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● *Original Contribution*

PRENATAL DIAGNOSIS OF ABNORMAL INVASIVE PLACENTA BY ULTRASOUND: MEASUREMENT OF HIGHEST PEAK SYSTOLIC VELOCITY OF SUBPLACENTAL BLOOD FLOW

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Abstract—The aim of the study described here was to identify an efficient criterion for the prenatal diagnosis of abnormal invasive placenta. We evaluated 129 women with anterior placenta previa who underwent transabdominal ultrasound evaluation in the third trimester. Spectral Doppler ultrasonography was performed to assess the subplacental blood flow of the anterior lower uterine segment by measuring the highest peak systolic velocity and resistive index. These patients were prospectively followed until delivery and evaluated for abnormal placental invasion. The peak systolic velocity and resistive index of patients with and without abnormal placental invasion were then compared. Postpartum examination revealed that 55 of the patients had an abnormal invasive placenta, whereas the remaining 74 did not. Patients with abnormal placental invasion had a higher peak systolic velocity of the subplacental blood flow in the lower segment of the anterior aspect of the uterus (area under receiver operating characteristic curve: 0.91; 95% confidence interval: 0.87–0.96) than did those without abnormal placental invasion. Our preliminary investigations suggest that a peak systolic velocity of 41 cm/s can be considered a cutoff point to diagnose abnormal invasive placenta, with both good sensitivity (87%) and good specificity (78%), and the higher the peak systolic velocity, the greater is the chance of abnormal placental invasion. Resistive index had no statistical significance (area under receiver operating characteristic curve, 0.56; 95% confidence interval: 0.46–0.66) in the diagnosis of abnormal invasive placenta. In conclusion, measurement of the highest peak systolic velocity of subplacental blood flow in the anterior lower uterine segment can serve as an additional marker of anterior abnormal invasive placenta. (E-mail: lihezhou67@outlook.com)

Key Words: **Abnormal invasive placenta, Prenatal diagnosis, Ultrasonography, Accreta.**

INTRODUCTION

Abnormal invasive placenta is a serious complication of pregnancy that can lead to several grave sequelae such as massive obstetric hemorrhage, hysterectomy, premature birth and even mortality (Pan et al. 2015; Rahman et al. 2008). Two clinical features known to be associated with the risk of abnormal placental invasion are history of cesarean section and placenta previa (Thurn et al. 2016; Wortman and Alexander 2013). Among patients with placenta previa, the greater the number of cesarean deliveries, the greater is the risk of abnormal invasion (Clark and Silver 2011; Okumura et al. 2016). Depending on the depth of the abnormal invasion of the placental villi into the myometrium, placental invasion is classified as accreta, increta or percreta (Benirschke et al. 2006).

The incidence of abnormal placental invasion has been increasing in the past few years. In the United States, statistics indicate a 10-fold increase in the incidence of placenta accreta over 50 y, reaching 1:2500 deliveries (Committee on Obstetric Practice 2002). As per the statistical records of the Third Affiliated Hospital of Zhengzhou University in Henan province of China, 32.9 per 1000 (361/10956) women (of gestational age >12 wk) were diagnosed with abnormal invasive placenta in the year 2015. Further, 57% (207/361), 41% (147/361) and 2% (7/361) of these cases were classified as accreta, increta and percreta, respectively.

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Currently, ultrasonography is the mainstay in the prenatal diagnosis of abnormal placental invasion. Specialized ultrasound studies such as gray-scale sonography, color Doppler and 3-D power Doppler have been found to indicate certain clinical signs that are suggestive of abnormal placental invasion (Chou et al. 2000; Collins et al. 2015; Finberg and Williams 1992; Pilloni et al. 2016; Shih et al. 2009). However, because of the lack of well-defined diagnostic markers, the diagnosis of abnormal invasion using these modalities may sometimes be missed or false positive. Shih et al. (2009) investigated pregnant women with placenta previa and recorded false-positive diagnoses with 3-D power Doppler (19/131), gray-scale ultrasonography (36/131) and color Doppler (41/131) criteria.

Abnormal neovascularization of the uteroplacental region is a characteristic feature of abnormal invasive placenta (Cali et al. 2013; Chou et al. 2000; Khong and Robertson 1987; Shih et al. 2009). Large and abnormal amounts of new blood vessels form and proliferate unusually and may be complicated by abnormal placental blood flow. Abnormal uteroplacental blood flow and irregular intraplacental vascularization can be identified by Doppler ultrasound and may serve as criteria for diagnosis of type of placenta invasion (Cali et al. 2013; Campbell et al. 1983). Turbulent blood flow in placental lacunae may be recorded during Doppler scan in the second and third trimesters of placental invasion (Volochovič et al. 2017).

The antenatal diagnosis of invasive placenta is usually based on characteristic findings with gray-scale ultrasound imaging, such as loss of a subendometrial echolucent zone or the presence of abnormal placental lacunae (Comstock et al. 2004; Finberg and Williams 1992; Levine et al. 1997). These vascular structures are known to exhibit high peak systolic velocity (PSV) and low resistive index (RI) (Chou et al. 2000; Shih et al. 2009). Recent studies have indicated that infiltration of chorionic villi into myometrial vascular spaces is characteristic of placenta accreta, and this finding may be associated with low-resistance myometrial vessels (Parra-Herran and Djordjevic 2016). Another mechanism involved in the pathogenesis of abnormal placental invasion is the occurrence of pregnancy-induced morphologic changes in the larger radial and arcuate arteries, although these changes are generally confined to the smaller spiral arteries. When the placental villi invade the myometrium, radial and arcuate arteries lose muscular and elastic tissue from their walls, and their diameter increases with an increase in the flow volume (Khong 2008). Taking this concept further, we thought that the hemodynamic changes in subplacental blood flow could be significantly associated with abnormal placental invasion.

In this study, we measured the PSV and RI of subplacental blood flow in the anterior lower segment of the uterus using spectrum Doppler ultrasonography in patients with anterior placenta previa, in the presence or absence of placental invasion. With this, we sought to identify an additional efficient criterion for the prenatal diagnosis of abnormal placental invasion.

METHODS

Patients and equipment

The study was designed as an assessor-blinded prospective investigation of 200 women in the third trimester (≥28 wk) of pregnancy who were treated for persistent anterior placenta previa, including complete previa and anterior placenta with ≤2-cm distance between the placental edge and internal os, at the Third Affiliated Hospital of Zhengzhou University between June 2014 and June 2016. The patients underwent transabdominal ultrasound examination with a B-mode color Doppler ultrasonography and spectral Doppler system (Voluson E8, GE Medical Systems, Zipf, Austria) equipped with a 4- to 8-MHz transducer. History of cesarean delivery was recorded. Pregnant women with complications such as pregnancy hypertension, diabetes and fetal growth restriction were excluded from the analysis.

Ultrasonographic studies

Before the examination, the women were asked to drink sufficient water so that their bladders were full. Then the fetus and placenta were scanned. The full maternal bladder acts as an acoustic window to produce a clear display of the lower segment of the anterior uterine wall, whereas the visual field of transvaginal ultrasound is quite limited. With a full maternal bladder, it was easy to adjust the angle of the acoustic beam, which is very important for the measurement of blood flow velocity. The position, thickness and internal echo of the placenta and retroplacental uterine serosa–bladder borderline were inspected independently. We focused on the subplacental blood flow in the anterior aspect of the lower uterine segment (LUS) (Fig. 1a, c). The sampling volume for pulsed-wave Doppler was set at 2 mm, and patients were asked to hold their breath for a few seconds during the measurement. The angle of insonation was kept as low as possible (≤15°). Blood flow velocity and RI were measured (Fig. 1b, d). Measurements were obtained from at least three different locations, especially where abnormal bulky blood vessels (relatively large and thick blood vessels with abnormal blood flow) were prominent. We then chose the highest PSV and the corresponding RI for further analysis. Care was taken to ensure that the uterine and parametrial arteries were avoided (Fig. 1e, f).

Diagnostic criteria and management

Prenatal diagnosis was based on loss of the retroplacental sonolucent zone, retroplacental myometrial thickness <1 mm, lacunae and exophytic placenta