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Case Report

Quantitative Image Analysis for Detecting into the Myometrium of the Placenta Accreta Spectrum: A Case Report

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Abstract

In this study, we investigated intrauterine observations of the placenta accreta spectrum (PAS), and image analysis of blood flow at the site of placental attachment using ultrasound images and open-source image processing software. This report analyzes preoperative images of uteruses using medical image processing software to detect placental vessels antimining the uterine wall. This process allowed us to quantify the blood flow through the myometrium, for application for our PAS patient.

Keywords: MRI; Placenta Accrete Spectrum; Quantitative Image Analysis

Introduction

Placenta accrete spectrum (PAS) is an abnormal trophoblast invasion where part of the placenta lodges too deeply into the myometrium of the uterine wall [1]. In 2015, the American College of Obstetrics and Gynecologists (ACOG), together with the Society for Maternal-Fetal Medicine, built a standardized risk-appropriate maternal care facility system, based on the region and expertise of the medical staff, to reduce overall maternal morbidity and mortality from PAS in the United States [2]. Placenta accrete spectrum (PAS) occurs in 3% of women diagnosed with placenta Previa with no history of cesarean deliveries. In the case of placenta Previa in a woman with a history of one or more previous cesarean deliveries, the likelihood of getting PAS dramatically increases. The risk of getting PAS is 3% after one cesarean delivery. This risk increases to 11%, 40%, and 61% after the second, third, and fourth + cesarean, respectively [3,4]. In this study, we encountered 123 cases of placenta Previa, 18 (14.6%) of which turned into PAS in our prenatal maternal care unit over the course of 12 years, and 13 (72.2%) of which were complicated by massive bleeding. Prior to cesarean section, we examined placenta Previa using color flow Doppler ultrasound and magnetic resonance imaging (MRI) to estimate the relationship between the placenta and myometrium of the uterus, and to predict blood volume during surgery. This report analyzes preoperative images of uteruses using medical image processing software to detect placental vessels antimining the uterine wall.

Case Presentation

Case: A 37-year-old, 36+0 weeks pregnant woman presented with placenta Previa. She had given birth via cesarean section twice before. We performed a selective cesarean section, but the placenta could not be removed from the uterine wall; therefore, we performed an emergency hysterectomy. The infant was male, weighing 2344 g, with Apgar scores of 8 points at 1 min, and 9 points at 5 min.

Methods

Image

Step-1: Ultrasound

A pregnant woman was examined using three-dimensional (3D) ultrasound (Voluson E10; GE Healthcare) with a C1-6-D trans-abdominal probe. High-definition and radiant flow methods were used to visualize the placental vessels bridging the placenta to the uterine margin.

Step-2: MRI

We conducted an MRI to confirm the diagnosis was correct, and to determine the depth of invasion and vasculature in the myometrium using 1.5 Tesla MRI (GE MEDICAL SYSTEM). The imaging conditions were T2-weighted FIESTA, with a slice size of 8 mm.

Step-3: Quantitative image analysis

Images obtained from MRI that import into the open-source medical image processing software 'Image J' 2.0.0-rc69/1.52p (developed by the National Institutes of Health (NIH)) were used to identify the image analysis ROI. The myometrium at the placental attachment, located near the bladder, was divided into three layers (upper, middle, and deep), that created a gray value distribution for each layer of the myometrium. We measured each layer to express the peak gray value (blood flow region).

Pipeline: To analysis of MRI.

1. Save the image to HD as DICOM.
2. Import to Image J 2.0.0-rc69/1.52p.
3. Re-identify the image analysis location (red line) on Image J.
4. Measure the brightness distribution of the attached placenta on the myometrium into the myometrium

Results

Ultrasonography: Massive blood flow was observed between the placenta and part of the myometrium, and the blood flowed close to the uterine serosa bladder (Figure 1).

Image analysis: MRI images showed disruption of the zone between the uterus and placenta, and many bright vessels (high signal) in the myometrium were observed using the T2-weighted imaging (Figure 2). Grayscale peak values coincided with the high signal of either invasion or vasculature within the myometrium on MRI-T2 weighted imaging. Peak gray scale value of upper layer of the myometrium was 975.7 (average gray scale value; 730.55) (Figure 3a), middle layer of the myometrium was 416.1 (average gray scale value; 331.38) (Figure 3b), and deep layer of the myometrium was 123.05 (average gray scale value; 98.73) (Figure 3c). The area with abundant blood flow on upper layer of the myometrium showed high values (>600). Areas with moderately high blood flow in the middle layer of the myometrium had median values (250~300). The deep layer of the myometrium showed low values (<80), which meant that there was little to no blood flow to the deep layer. This gray scale value was significantly different between abundant vascular, invasion and poor vascular, or non-invasion within the myometrium.

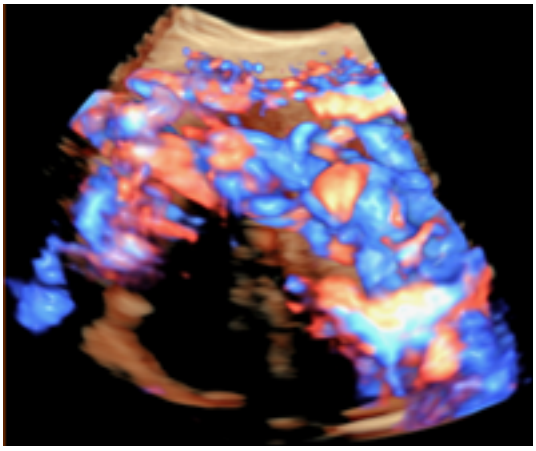

Figure 1: Ultrasound image of placenta accrete spectrum using three-dimensional (3D) high definition-flow with radiant flow method.

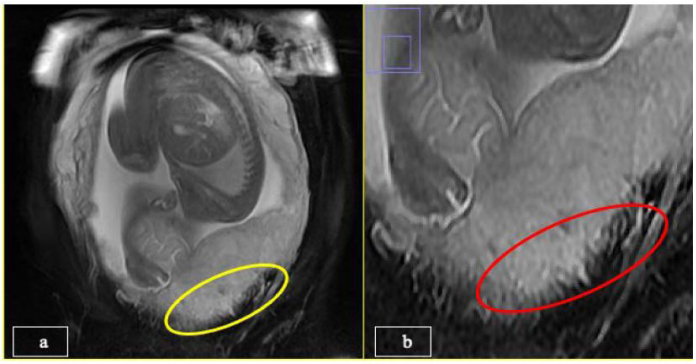

Figure 2: MRI of placenta accreta spectrum (placenta previa with accreta). a; yellow circle shows the placenta tissue invasion within the myometrium (regular size image). b; red circle shows the area of placenta tissue invasion and vessels (zoomed image).

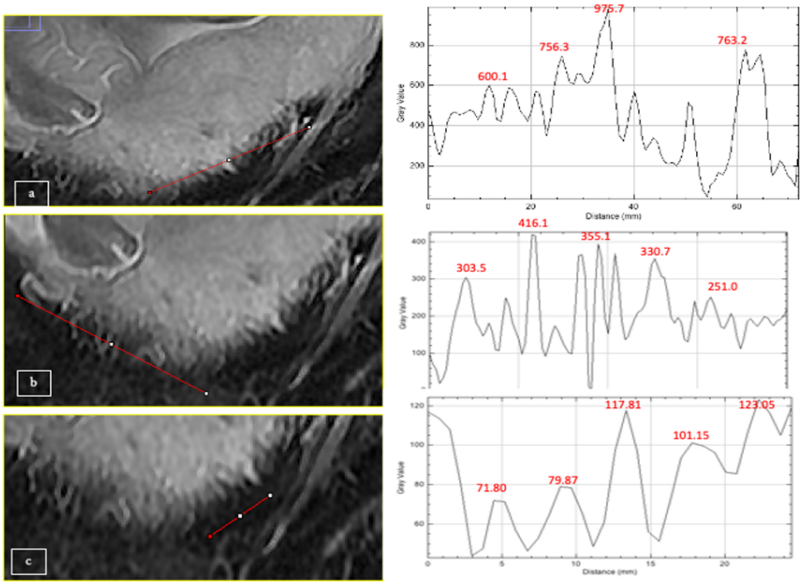

Figure 3: The myometrium at the placental attachment around the bladder was divided into three layers (a: the upper layer of myometrium, b: the middle layer of myometrium. c: the deep layer of myometrium). Image analysis: The graph depicts gray value of each MR image. A peak grayscale value coincided with the high signal of either invasion or vasculature within the myometrium on MRI-T2 weighted imaging.

Discussion

We quantified the images of vessels in the myometrium of the PAS using open-source medical image processing software. This is to prevent excessive bleeding, perform a cesarean section safely, and decide the need for hysterectomy. PAS is considered a high-risk condition associated with serious morbidities; therefore, the ACOG and the Society for Maternal-Fetal Medicine recommended that these patients receive Level III or higher care [3]. The rate of PAS is increasing; observational studies from the 1970s and 1980s described the prevalence of placenta accrete as between 1 in 2,510 and 1 in 4,017 compared with a rate of 1 in 533 from 1982 to 2002 [5]. A 2016 study conducted using the National Inpatient Sample found that the overall rate of placenta accrete in the United States was 1 in 272 women who had a birth-related hospital discharge diagnosis, which is higher than that reported in any other published study [5-8]. There are several risk factors for PAS, the most common being a previous cesarean delivery, with the incidence of PAS increasing with the number of prior cesarean deliveries [1,9,10]. Additional risk factors include advanced maternal age, multiparty, prior uterine surgery or curettage, and Asher man syndrome [9,11,12]. Placenta Previa is another significant risk factor. PAS occurs in 3% of women diagnosed with placenta Previa and no prior cesarean deliveries [13]. The primary modality for antennal diagnosis is obstetric ultrasonography, and the use of color-flow Doppler imaging may facilitate the diagnosis. Turbulent lacunar blood flow is the most common finding in the PAS on color flow Doppler imaging 3 MRI is another major tool used for the antenatal diagnosis of PAS 3. To use MRI for the prediction of the placenta accrete spectrum is reasonably accurate, with a systematic review reporting sensitivities of 75-100% and specificities of 65-100% [13].

Conclusion

We examined placenta Previa with placenta accrete, which is PAS before cesarean delivery, using ultrasound and MRI to investigate the invasion of placental tissue and vessels within the myometrium, and realized that more information was required. We then performed quantitative image analysis using MRI, which allowed us to locate the vessel area in the myometrium. This proves that image processing can be used to draft specific treatment plans, such as careful surgery, intraoperative and postoperative bleeding, uterine artery embolization, and the possibility of hysterectomy. We believe that performing image processing before surgery will allow swifter and more accurate responses during and after surgery. We expect a hybrid cesarean delivery (Image-Gide-cesarean delivery) using medical images during cesarean delivery for placenta Previa.

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Ethics approval: Informed consent was obtained from the patient

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