European Journal of Radiology 93 (2017) 76–89

Contents lists available at ScienceDirect

European Journal of Radiology

journal homepage: www.elsevier.com/locate/ejrad

Magnetic resonance imaging in tubal and non-tubal ectopic pregnancy

Sitthipong Srisajjakul[a,1,*], Patcharin Prapaisilp[a,1], Sirikan Bangchokdee[b,2]

[a] Department of Radiology, Division of Diagnostic Radiology, Faculty of Medicine, Siriraj Hospital, Mahidol University, Bangkok, Thailand
[b] Department of Internal Medicine, Pathum Thani Hospital, Pathum Thani, Thailand

ARTICLE INFO

Keywords:
Ectopic pregnancy
Imaging of ectopic pregnancy
MRI of ectopic pregnancy
Tubal and non-tubal ectopic pregnancy

ABSTRACT

Ectopic pregnancy is the leading cause of pregnancy-related death in the first trimester. Ectopic pregnancy is usually diagnosed by clinical, laboratory, and sonographic findings, with implantation most commonly located in the ampullary part of the fallopian tube. However, pregnancies that develop at unusual implantation sites, such as angular, interstitial, cornual, cervical, ovarian, cesarean scar, and abdominal cavity pregnancies, may rarely occur. Although ultrasound is considered the primary pregnancy-related imaging modality, it may not be able to illustrate the implantation site in certain types of pregnancy. Magnetic resonance imaging (MRI) has gained popularity as an imaging tool for evaluating pregnant patients, and it is used as a problem-solving tool in special circumstances, including ectopic pregnancy. MRI can confirm abnormal implantation site, and distinguish rupture from nonrupture cases before management. Other benefits include absence of ionizing radiation, superb soft tissue contrast, and sensitivity sufficient for identifying hemorrhage and its stages. This article summarizes imaging findings in tubal and non-tubal ectopic pregnancy with an emphasis on the roles and protocols of MRI, key MRI features, and differential diagnosis.

1. Introduction

Ectopic pregnancy occurs when the fertilized ovum implants and matures external to the endometrial cavity. Ectopic pregnancy is the leading cause of pregnancy-related mortality in the first trimester. The prevalence of ectopic pregnancy is increasing due to an increase in risk factors that include growth in the popularity of assisted reproductive technology, and an increase in the number of women with prior ectopic pregnancy and/or tubal disease. Ectopic pregnancy is classified as either tubal or non-tubal. Ectopic pregnancy can result in rupture and subsequent massive hemorrhage. Increased serum beta human chorionic gonadotropin (beta hCG) level and an empty uterus on initial sonography are the most compelling early diagnostic clues. The intent of this article is not to displace sonography as the standard imaging modality for diagnosing ectopic pregnancy. Rather, the intended aim was to better acquaint the reader with MRI as an effective diagnostic imaging alternative in cases where sonography is inconclusive or when more precise information is needed to make correct diagnosis and/or to guide clinical management. At our center, the first-line investigation for ectopic pregnancy is transvaginal sonography that is performed by a gynecologist. In cases in which ultrasound is unable to provide conclusive findings, MRI is subsequently performed by a radiologist. This article sets forth to review MRI findings in early intrauterine pregnancy that may be small and inconspicuous in the first trimester; to review the role and imaging protocol of MRI in ectopic pregnancy; to describe characteristic imaging findings that can be used to confidently diagnose tubal and non-tubal ectopic pregnancy; and, to describe and discuss potential mimics and differential diagnosis in ectopic pregnancy.

2. Overview

- The most common site of ectopic pregnancy is the non-interstitial portion or ampulla of the fallopian tube.
- A one-time measurement of serum beta hCG level cannot reliably differentiate between intrauterine and extrauterine pregnancy.
- When ectopic pregnancy cannot be detected in the adnexa, atypical implantation site must be suspected and investigated.
- If ectopic pregnancy is identified, measurement in three dimensions should be performed, since the maximal diameter of the gestational sac will influence the mode of treatment.
- Interstitial pregnancy is associated with the highest risk of massive or uncontrollable bleeding.
- Major concerns associated with positive pregnancy test or positive

* Corresponding author. Tel.: +66 824456905; fax: +66 25869904.
E-mail addresses: tiam.mahidol@gmail.com (S. Srisajjakul), charinprapai@gmail.com (P. Prapaisilp), yuisirikan@gmail.com (S. Bangchokdee).
[1] Division of diagnostic radiology, Department of radiology, Faculty of medicine, Siriraj hospital, Bangkok, Thailand, 2 Wanglang road Bangkoknoi, Bangkok, Thailand 10700.
[2] Department of internal medicine, Pathum Thani hospital, Pathum Thani, Thailand, 7 Ladlumkaew Muang district, Pathum Thani, Thailand 12000.

http://dx.doi.org/10.1016/j.ejrad.2017.05.023
Received 22 February 2017; Received in revised form 14 May 2017; Accepted 19 May 2017

serum beta hCG with nondetectable intrauterine pregnancy are very early pregnancy, failed pregnancy, and ectopic pregnancy.

- Ectopic pregnancy should be strongly suspected in patients with positive pregnancy test, hemoperitoneum/hematosalpinx, and no intrauterine gestational sac, despite the absence of a clearly identified extrauterine gestational sac.
- Cesarean scar pregnancy, angular pregnancy, and cornual pregnancy are classified under the umbrella classification of ectopic pregnancy; however, none of the three are true ectopic pregnancies.

3. MRI in Early Intrauterine Pregnancy

Occasionally, early pregnancy is unintentionally imaged by MRI for concomitant pathology. It is, therefore, necessary to disclose and discuss MRI findings in early intrauterine pregnancy. Radiologists must be able to: 1) recognize MRI findings in early pregnancy; 2) rule out normal gestational sac and heterotopic pregnancy in patients with positive pregnancy test; and, 3) avoid misdiagnosis of other intrauterine pathology.

During the second and third trimester of pregnancy, it is not difficult to recognize the intrauterine fetal part. Fetal parts are usually not visibly detected during the early and mid-first trimester. MRI findings in normal pregnancy include a small fluid-filled cystic structure in the uterine cavity, curvilinear enhancing structure of placenta, thickened endometrium, and associated corpus luteum cyst [1,2]. A small fetal pole is visible in the late first trimester (Fig. 1).

4. Diagnostic Strategy in Ectopic Pregnancy

In ectopic pregnancy, patients typically experience amenorrhea for 6–8 weeks after the last menstrual period (LMP) and they have abnormal vaginal bleeding.

In complicated cases, such as ruptured ectopic pregnancy, patients complain of acute severe abdominal cramping or pain, and they present with signs of peritonitis and unstable hemodynamic status at physical examination.

Due to the potential danger of a delayed diagnosis and rupture of an ectopic pregnancy, the clinician should perform a urine pregnancy test (qualitative beta hCG levels) prior to any type of cross-sectional imaging.

If the patient is pregnant, further investigations to detect for a possible ectopic or ruptured ectopic pregnancy should be conducted. Transvaginal ultrasound is the diagnostic tool of choice for ectopic pregnancy.

Equivocal sonographic results should be assessed in conjunction with quantitative beta hCG levels. Combined transvaginal ultrasonography and serial quantitative beta-hCG measurement was reported to have close to 96% sensitivity and 97% specificity for diagnosing ectopic pregnancy [3].

Ultrasonography is the first-line imaging modality for diagnosing ectopic pregnancy, but it is also the most operator-dependent imaging option. In complex and inconclusive cases, MRI may yield additional useful information and it is quite sensitive to blood (i.e., hemoperitoneum) and it can identify stage of hemorrhage.

Given the longer scan time of MRI compared to ultrasound, MRI is not recommended in a patient who presents with shock or profound hypotension, as that patient requires immediate surgical intervention.

5. Laboratory Investigations in Ectopic Pregnancy

A negative serum beta hCG level virtually excludes the possibility of live pregnancy. Serum beta hCG is secreted by the placenta and can be detected in the blood stream about 9 days after conception or approximately 3 weeks after last menstrual period (LMP). It should be acknowledged that many reference standards are used for interpreting the results of serum beta hCG levels and it is important to know which standard is used at your medical center. At present and at our laboratory, International Reference Preparation (IRP) is most commonly used. According to IRP standard, a gestational sac should be visible on transvaginal sonography if the serum beta hCG level is 1800–2000 mIU/ml [4]. In normal healthy pregnancies, the beta hCG level should double about every 2 days.

At out center, if no intrauterine pregnancy is detected, knowledge of the beta hCG level is crucial. A beta hCG level of $<$ 2000 mIU/ml (IRP) suggests three diagnostic possibilities, including early intrauterine pregnancy, ectopic pregnancy, or abnormal intrauterine pregnancy, such as spontaneous abortion. A careful investigation to identify which of these possible outcomes has developed in your patient is recommended. If the initial work-up reveals no abnormality at both adnexa, the patient should be followed-up with a repeat ultrasound in 5–7 days with serial monitoring of beta hCG levels. If follow-up scans show abnormality in the adnexal region, ectopic pregnancy should be considered. If the beta hCG level is $>$ 2000 mIU/ml (IRP), the intrauterine gestational sac should be identified. If intrauterine pregnancy is not identified, tubal or non-tubal ectopic pregnancy should be strongly suspected.

6. The Importance of Early Diagnosis of Ectopic Pregnancy

Early prompt diagnosis of ectopic pregnancy is essential, because

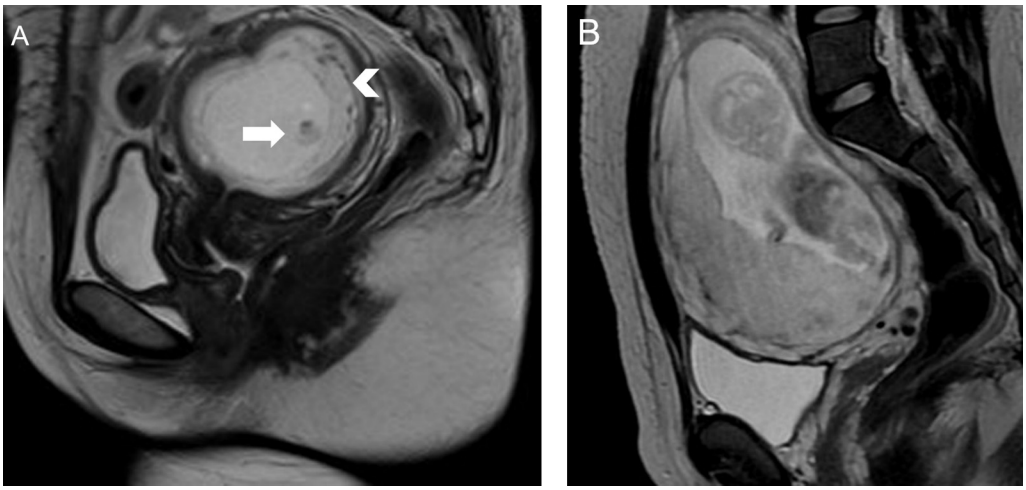

Fig. 1. Normal intrauterine pregnancy: A) Sagittal T2-weighted image of intrauterine early pregnancy shows small fetal pole (arrow) with thick curvilinear placenta (arrowhead); B) Sagittal T2-weighted image of intrauterine pregnancy at second trimester shows placenta and fetus.