa | Number of patients | Placental invasion, n (%) | No placental invasion, n (%) | OR (95% CI) | P* |
|--------------------------|------------------|--------------------------|----------------------------|-------------|-----|
| Yes                      | 77               | 48 (62.3)                | 29 (37.7)                  | 1.41 (0.43-4.63) | 0.56 |
| No                       | 13               | 7 (53.8)                 | 6 (46.2)                   | 1.00 (reference) |     |

*Significant, Logistic regression. LSCS: Lower-segment cesarean section, OR: Odds ratio, CI: Confidence interval
their study an increase odds of having high mean arterial pressure (MAP) with increased maternal age, in women with previous cesarean sections.[13]

In the present study, there was significant association between placental invasion with 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 means that cesarean section scar increases the chances of placental invasion. Chances of placental invasion increased as the number of cesarean sections increased. One author reported that a number of prior cesarean deliveries were significantly associated with the risk of placental invasion. Another author reported that the risk of accrete was 11%, 40%, and >60% in women with 1, 2, and 3 prior cesarean sections with placenta previa respectively. One author reported increased odds of having placenta accreta, increta, and percreta (at 95% confidence interval [CI] odds ratio [OR] 3.4–8.9) in women who had a history of previous uterine surgery and myomectomy.[11]

Ultrasoundography parameters and placental invasion

One study reported that number and bizarre appearance of lacunar spaces were directly correlated with certainty and severity of placenta accreta spectrum.[12] In our study, Grade-3 lacunae was found in 75.56% cases out of these 67.6% (n=46) Grade 3 lacunae associated with placental invasion, as the grade of lacunae increased from 1 to 3 placental invasions also increased and P = 0.0001 and OR (95% CI) 0.12 (0.04–0.35). Thus in this study there were 12 times increased risk of placental invasion was observed with grade -3 lacunae. A large prospective study on gray-scale ultrasound for diagnosis of abnormal placentation reported that visualization of lacunae had the highest sensitivity (79%) in the 15–20-week range and a sensitivity of 93% in the 15–40-week gestational age.[8]

In our study, minimum sagittal myometrial thickness <1 mm had significant association with placental invasion (69.8%). On the other hand, 33.3% of patients with myometrial thickness of >3 mm presented with invasion. The measurement of <1 mm for the smallest myometrial thickness or the presence of large intraplacental lakes was 100% sensitive in predicting placenta accreta spectrum as observed on color Doppler ultrasound flow mapping when placenta implanted in proximity to the prior uterine scar.[13]

Another study reported that a smallest myometrial thickness <1 mm identified in the third trimester of pregnancy, and the risk for placental invasion was 100% sensitive and 72% specific with a positive predictive value and negative predictive value of 72% and 100%, respectively.[14]

No significant association of placental invasion with bridging vessels was found in our study. One study reported

### Table 3: Association of prevalence of placental invasion with various ultrasonographic parameters

| Lacunae          | Number of patients | Placental invasion, n (%) | No placental invasion, n (%) | OR (95% CI) | P< 
|------------------|--------------------|---------------------------|-----------------------------|-------------|---- 
| Grade 0          | 4                  | 1 (25.0)                  | 3 (75.0)                    | 0.15 (0.02-1.62) | 0.12 
| Grade 1          | 3                  | 2 (66.7)                  | 1 (33.3)                    | 0.95 (0.08-11.12) | 0.97 
| Grade 2          | 15                 | 6 (40.0)                  | 9 (60.0)                    | 0.31 (0.10-1.01) | 0.05 
| Grade 3          | 68                 | 46 (67.6)                 | 22 (32.4)                   | 1.00 (reference) | 
| Sagittal smallest myometrial thickness (mm) |                |                           |                            |             |    
| <1               | 63                 | 44 (69.8)                 | 19 (30.2)                   | 4.63 (1.04-20.48) | 0.04* 
| 1-3              | 18                 | 8 (44.4)                  | 10 (55.6)                   | 1.60 (0.30-8.49) | 0.58 
| >3               | 9                  | 3 (33.3)                  | 6 (66.7)                    | 1.00 (reference) | 
| Bridging vessels |                    |                           |                            |             |    
| Yes              | 49                 | 31 (63.3)                 | 18 (36.7)                   | 1.22 (0.52-2.85) | 0.64 
| No               | 41                 | 24 (58.5)                 | 17 (41.5)                   | 1.00 (reference) | 

*Significance, aLogistic regression. OR: Odds ratio, CI: Confidence interval

### Table 4: Type of placental invasion after histopathological analysis (n=72)

| Outcome          | Number of patients | Placental invasion, n (%) | No placental invasion, n (%) | OR (95% CI) | P< 
|------------------|--------------------|---------------------------|-----------------------------|-------------|---- 
| Placenta accreta |                    |                           |                            |             |    
| Yes              | 23                 | 23 (100.0)                | 0 (0.0)                     | -           | -  
| No               | 67                 | 32 (47.8)                 | 35 (52.2)                   | 1.00 (reference) | 
| Placenta increta |                    |                           |                            |             |    
| Yes              | 31                 | 31 (100.0)                | 0 (0.0)                     | -           | -  
| No               | 59                 | 24 (40.7)                 | 35 (59.3)                   | 1.00 (reference) | 
| Placenta percreta|                    |                           |                            |             |    
| Yes              | 18                 | 18 (100.0)                | 0 (0.0)                     | -           | -  
| No               | 72                 | 37 (51.4)                 | 35 (48.6)                   | 1.00 (reference) | 

*Multiple response, aLogistic regression. OR: Odds ratio, CI: Confidence interval
that the presence of bridging vessels identified with color Doppler imaging was the most predictive ultrasound parameter of placenta accreta spectrum.

Another author reported that if they remove placenta previa from analysis in multivariate model, then they found that there was no linear association between placenta accreta, placenta increta, and placenta percreta (MAP) with previous cesarean sections. Another author reported that the risk of invasion based only on number of cesarean deliveries and placental location was 40%. We found that a high score can be derived from the ultrasound parameters such as smallest myometrial thickness, lacunar spaces, and presence of bridging vessels, in addition to the number of prior cesarean deliveries and placental location.

One study reported that histopathological invasion of the placenta was found in 68.5%, of these 55.9% accreta, 8.1% increta, and 4.5% percreta were reported. However, in our study, placental invasion was found in 80% on histopathological examination and accrete in 31.9% (23), increta in 43% (31), and percreta found in 25% (18).

Our study confirms the predictive value of combining patient characteristics with ultrasound variables and its association with placental invasion, and it also acknowledges the interaction between the different variables as they contribute to individual risk depending on the availability of local resources and multidisciplinary care. The results from our study could be used for counseling during the antenatal period and making referral decision of the patient with placenta previa and previous cesarean section. One study recently reported series of 92 women with placental invasion and found that the combination of placenta previa, number of previous cesarean deliveries, and ultrasound suspicion of invasion was more predictive than ultrasound variables alone.

CONCLUSION

Our study also provides individual predictive value of each ultrasound parameter of placenta accreta spectrum. Grade-3 lacunae and >1 prior cesarean delivery were weighted the highest in the present study. A strong relationship was observed between lacunar spaces on ultrasound and placental invasion. Although the ultrasound is a good noninvasive tool for the detection of placental invasion, histopathological examination of the tissue still is a gold standard to diagnose placental invasion.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Belfort MA. Placenta accreta. Am J Obstet Gynecol 2010;203:430-9.
2. Miller DA, Chollet JA, Goodwin TM. Clinical risk factors for placenta previa-placenta accreta. Am J Obstet Gynecol 1997;177:210-4.
3. Silver RM, Landon MB, Rouse DJ, Spong CY, Thom EA, et al. Maternal morbidity associated with multiple repeat cesarean deliveries. Obstet Gynecol 2006;107:1226-32.
4. Goh WA, Zalud I. Placenta accreta: Diagnosis, management and the molecular biology of the morbidly adherent placenta. J Matern Fetal Neonatal Med 2016;29:1795-800.
5. Comstock CH. Antenatal diagnosis of placenta accreta: A review. Ultrasound Obstet Gynecol 2005;25:86-96.
6. Twickler DM, Lucas MJ, Balis AB, Santos-Ramos R, Martin L, Malone S, et al. Color flow mapping for myometrial invasion in women with a prior cesarean delivery. J Matern Fetal Med 2000;9:330-5.
7. Lerner JP, Deane S, Timor-Trisch IE. Characterization of placenta accreta using transvaginal sonography and color Doppler imaging. Ultrasound Obstet Gynecol 1995;5:198-201.
8. Rac MW, Dashie JS, Wells CE, Moschos E, McIntire DD, Twickler DM. Ultrasound predictors of placental invasion: The placenta accreta index. Am J Obstet Gynecol 2015;212:343.e1-7.
9. Calì G, Giambanco L, Puccio G, Forlani F. Morbidly adherent placenta: Evaluation of ultrasound diagnostic criteria and differentiation of placenta accreta from percreta. Ultrasound Obstet Gynecol 2013;41:406-12.
10. Bryant-Greenwood GD, Yamamoto SY, Lowendes KM, Webster LE, Parg SS, Amano A, et al. Human decidual relaxin and preterm birth. Ann N Y Acad Sci 2005;1041:338-44.
11. 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:e52893.
12. Finberg HJ, Williams JW. Placenta accreta: Prospective sonographic diagnosis in patients with placenta previa and prior cesarean section. J Ultrasound Med 1992;11:333-43.
13. Yang JI, Lim YK, Kim HS, Chang KH, Lee JP, Ryu HS. Sonographic findings of placental lacunae and the prediction of adherent placenta in women with placenta previa totalis and prior Cesarean section. Ultrasound Obstet Gynecol 2006;28:178-82.
14. D’Antonio F, Iacovella C, Btuide A. Prenatal identification of invasive placentation using ultrasound: Systematic review and meta-analysis. Ultrasound Obstet Gynecol 2013;42:597-709.
15. Wu S, Kocherginsky M, Hibbard JU. Abnormal placentation: Twenty-year analysis. Am J Obstet Gynecol 2005;192:1458-61.
16. Weiniger CF, Einar S, Deutsch L, Ginosar Y, Ezra Y, Eidl I. Outcomes of prospectively-collected consecutive cases of antenatal-suspected placenta accreta. Int J Obstet Anesth 2013;22:273-9.