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PICTORIAL REVIEW

MRI of placental adhesive disorder

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ABSTRACT

Placental adhesive disorder (PAD) is a serious pregnancy complication that occurs when the chorionic villi invade the myometrium. Placenta praevia and prior caesarean section are the two important risk factors. PAD is classified on the basis of the depth of myometrial invasion (placenta accreta, placenta increta and placenta percreta). MRI is the preferred image modality for pre-natal diagnosis of PAD and as complementary technique when ultrasonography is inconclusive. Imaging findings that are helpful for the diagnosis include dark intraplacental bands, direct invasion of adjacent structures by placental tissue, interruption of normal trilayered myometrium and uterine bulging. Clinicians should be aware of imaging features of PAD to facilitate optimal patient management.

The placental adhesive disorders (PADs), including placenta accreta, placenta increta and placenta percreta, are frequent aetiologies of serious obstetrics complication such as post-partum haemorrhage. The placenta praevia and prior caesarean section are the principal risk factors. Ultrasonography represents the primary tool in evaluating females at risk for disorders of invasive placentation.¹ Ultrasonography should be performed at or around 32 weeks of gestation, while MRI is usually carried out when ultrasonography is not conclusive.² In this article, we review the normal placental and uterine wall anatomy, MRI protocol and MRI features of PAD.

MRI FINDINGS OF NORMAL PLACENTA AND GRAVID MYOMETRIUM

The gravid uterus should be pear shaped with the fundus and body being wider than the lower uterine segment. The uterine contour is usually smooth and focal bulging should not be present. The inner and outer layers of the myometrium are seen as thin bands of low T_2 signal intensity. The middle layer is thicker, has an intermediate T_2 signal intensity and frequently contains multiple flow voids representing the normal myometrial vascularity (Figure 1). As the pregnancy progresses, the myometrium can become thin and should appear as a continuous band of low T_2 signal intensity surrounding the placenta.

The normal placenta attaches to the anterior or posterior aspect of the uterus. The mid portion of the placenta typically measures between 2 and 4 cm in thickness, and the placenta undergoes changes during gestation. Placental

thinning has been described in systemic vascular and haematologic disorders that result in microinfarctions. Thicker placenta >4 cm are seen in ante-partum infection, maternal diabetes, foetal hydrops and maternal anaemia. Placental thickening can be simulated by myometrial contractions and underlying fibroids³ (Figure 2).

The placenta has homogeneous intermediate signal intensity and is usually clearly distinct from the underlying myometrium. Placenta septa and cotyledon are more often seen when imaging with a 3-T system (Figure 3). Normal placental septa and linear areas of decreased T_2 signal intensity are found running through the myometrium (Figure 4). The normal subplacental vascularity can be seen as numerous flow voids under the placenta (Figure 5) and are usually in the vicinity of the insertion point of the umbilical cord.

In comparison with 1.5-T scanners, 3-T MRI is acceptable because of its increased signal-to-noise ratio, faster sequences and higher spatial resolution, and no proven reproducible harmful effects have been reported so far.

PATIENT PREPARATION

Most patients in the second trimester of pregnancy can tolerate supine positioning within the MRI system bore. For patients in the third trimester, left lateral decubitus positioning may be better tolerated and decreases the risk of impaired venous return from caval compression by the gravid uterus. The urinary bladder should be only moderately full, both for patient comfort and to avoid over- and

Figure 1. Axial T_2 balanced steady-state free precession (true-fast imaging with steady-state precession) image shows three layers of normal myometrium. Thin bands of low-signal intensity at inner and outer layers (arrows) surround the higher signal intensity middle layer, which contains vasculatures.

underdistention that could complicate evaluation of potential bladder invasion. Patients were routinely given oxygen via a nasal cannula to reduce foetal motion. A radiologist should be present at the time of examination. No other patient preparation is typically required.

MRI PROTOCOLS TO EVALUATE PLACENTAL ADHESIVE DISORDER

Placental MRI protocols include:

- single-shot fast spin echo (FSE), turbo spin echo (TSE) and half acquisition TSE; or balanced steady-state free precession (true-fast imaging with steady-state precession or fast imaging employing steady-state acquisition) in the axial, coronal and sagittal views in order to assess placental position, attachment and depth of invasion
- high-resolution respiratory triggered or breath-hold T_2 weighted imaging (FSE or TSE) as needed to evaluate details

of placenta–uterine interface, adjacent pelvic structures and the cervix

- additional sequences such as axial fat-suppressed gradient echo T_1 weighted images to assess for haemorrhage.

Use of gadolinium-based contrast material

Gadolinium crosses the placental membrane and circulates through the amniotic fluid and is subsequently swallowed and reabsorbed by the foetus. The gadolinium is considered a pregnancy class C in whose use risk cannot be ruled out. Some investigators have advocated the use of gadolinium to improve the specificity of MRI for diagnosis of placenta accreta by better defining the outer placental surface and myometrium and distinguishing placenta accreta from percreta.⁴ However, we do not routinely administer the gadolinium to any of the gravid patients unless the potential risks to the patient are outweighed by the potential benefits of contrast-enhanced imaging. The gadolinium may be given in the lowest dose required to provide essential diagnostic information to the patients who are scheduled for delivery shortly.

Imaging findings of placental adhesive disorder

PAD is classified on the basis of the depth of myometrial invasion. In placenta accreta, the mildest form of PAD, villi are attached to the myometrium but do not invade the muscle. In placenta increta, villi partially invade the myometrium. In placenta percreta, the most severe form, villi penetrate through the entire myometrial thickness or beyond the serosa.

Prior caesarean section and placenta praevia are the two most important risk factors to develop PAD. Deficiency of the decidual basalis at the site of caesarean section scar at the lower uterine segment is thought to be the causative factor (Figure 6). There are four categories of placenta praevia depending on the relationship and distance to the internal cervical os. A low-lying placenta occurs when the placenta extends to within 2 cm of the internal cervical os. A marginal placenta praevia occurs when the placenta's edge extends to the margin but does not cover the internal os. A partial placenta praevia occurs when the placenta partially covers the internal cervical os. A complete praevia occurs when the placenta completely covers the internal cervical os (Figure 7).

Figure 2. Leiomyoma. Axial T_2 half acquisition turbo spin-echo (a) and coronal T_2 balanced steady-state free precession (true-fast imaging with steady-state precession) (b) images of a 30-year-old female. A leiomyoma appears as a well-defined mass of low-signal intensity that persists on both axial and coronal images (arrows). Myometrial contraction could have the same appearance but should not persist on all sequences.

Figure 3. Coronal T_2 half acquisition turbo spin-echo image on 3-T MRI scanner nicely shows the cotyledons of the placenta (arrows).

PAD may be complicated by post-partum haemorrhage and/or retained products of conceptus, as the placenta fails to separate from the uterus at the time of delivery.

Several MRI findings or criteria of PAD have been described, including:

- dark intraplacental bands on T_2 weighted image
- uterine bulging
- interruption of the normal layered appearance of the myometrium
- direct invasion of adjacent pelvic structures by placental tissue
- tenting of the urinary bladder
- heterogeneous signal intensity within the placenta or increased placental vascularity.

Uterine bulging or widening of the lower uterine segment is an hourglass-shaped uterus (Figure 7) as opposed to an inverted pear-shaped uterus and can be associated with PAD when additional findings are shown. Dark intraplacental bands can be

seen in patients with PAD, appearing as nodular or linear areas of low-signal intensity on T_2 weighted images (Figures 8 and 9). These dark bands are usually thicker and have more random distribution than the normal placental septa, and they extend from the uterine–myometrial interface. If the placenta is homogeneous and without dark intraplacental bands, it is unlikely that the patient has invasive placentation.

A study by Lax et al⁵ found that the most useful findings were uterine bulging, heterogeneous signal intensity within the placenta (Figure 10) and dark intraplacental bands on T_2 weighted image. Alamo et al⁶ found that the presence of dark intraplacental bands was the most useful sign for predicting placental invasion, followed by a focally interrupted myometrial border, invasion of pelvic organs and tenting of the bladder (Figure 11). Heterogeneous signal intensity in the placenta depends on the presence or absence of haemorrhage, increased vascularity and abnormal T_2 dark placental bands.

In some cases, it is almost impossible to differentiate between placenta accreta and placenta percreta using MRI, especially if there is no involvement of the adjacent pelvic structures. Focal interruption of the myometrial wall (high specificity for placenta increta and placenta percreta) (Figures 12 and 13) can be seen at the site of placental invasion. Visualization of direct bladder invasion (Figure 14) or tenting the bladder is specific for placenta percreta.

Bladder varices in pregnant females may be a source of confusion for PAD. The diagnosis of bladder varices is supported by the lack of uterine bulging, myometrial invasion and hyper-vascularity linking placenta to bladder.

Thinning myometrium has been described as a finding of PAD. In our experience, focal thinning of the myometrium is an unhelpful sign and can lead to false-positive interpretations (Figure 15).

CONCLUSION

MRI is an excellent diagnostic modality in gravid patients with high risk for PAD, and practitioners should be aware of this condition and its imaging features.

Figure 4. Sagittal and axial T_2 half acquisition turbo spin-echo images (a, b) of different patients show homogeneous signal intensity of placenta with thin linear areas of low-signal intensity representing normal placental septa (arrows).

Figure 5. Coronal oblique T_2 half acquisition turbo spin-echo image shows low-signal intensity flow voids underneath the placenta representing subplacental vascularity (arrow).

Figure 6. Sagittal T_2 weighted image shows focal area of defect representing caesarean section scar (arrow) that predispose the placental adhesive disorder.

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Figure 7. Complete placenta praevia and placenta percreta in a 32-year-old female at 35 weeks of gestation. Sagittal T_2 true-fast imaging with steady-state precession image shows placenta that entirely covers the cervical os, widening of the lower uterine segment (hourglass appearance) (arrow) and dark intraplacental band. Hysterectomy specimen and pathology showed placenta accreta.

Figure 8. Complete placenta praevia and placental percreta at the lower uterine segment. Sagittal T_2 true-fast imaging with steady-state precession image shows stellate-shaped dark intraplacental band on maternal side of placenta extending from the uterine-myometrial interface (arrow). Hysterectomy specimen and pathology showed placenta percreta.

Figure 9. Dark intraplacental bands. Sagittal T_2 half acquisition turbo spin-echo image shows nodular areas of low-signal intensity representing intraplacental bands (arrows).

Figure 10. Axial T_2 half acquisition turbo spin-echo image through the placenta at the lower uterine segment shows heterogeneous signal intensity and increased flow voids of vascularity (arrow).

Figure 11. Placenta percreta. Sagittal T_2 half acquisition turbo spin-echo image shows bulging of lower uterine segment. Tenting of the urinary bladder is shown at the superior aspect (arrow).

Figure 12. Coronal T_2 true-fast imaging with steady-state precession image shows loss of normal layered myometrium and focal interruption with invasion of myometrium by placental tissue (arrows).

Figure 13. Placenta increta and placenta percreta in a 36-year-old female at 30 weeks gestation show the placental tissue partially invade the myometrium; placenta increta (vertical arrow) and another larger area where the placental tissue penetrates through the entire myometrial layer; placenta percreta (horizontal arrow). Hysterectomy specimen and pathology showed placenta increta and placenta percreta

Figure 15. Normal placenta with focal myometrial compression. Axial T_2 half acquisition turbo spin-echo image in a 35-year-old female with twin pregnancy shows compression of myometrium over the area of the spine at the level of the lower abdominal aorta (arrow).

Figure 14. Coronal T_2 half acquisition turbo spin-echo (a) and T_2 true-fast imaging with steady-state precession (b) images at the same location in a 28-year-old female at 30 weeks gestation show focal invasion at the superior aspect of bladder by placental tissue (arrows).