Diagnostic Accuracy of Doppler Ultrasonography in the Antenatal Diagnosis of Abnormal Placental Invasion Secondary to Placenta Praevia

Huda Sajid[1], Syed Mubarak Ali[2], Roomi Mahmud[3], Asma Javed[4], Ameet Jesrani[4]

Abstract

Objective: To determine the diagnostic accuracy of Doppler Ultrasonography in a tertiary care hospital, for the antenatal diagnosis of abnormal placental invasion secondary to placenta praevia, taking operative findings of caesarean section as gold standard.

Methods: This is a cross-sectional study carried out in the Department of Radiology, Liaquat National Hospital, Karachi, from 1st August 2013 to 31st July 2014. A total of 591 pregnant women (multipara) having placenta praevia were included in this study. The diagnosis of abnormal placental invasion was made by Doppler USG and compared with operative findings of caesarean section as gold standard. A predesigned pro forma was used to document findings. SPSS version 17 was used for all statistical analysis.

Results: Sensitivity, specificity, positive and negative predictive value as well as accuracy of Doppler ultrasonography (USG) in the detection of abnormal placental invasion was found to be 84.8%, 93.9%, 91.8%, 88.5% and 89.95%, respectively.

Conclusion: Any persistent placenta praevia, will benefit from antenatal Doppler USG studies to identify abnormal utero-placental vascular flow patterns and these findings clearly aid in the management of this most challenging obstetric complication.

Keywords: Placenta previa, Doppler ultrasonography, caesarean section, antenatal care, diagnostic imaging.

Introduction

Placenta praevia has high risks of fetal and maternal complications, which are not only attributable to the location of placenta but is associated to a variable degree of uterine wall invasion by placen-

[1] Department of Radiology,
Ziauddin University.
[2] Department of Radiology,
Abbasi Shaheed Hospital.
[3] Department of Radiology,
Liaquat National Hospital.
[4] Department of Radiology,
Sindh Institute of Urology and Transplantation.

Correspondence: Dr. Syed Mubarak Ali
Department of Radiology,
Abbasi Shaheed Hospital & KMDC.
Email: mubarakali@dr.com
Date of Submission: 11th April 2018
Date of Acceptance: 1st May 2018

tal tissue. Antenatal diagnosis is imperative in order to prevent potentially fatal outcomes[1].

Placenta praevia is a fatal complication of pregnancy due to localisation of placenta in the lower segment of the uterus over or near the internal cervical os[1]. Its incidence is 3 to 4.5 per 1000 pregnancies in Asian women[2]. Women having placenta praevia are at a risk of foetal as well maternal adverse outcomes. Maternal adverse outcomes consist of postpartum haemorrhage and shock in 84% of women at the time of admission, with resultant increase in maternal morbidity and mortality[3,4]. Whereas, foetal outcomes include still-birth, prematurity, and early neonatal death[1]. These risks are not only attributable to the location of placenta but to the associated variable degrees of uterine wall in-

vasion (accreta, percreta and increta), Sect et al.[5] found 64.7% and 52.3% rates of preterm birth and 24% and 29% of low birth weight in deep (placenta percreta and increta) and superficial (accreta) placenta invasion, respectively. Therefore, antenatal diagnosis is imperative in order to prevent these potentially fatal outcomes.

A number of diagnostic modalities have been used in the detection of antenatal diagnosis of placenta praevia and its various forms. These include trans-abdominal ultrasonography (USG), Doppler USG and magnetic resonance imaging (MRI)[6,7]; among them Doppler USG is a popular technique due to its low cost, non-invasiveness and easy accessibility. Despite these advantages, the reliability of Doppler USG is variable, which is the subject of debate in literature. Lim et al.[8] concluded that abnormal placenta invasion was identified in 67% of women. Warshak et al.[9] accurately predicted placenta accrete in 77% and correctly ruled out in 96% of cases. Chou and colleagues[10] have reported 82.4% sensitivity and 96.8% specificity of colour Doppler USG in the diagnose of placenta praevia accreta. Nonetheless, a large body of literature shows a questionable accuracy of this diagnostic modality when used alone and advised subsequent employment of MRI in order to correctly diagnose placental invasion. The use of MRI in a low socioeconomic country like Pakistan to diagnose abnormal placental invasion is not cost-effective, moreover, it is not easily accessible. Therefore, to a great extent, the diagnosis still relies on Doppler USG[11].

It has been reported that colour Doppler USG has a sensitivity between 82.4% and 100%, and a specificity between 92% and 96.8%[12]. The expected prevalence of ultrasound in detecting abnormal placental invasion was 82%[11]. Considering the life-threatening problem of foetal and maternal outcomes, this study was planned to determine the diagnostic accuracy of Doppler USG in antenatal diagnosis of abnormal placental invasion. If it is diagnosed at an early stage through this non-invasive and easily accessible technique, timely manage-ment can help prevent associated morbidity and mortality. Operative findings of caesarean section were taken as gold standard.

The objective of this study was to determine the diagnostic accuracy of Doppler ultrasound in the antenatal diagnosis of abnormal placental invasion secondary to placenta praevia, taking operative findings of caesarean section as gold standard.

Patients and Methods

This cross-sectional study was carried out in Department of Radiology, Liaquat National Hospital Karachi from 1st August 2013 to 31st July 2014. This study was conducted after approval from College of Physicians and Surgeons of Pakistan. The procedure and purpose of the study was explained to all included women and informed consent was obtained. Pregnant women between 20 to 40 years of age with suspicion of placenta praevia were included in study, however, primigravida and complicated pregnancies like hypertension, diabetes mellitus and cardiac disease were excluded. Sampling technique was non-probability consecutive.

A total of 591 pregnant women, by convenience sampling, were included in this study, with suspicion of placenta praevia i.e history of painless bleeding starting after 28 week or spotting occurring earlier, history of pain and in some patients there were no symptoms only routine ultrasound showed the presence of placenta praevia,. Each woman, after history-taking, underwent colour Doppler USG by the consultant sonologist (3 years post-fellowship experience). Doppler USG diagnosis was made after 26 weeks of gestation on the basis of any one the following features: (i) complete loss of retro-placental sonolucent zone; (2) thinning or disruption of hyperechoic uterine-bladder interface with abnormal blood vessels linking the placenta to the bladder; (3) sonolucent vascular lakes with turbulent flow; and (4) markedly dilated vessels over the peripheral sub-placental region. Later on, operative findings were recorded after caesarean section by a consultant gynaecologist. A pre-designed pro forma was used to record findings.

Table . Diagnostic accuracy of Doppler Ultrasonography in detection of abnormal placental invasion (n= 591).

Doppler USG detection of Abnormal placental invasion	Operative diagnosis of Abnormal placental invasion		Total
	Yes	No	
Yes	224 (TP)	20 (FP)	224 (44.3%)
No	40 (FN)	307 (TN)	347 (58.7%)
Total	264 (44.7%)	327 (55.3%)	591

Sensitivity 84.8%   Specificity 93.9%   Diagnostic Accuracy 89.9%
Positive predictive value   91.8%
Negative predictive value 88.5%

SPSS version 17 was used for all statistical analysis. Frequency and proportions were computed for categorical variable like parity, abnormal placental invasion on Doppler USG, abnormal placental invasion on surgery and diagnostic accuracy. Effect modifiers like age and parity was controlled by stratification. Applying Chi square test p=0.05 was taken as significant. Sensitivity, specificity, positive and negative predicated values were also calculated.

Results

A total of 591 pregnant women between 20-40 years of age with the suspicion of placenta praevia were enrolled in this study. The average age of the patients was 29.22 ± 5.19 years. Out of 591 patients, 505 (85.45%) patients were having <3 parity and 86 (14.55%) had >3 parity. Doppler USG findings in detection of abnormal placental invasion were recorded and compared with operative findings taken as gold standard.

Out of a total of 591 women, abnormal placental invasion was found in 264 women on operative findings, while Doppler USG diagnosed it in 244 women. About 531 women had the same results on both Doppler USG and surgery, of which 224 cases were positive and 307 cases negative. In 40 surgically proven cases Doppler USG was negative (false -ve). There were 20 cases in which Doppler USG showed positive findings while surgical findings were negative (false +ve) (Fig). Thus, sensitivity, specificity and accuracy of Doppler USG for detection of abnormal placental invasion were 84.8%, 93.9% and 89.9%, respectively. Whereas
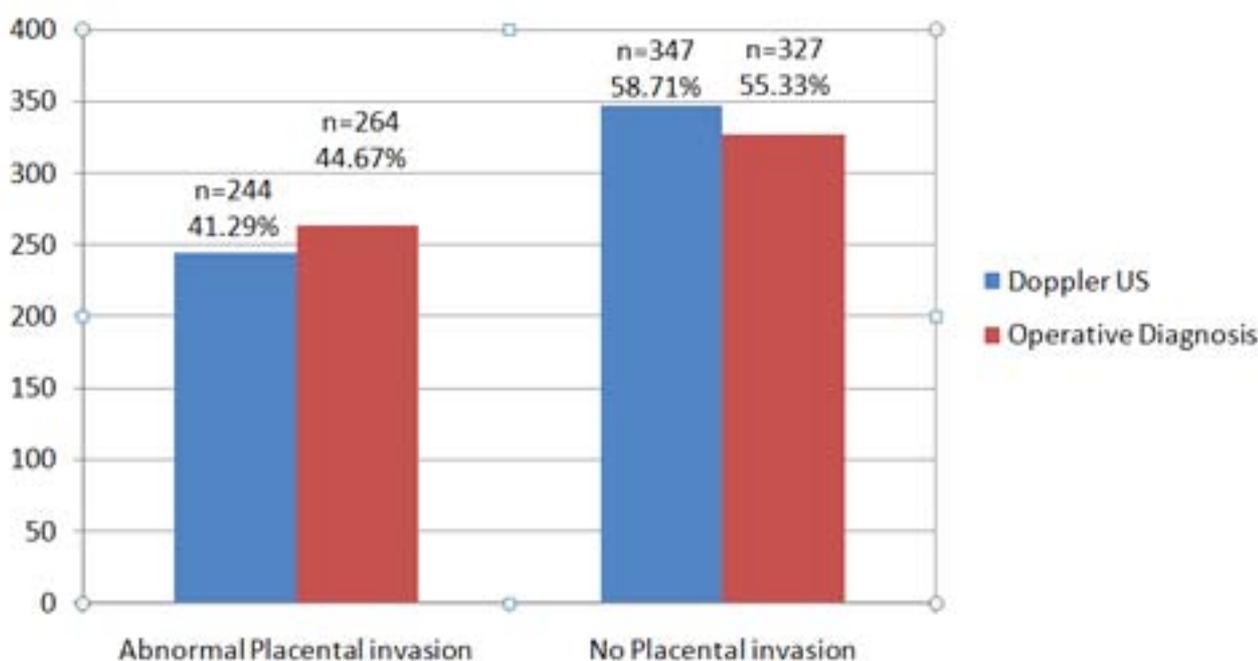

Fig. Comparison of abnormal placental invasion, Doppler Ultrasonography & Operative findings (n= 591).

positive predictive value (PPV) was 91.8% and negative predictive value (NPV) 88.5%, (Table).

With respect to age groups, in women of age 30 years or less the sensitivity, specificity, accuracy, positive and negative predictive value of Doppler USG in the detection of abnormal placental invasion was 86.0%, 93.2%, 89.7%, 92.5% and 87.3%, respectively. While in women of more than 30 years of age the sensitivity, specificity, accuracy, positive and negative predictive value of Doppler USG in the detection of abnormal placental invasion was 82.6%, 94.7%, 90.1%, 90.5% and 89.9%, respectively.

On further stratification with respect to parity, in women with 2-3 parity, the sensitivity, specificity, accuracy, positive and negative predictive value of Doppler USG in the detection of abnormal placental invasion was 83.6%, 93.9%, 88.97%, 92.7% and 86.0%, respectively. While in women with more than 3 parity the sensitivity, specificity, accuracy, positive and negative predictive value of Doppler USG in the detection of abnormal placental invasion was 100.0%, 93.9%, 95.3%, 83.3% and 100.0%, respectively.

Discussion

Abnormal placental invasion is a potentially dangerous complication of pregnancy. Depending upon depth of invasion it is known as placenta accreta, increta and percreta. Among these, placenta accreta is the most common condition. There are numerous risk factors, the placenta praevia, prior uterine surgery, increased parity are reported as the most common and critical risk factors. Moreover, this is also associated with adverse maternal and neonatal outcomes. The most significant maternal outcomes include the postpartum haemorrhage and peri-partum hysterectomy. Important neonatal outcomes include preterm birth, low-birth weight, reduced 5-minute Apgar scores and the need for NICU admission and steroid administration. With the rising incidence of uterine surgery like caesarean section, the cases of placenta accreta have been on the rise as well[9]. There are a twofold risk among those with a prior caesarean section and an 8-fold risk in women with two or more prior caesarean sections[13]. Antenatal diagnosis of placenta accreta is of importance because it reduces foetal and maternal morbidity, as appropriate pre-operative and peri-operative measures are possible[6].

Ultrasonography is useful in screening for detection of abnormal placental invasion. Features such as loss of the hypoechoic retro-placental zone, irregular uterine serosa and thinning of uterine wall are found in grayscale USG. Previous reports have emphasized the B-mode grey-scale ultrasound findings[14]. Finberg and Williams[15] reported grey-scale ultrasound sensitivity of 93% and specificity of 79% in the diagnosis of placenta accreta. However, they recommended that a tentative diagnostic probability statement should be given[15]. With the advent of colour Doppler technology, several authors have described the colour Doppler sonographic features such as increased vascularity between myometrium and placenta, intra-placental lacunae or dilated peripheral sub-placental vascular channels with pulsatile venous-type flow over the uterine cervix and absence of sub-placental vascular signals in the areas lacking the peripheral sub-placental hypoechoic zone. Many authors have emphasized the colour and power Doppler findings[16,17].

Chou et al.[17] evaluated 80 patients with persistent placenta praevia by trans-abdominal grey-scale and Doppler USG for detection of abnormal placental invasion or placenta accreta. They reported 82.4% sensitivity and 96.8% specificity with PPV 87.5% and NPV 95.3%. In our study, the overall sensitivity, specificity, positive and negative predictive values were 84.8%, 93.9%, 91.8 and 88.5%, respectively. The sensitivity and PPV are slighty better in our study; however, specificity and NPV are slighty less but shows almost similar results.

Another study in southern Saudi Arabia by Maher et al.[18] showed that ultrasonography accurately predicted placenta accreta in 33 of 39 of women. They reported sensitivity 95.1% and speci-

ficity 95.5%. As compared to our study, it showed higher sensitivity and specificity, may be because of demographic difference and also number of positive cases were very small (39) as compare to our study (264). However, they correctly ruled out placenta accreta in 512 of 514 without placenta accreta.

Pilloni et al.[19] in a study using Doppler USG, diagnosed 30/37 women with placental attachment disorder (PAD) due to abnormal invasion, providing a sensitivity of 81.1%, a specificity of 98.9% (274/277) and PPV and NPV of 90.9% and 97.5%, respectively. In our study, the overall sensitivity, specificity, positive and negative predictive values were 84.8%, 93.9%, 91.8% and 88.5%, respectively. As compared to our study they have reported significantly higher specificity and NPV, most likely because of smaller group and they have used two-criterion system.

According to Warshak et al.[9] USG accurately predicted placenta accreta in 30 of 39 of women and correctly ruled out placenta accreta in 398 of 414 without placenta accreta (sensitivity: 77%, specificity: 96%). The high specificity could be because trans-vaginal USG was used while we used trans-abdominal USG.

MR imaging enabled the diagnosis of placenta accrete. In study by Maher et al.[18], out of 20 women who underwent MRI because of suspicion of placenta accreta by ultrasonography. Six were accurately predicted placenta accreta and 10 of 20 cases were correctly ruled out placenta accreta (sensitivity 85.7% and specificity 76.9%). Similarly, Warshak et al.[9], did MRI of 42 women because Doppler USG findings were suspicious or inconclusive and MRI accurately predicted placenta accreta in 23 of 26 cases with placenta accreta and correctly ruled out placenta accreta in 14 of 14 (sensitivity 88%, specificity 100%). A multicenter, cohort study by Dwyer et al.[20] in which 32 women at risk of placenta accrete underwent both USG and MRI, reported sensitivity, specificity of Doppler USG 93%, 71% and MRI 80%, 65%, respectively. Some authors have suggested a two-stage protocol for

evaluating women at a high risk of abnormal placental invasion, which uses Doppler USG first, and then MRI for cases with inconclusive ultrasound features[9]. MRI is also recommended in suspicious cases of posterior placenta praevia. However, in this study MRI was not done.

The results of our study are comparable with international literature. Further stratification of data with respect of age and parity shows higher sensitivity, accuracy and negative predictive value of Doppler USG (100.0%, 95.3% and 100.0%, respectively) in women with >3 parity, however, no significant difference noted with age.

There are many studies related to this common topic, however studies from our local institute were lacking, hence this study was conducted. The strength of our study is that it directly compared the accuracy of Doppler USG with operative findings. Furthermore, the stratification of data shows higher sensitivity and specificity in multipara women. The limitation of our study is that it is limited to one centre, therefore results cannot be generalised. A multicentre study with a larger number of patients would be necessary to make this feasible. However, this study will add in the local database which will be further helpful for treatment and management protocol. Another limitation is that convenience sampling was done and sample size calculation was not done, prior to starting this study. However, future multicentre studies will hopefully rectify this limitation with appropriate sample size calculation.

Conclusion

This study emphasises that any persistent placenta praevia, must benefit from antenatal Doppler ultrasound studies to identify abnormal utero-placental vascular flow patterns and these findings clearly aid in the management of this most challenging obstetric complication.

Conflict of Interest

Authors have no conflict of interests and no grant/funding from any organisation.

References

1. Raheel R, Tabassum R, Bhutto A, Riaz H, Hanif R. Fetal outcome in cases of placenta previa-a retrospective study [Online]. Med Channel 2010;16:256-9. Available from: http://www.pakmedinet.com/15547. Accessed on April 18, 2018.

2. Yang Q, Wu Wen S, Caughey S, Krewski D, Sun L, Walker MC. Placenta previa: its relationship with race and the country of origin among Asian women. Acta Obstet Gynecol Scand 2008;87:612-6. [DOI: 10.1080/00016340802071037].

3. Zaman BS, Zubair A, Bhatti SZ, Malik MZS. Effect of Placenta Previa on fetal and maternal mobidity/mortality [Online]. Ann King Edward Med Uni 2005;11:205-7. Available from: http://annalskemu.org/journal/index.php/annals/article/view/997. Accessed on April 18, 2018.

4. Sumigama S, Itakura A, Ota T, Okada M, Kotani T, Hayakawa H, et al. Placenta previa increta/percreta in Japan: a retrospective study of ultrasound findings, management and clinical course. J Obstet Gynaecol Res 2007;33:606-11. [DOI: 10.1111/j.1447-0756.2007.00619.x].

5. Seet EL, Kay HH, Wu S, Terplan M. Placenta accreta: depth of invasion and neonatal outcomes. J Matern Fetal Neonantal Med 2012;25:2042-5. [DOI: 10.3109/14767058.2012.678429].

6. Taipale P, Orden MR, Berg M, Manninen H, Alafuzoff I. Prenatal diagnosis of placenta accreta and percreta with ultrasonography, color Doppler, and magnetic resonance imaging. Obstet Gynecol 2004;104:537-40. [DOI: 10.1097/01.AOG.0000136482.69152.7d].

7. Zhang L, Li P, He G, Liu X, Yang T, Luo H, et al. [Value of prenatal diagnosis of placenta previa with placenta increta by tranabdominal color Doppler ultrasound]. Zhonghua Fu Chan Ke Za Zhi 2006;41:799-802.

8. Lim PS, Greenberg M, Edelson MI, Bell KA, Edmonds PR, Mackey AM. Utility of ultrasound and MRI in prenatal diagnosis of placenta accrete: a pilot study. AJR Am J Roentgenol 2011;197:1506-13. [DOI: 10.2214/AJR.11.6858].

9. Warshak CR, Eskander R, Hull AD, Scioscia AL, Mattery RF, Benirschke K, et al. Accuracy of ultrasonography and magnetic resonance imaging in the diagnosis of placenta accreta. Obstet Gynecol 2006;108:573-81. [DOI: 10.1097/01.AOG.0000233155.62906.6d].

10. Chou MM, Ho ES, Lee YH. Prenatal diagnosis of placenta previa accreta by transabdominal color Doppler ultrasound. Ultrasound Obstet Gynecol 2000;15:28-35. [DOI: 10.1046/j.1469-0705.2000.00018.x].

11. Jalil S, Nausheen S, Akhter AZ. Reducing morbidity and mortality in morbidly adherent placenta: an experience [Online]. Pak J Surg 2011;27:59-63. Available from: http://www.pjs.com.pk/journal_pdfs/jan_mar11/p59.pdf. Accessed on April 18, 2018.

12. Thia EWH, Lee SL, Tan HK, Tan LK. Ultrasonographical features of morbidly-adherent placentas [Online]. Singapore Med J 2007;48:799-802. Available from: http://www.smj.org.sg/article/ultrasonographical-features-morbidly-adherent-placentas. Accessed on April 18, 2018.

13. Wu S, Kocherginsky M, Hibbard JU. Abnormal placentation: twenty-year analysis. Am J Obstet Gynecol 2005;192:1458-61. [DOI: 10.1016/j.ajog.2004.12.074].

14. Hoffman-Tretin JC, Koenigsberg M, Rabin A, Anyaegbunam A. Placenta accrete. Additional sonographic observations. J Ultrasound Med 1992;11:29-34.

15. 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.

16. Levine D, Hulka CA, Ludmir J, Li W, Edelman RR. Placenta accreta: evaluation with color Doppler US, power Doppler US, and MR imaging. Radiology 1997;205:773-6. [DOI: 10.1148/radiology.205.3.9393534].

17. Chou MM, Ho ES. Prenatal diagnosis of placenta previa accreta with power amplitude ultrasonic angiography. Am J Obstet Gynecol 1997;177:1523-5.

18. Maher MA, Abdelaziz A, Bazeed MF. Diagnostic accuracy of ultrasound and MRI in the prenatal diagnosis of placenta accreta. Acta Obstet Gynecol Scand 2013;92:1017-22. [DOI: 10.1111/aogs.12187].

19. Pilloni E, Alemanno MG, Gaglioti P, Sciarrone A, Garofalo A, Biolcati M, et al. Accuracy of ultrasound in antenatal diagnosis of placental attachment disorders. Ultrasound Obstet Gynecol 2016;47:302-7. [DOI: 10.1002/uog.14893].

20. Dwyer BK, Belogolovkin V, Tran L, Rao A, Carroll I, Barth R, et al. Prenatal diagnosis of placenta accreta: sonography or magnetic resonance imaging? J Ultrasound Med 2008;27:1275-81.