Diagn Interv Radiol 2012; 18:496–502

CASE REPORT

Fetal MRI in the pre-operative diagnosis and assessment of secondary abdominal pregnancy: a rare sequela of a previous caesarean section

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ABSTRACT
Secondary abdominal pregnancy is a rare type of ectopic pregnancy. Following fertilization, the blastocyst escapes from the uterine cavity and implants in the peritoneal cavity. The early antenatal diagnosis and identification of the site and extent of placental implantation in an abdominal pregnancy are important to prepare for the eventual surgery. We present the case of a 24-year-old patient presenting with loss of fetal movement at 26 weeks of gestation for whom an abdominal pregnancy was suspected on ultrasonography and later confirmed on magnetic resonance imaging (MRI). She had one caesarean section in the past. The MRI findings suggested a scar dehiscence. She was eventually managed surgically, and the unviable fetus was removed. Abdominal pregnancies must be treated as emergencies. They usually present with complications such as fetal death and intra-abdominal hemorrhaging and can be easily missed on routine antenatal ultrasonography. The exact anatomical relationships of the fetus, the placenta, and vital maternal intra-abdominal structures can be accurately delineated with MRI, which greatly aids the management of patients with abdominal pregnancy. A proposed imaging protocol and technical suggestions for improving the diagnostic capability of ultrasonography and MRI in abdominal pregnancies have been provided to aid in the appropriate evaluation of suspect cases.

Key words: • *abdominal pregnancy* • *fetal death* • *magnetic resonance imaging* • *placentation*

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Received 10 October 2011; revision requested 2 November 2011; revision received 22 November 2011; accepted 23 November 2011.

Published online 24 January 2012
DOI 10.4261/1305-3825.DIR.5200-11.1

Abdominal pregnancy is a unique type of ectopic pregnancy that can be easily missed in routine obstetric practice. Current studies estimate an incidence of 1.3% (1–4). This type of pregnancy can be classified as primary or secondary, based on whether fertilization occurs in the peritoneal cavity followed by peritoneal implantation or whether normal fertilization is followed by rupture of the uterine or tube wall, leading to secondary implantation in the peritoneal cavity (5–7). The affected woman may not have any major complaints other than some discomfort. The abdomen enlarges, just as in normal pregnancy. To an unsuspecting radiologist doing a routine ultrasonography, the growing intra-abdominal fetus may appear quite healthy and have normal systemic development. We present the case of a 24-year-old patient who presented with loss of fetal movement at 26 weeks and subsequently was diagnosed with abdominal pregnancy by magnetic resonance imaging (MRI). We emphasize the importance of MRI in suspected abdominal pregnancies. In our case, the MRI both provided a definitive diagnosis and revealed the significant anatomical relationships of the intra-abdominal organs, thus aiding in the surgical management.

Case report

A 24-year-old female (gravida 2, para 1, living 1) presented with a six-month history of amenorrhea, vague abdominal pain, and loss of fetal movements for 10 days. She had no history of vaginal bleeding or passage of clear fluid. She had undergone a caesarean section for her first child one year previously. There was no history of contraceptive use. The patient consulted a local hospital after she noticed reduced fetal movement, and an intra-uterine fetal demise was diagnosed following an ultrasound scan. Medical induction for delivery of the non-viable fetus was attempted, but despite adequate doses of an inducing agent, there were no signs of progress into labor. There was history of some form of attempted instrumentation. Following the unsuccessful induction, the patient was referred to our institute.

On examination, the patient was pale with a heart rate of 90/min and blood pressure of 110/68 mmHg. An obstetric examination revealed a fundal height corresponding to 28 weeks, with a transverse lie and easily palpable fetal parts. The fetal heart could not be auscultated. The external os was closed on vaginal and speculum examination, and minimal bleeding was noted. Apart from mild anemia (hemoglobin, 11 g/dL), the laboratory results were within normal limits.

A preliminary ultrasound scan with a 3–5 MHz curvilinear probe (Siemens Sonoline G50, Siemens Medical Solutions, Issaquah, Washington, USA) at our institute revealed a non-viable fetus with a transverse lie (Fig. 1). A normally echogenic uterine wall was not noted, which raised the suspicion of an abdominal pregnancy. The placental

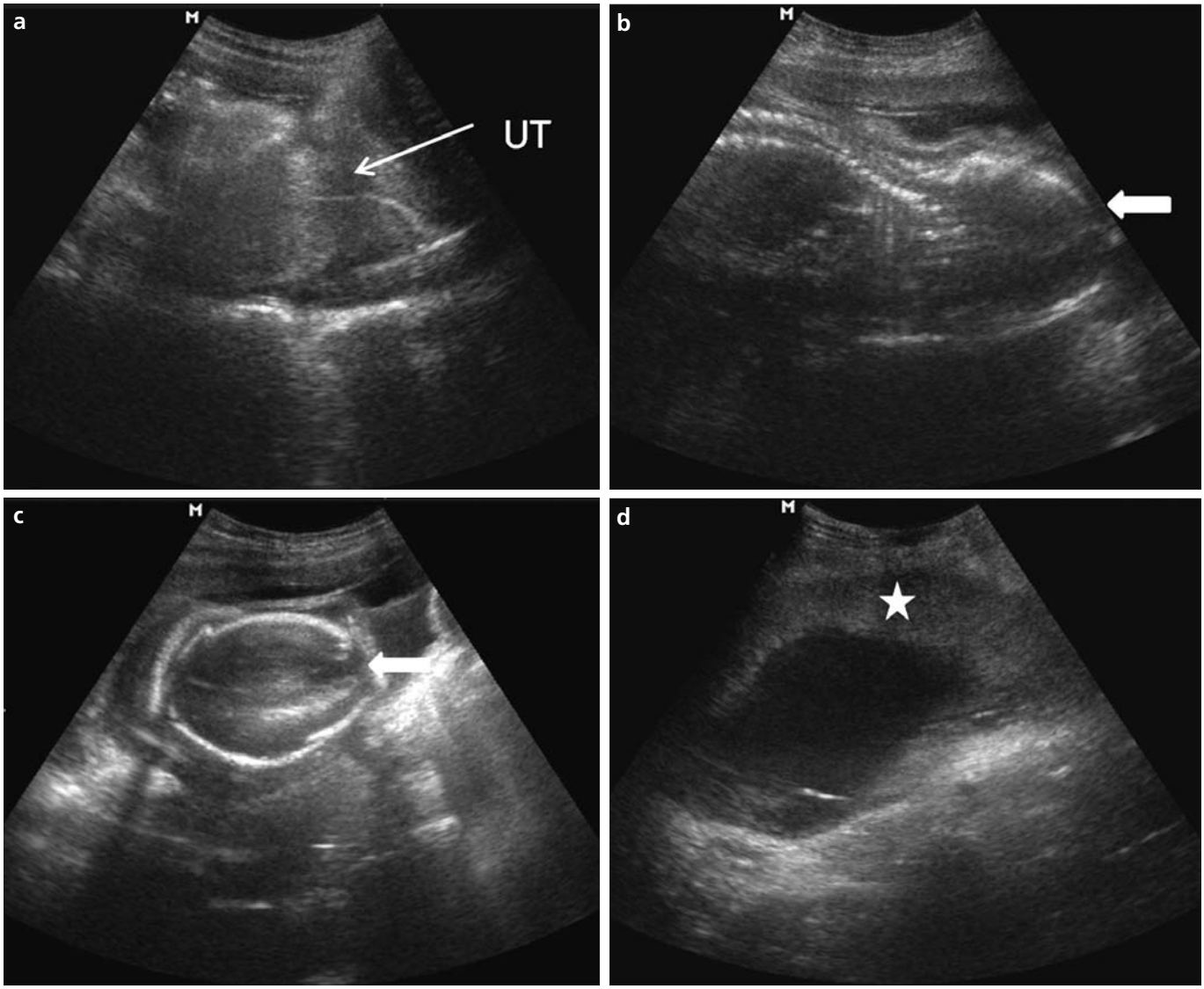

Figure 1. a–d. Transabdominal ultrasonography using a 3–5 MHz curvilinear probe shows the empty bulky uterus with an echogenic endometrial lining **(a**, *arrow***)**, the fetus without a myometrial cover around it **(b**, *thick arrow***)**, the abnormal overriding of the fetal skull bones, the ultrasonographic Spalding's sign suggesting maceration **(c**, *thick arrow***),** and the anteriorly implanted placenta outside the uterus **(d**, *asterisk***)**.

position was anterior. The fetal parameters corresponded to 26 weeks, 4 days. There were fetal ascites, pleural effusion and fetal skin thickening, indicating hydrops fetalis. The vault seemed deformed, with overriding skull bones (Spalding's sign on ultrasonography). A bulky and empty uterus with an echogenic endometrial lining was noted in the pelvis. Fetal demise with signs of maceration was diagnosed, with a suspicion of an extra-uterine, intra-abdominal pregnancy.

An MRI was performed using a 1.5 T unit (Siemens Magnetom 1.5 T, Siemens Medical Solutions) to further evaluate the patient. Sagittal T2-weighted (W) turbo spin echo images (TSE) (TR/TE, 3300/126 ms; field of view, 240×240 mm; slice thickness, 3.5 mm; echo train length, 15) showed an intra-abdominal fetus in a hyperintense amniotic cavity outside the uterus (Fig. 2). The placenta was located on the peritoneal surface of the anterior abdominal wall, with the umbilical cord arising from it. The placenta extended superiorly, curving over the under surface of the displaced mesenteric peritoneum and inferiorly along the posterior surface of the anterior abdominal wall, reaching the peritoneal reflection on the superior surface of the urinary bladder. The uterus was in the pelvic cavity. The anterior margin of the uterus was irregular and heterogeneous. A slightly hyperintense, ill-defined tract appeared to extend from the endometrial cavity to the anterior peritoneal surface of the uterus (Fig. 2c). An air-fluid level was present between the uterus and the amniotic cavity. The fluid collections anterior to the uterus and in the pouch of Douglas were slightly hypointense to amniotic fluid, possibly indicating an old hemorrhage. Overriding of the skull bones and asymmetric distortion of the brain parenchyma was also noted, indicating fetal maceration (Fig. 2d). A coronal T2W turbo inversion recovery with magnitude display (TIRM) (TR/TE, 4190/70; field of view, 280×280 mm; slice thickness, 3 mm; echo train length, 11) and coronal T2W true fast imaging with steady-state precession images (TrueFISP or TRUFI) (TR/TE,

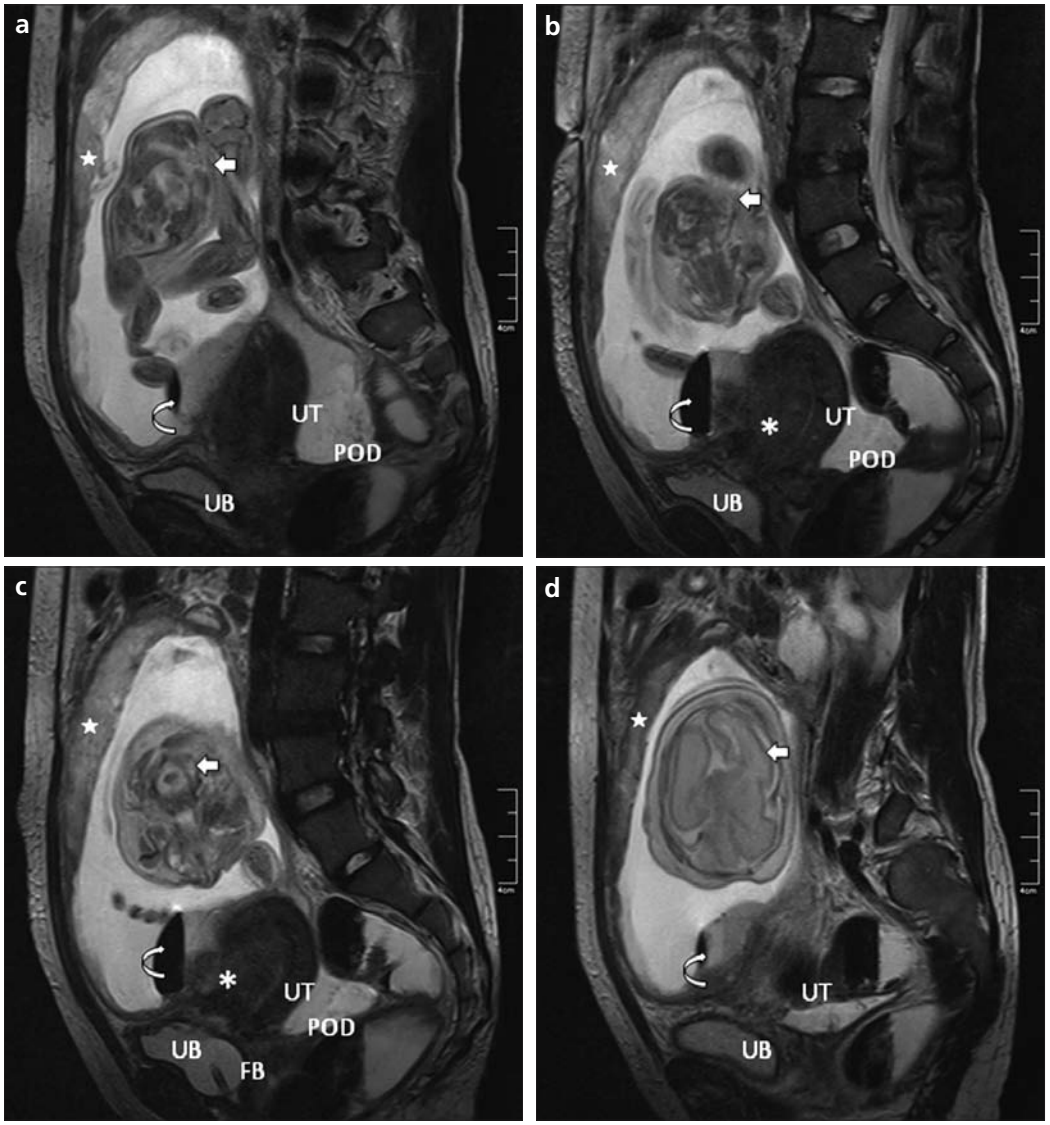

Figure 2. a–d. The sagittal T2-weighted turbo spin echo images show an extra-uterine, intra-abdominal pregnancy. The fetus is seen in the hyperintense fluid-filled cavity in the abdomen outside the uterus **(a–d**, *thick arrows***)**. The fetal head shows overriding of the skull bones and an asymmetric deformed cortex, suggesting maceration **(d**, *thick arrow***)**. The empty uterus is seen in the pelvic cavity. The placenta is seen implanted on the posterior surface of the anterior abdominal wall **(a–d**, *pointed asterisks***)**. The placenta extending over the undersurface of the pushed-up bowels and then over the posterior abdominal wall can be seen. Inferiorly, the placental tissues extend down to the bladder. The umbilical cord can be seen arising from the placenta **(a**, *pointed asterisk***)**. There is air-fluid level anterior to the uterus **(a–d**, *curved arrow***)**. The anterior margin of the uterus is irregular **(b, c**, *asterisk***)**. A slightly hyperintense irregular tract is seen extending from the endometrium to the anterior uterine margin, demonstrating the site of the scar dehiscence (**c**, *asterisk*). There is slightly hyperintense fluid in the pouch of Douglas indicating hemorrhagic content. The Foley's bulb is seen *in situ*. UT, uterus; UB, urinary bladder; POD, pouch of Douglas; FB, Foley's bulb.

3.61/1.47 ms; field of view, 332×380 mm; slice thickness 6 mm; echo train length, 1) showed an intra-abdominal amniotic sac with a transversely oriented fetus (Figs. 3 and 4). A placenta reaching the under surface of the omental and mesenteric peritoneum was confirmed.

The conformation of an intra-abdominal pregnancy with fetal demise left no option for conservative management, and the patient underwent an emergency laparotomy. The intraoperative findings further confirmed the MRI observations. Because the MRI showed positioning of the placenta superior to the level of the umbilicus, a midline incision was avoided; a right para-sagittal infra-umbilical incision was made, and the abdomen was opened. The fetus was macerated and encased in a fluid filled sac outlined by a thin membrane with underlying omental fat. The non-viable fetus was delivered (Fig. 5a). The umbilical cord was traced to the placenta and ligated as close to the placenta as possible (Fig. 5b). A significant portion of the placenta had adhered to the peritoneum covering the mesentery and the small bowel; it was left in place due to the deep implantation and to prevent further hemorrhage. A foul-smelling intra-abdominal fluid collection was noted in the pelvic cavity and was drained. The uterus was separated from the fetal sac in the pelvis. A moderate degree intra-peritoneal hemorrhagic fluid was also drained, mainly from the pouch of Douglas. The anterior surface of the uterus had a defect with ragged margins. The necrotic portion was removed, and the wound margins were freshened. The opposing myometrial ends were sutured together. The abdomen was closed after multiple peritoneal lavages, and the lumbar drain tubes were left in situ. The patient was post-operatively managed with fluids, blood transfusion, and antibiotics.

Discussion

During embryogenesis, the morula enters the uterine cavity at approximately three days post fertilization. Implantation into the endometrium occurs at 5–6 days in the blastocyst stage. Implantation that occurs anywhere outside the uterine cavity is termed an ectopic pregnancy. According to one recent estimate, the annual age-adjusted ectopic pregnancy

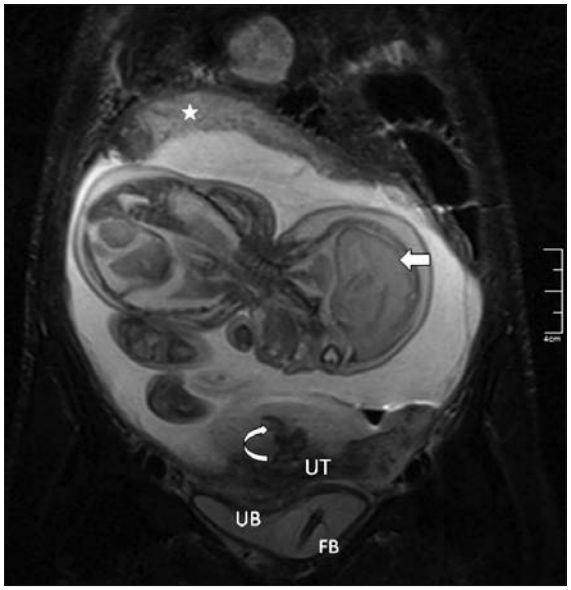

Figure 3. A coronal T2-weighted turbo inversion recovery with magnitude display shows an extra-uterine, intra-abdominal pregnancy. The fetus (*thick arrow*) is seen lying transversely in a hyperintense fluid-filled cavity in the abdomen, outside the uterus. Fetal pleural effusions and ascites are seen, consistent with signs of maceration. An irregular, heterogeneous, hypodense structure with air-fluid levels is seen in lower abdomen (*curved arrow*). UT, uterus; UB, urinary bladder; FB, Foley's bulb.

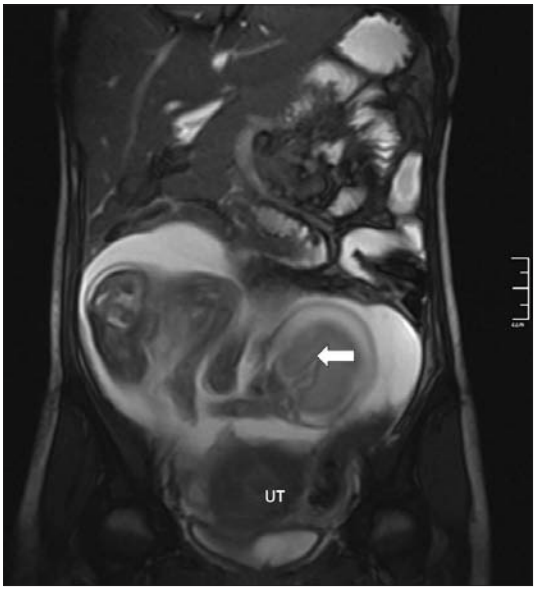

Figure 4. Coronal T2-weighted true fast imaging with steady-state precession images shows the intra-abdominal sac with a transversely oriented fetus (*thick arrow*) outside the uterus and displacing the bowel loops superiorly. UT, uterus.

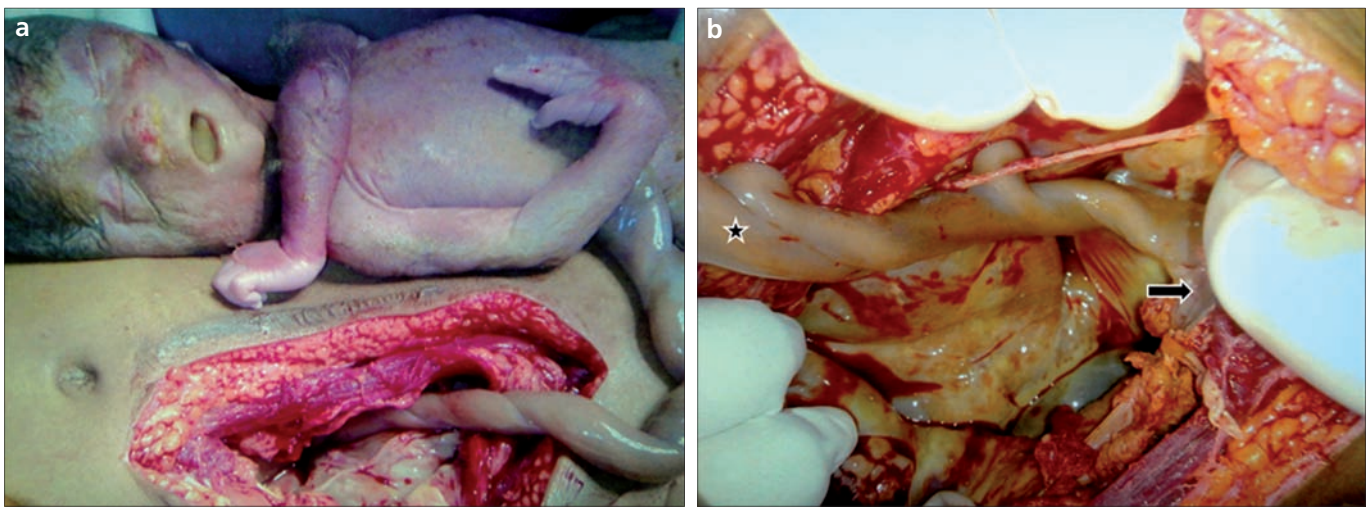

Figure 5. a, b. Intra-operative photographs showing the fetus removed from the abdomen via a right parasagittal infraumbilical incision. The fetus is macerated **(a)**. The umbilical cord **(b,** *asterisk***)** and its attachment to the placenta **(b,** *arrow***)** on the posterior surface of the anterior abdominal wall are seen.

rate is 17.9 per 10 000 woman-years. Two percent of all first-trimester pregnancies in the USA are ectopic, and these account for 2% of all pregnancy-related deaths. The risk of death from an extra-uterine pregnancy is greater than that for a pregnancy that either results in a live birth or is intentionally terminated (1–2). The incidence of ectopic pregnancy in developing countries may be slightly higher, on the order of up to 4.6% (3).

The fallopian tubes are the most common site of ectopic pregnancy, with interstitial (2.4%), isthmic (12.0%), ampullary (70.0%), and fimbrial (11.1%) implantation being possible. The non-tubal sites of implantation can be ovarian (3.2%) or abdominal (1.3%). Cervical pregnancies are much more rare (4). Although the classical clinical triad of an ectopic pregnancy is a woman of reproductive age presenting with amenorrhea, abdominal pain and vaginal bleeding, this pattern represents only approximately half of the cases. Furthermore, such a presentation is mainly seen in tubal pregnancies. Extra-tubal pregnancy may present much more subtly.

True primary intra-abdominal pregnancies are rare and need to satisfy Friedrich and Rankin's modification of the Studdiford's criteria (5–6): a pregnancy with a histological gestational age of less than 12 weeks in which the

trophoblastic attachments are related solely to a peritoneal surface, grossly normal tubes and ovaries, and the absence of a uteroperitoneal fistula. Any abdominal pregnancies that do not fulfill these criteria can be considered to be secondary in nature. Secondary abdominal pregnancies almost always result from a developing fetus escaping into the abdomen following the rupture of a tubal implantation (7). There have been reports of an alternate route of escape for a viable fetus, such as a scar dehiscence of a previous caesarean section (8) or the rupture of a rudimentary horn (9). In one study, the implantation site was found to be virtually any structure in the peritoneal cavity: the uterine cornu, fallopian tube, loops of bowel, omentum, uterine fundus, posterior abdominal wall, over the lumbar vertebrae, the pouch of Douglas, or anterior abdominal wall (10). The pregnancy can progress undetected well into the third trimester and up to term and delivery of live fetus (10).

In clinical scenarios, the most common cause of morbidity and mortality in abdominal pregnancy is deep implantation of the placenta on important vascular intra-abdominal structures. Placental bed hemorrhage is the most common cause of maternal mortality, which ranges up to 72% when hemorrhage occurs (11). A routine obstetric examination may not reveal anything that differs from a normal intra-uterine pregnancy. A history of previous contraceptive device use or pelvic inflammatory disease may raise the suspicion of an ectopic pregnancy. However, identifying an intra-abdominal, extra-uterine fetus is nearly impossible by routine history and examination because there are no specific signs or symptoms. The sonographic findings in abdominal pregnancy have been studied, and the presence of an intact empty uterus has been found to be the most important indicator, followed by an extra-uterine placenta, absent echogenic myometrium around the fetal sac, and an abnormal lie (12). Ultrasonography is relatively inexpensive, readily available and can prompt the initial diagnosis in some cases. However, it is limited by various factors, such as observer dependence, incomplete penetration in advanced pregnancy owing to less amniotic fluid, ossification of fetal bones, and bowel gas.

In our case, a 24-year-old patient presented with loss of fetal movements after six months of amenorrhea. Two ultrasonography scans reported intra-uterine fetal death, and an induction was attempted at the local hospital where she first consulted. After an unsuccessful induction, some form of instrumentation was also performed, most likely manual cervical dilatation. When these interventions did not yield any progress towards labor, the patient was referred to our institute. There have been previous studies reporting the lack of uterine response to inducing agents in advanced abdominal pregnancies (10). The valid history in our case also supports this observation. An abdominal ultrasound at our institute raised the suspicion of an abdominal pregnancy when the uterus was empty and an echogenic myometrium around the fetus was not visualized.

The use of MRI, with the advantages of multi-planar imaging and the absence of radiation, provided an accurate diagnosis of abdominal pregnancy in this patient. With MRI, it was possible to delineate the exact location of the transversely placed fetus, the placenta implanted over the anterior abdominal wall and extending well beyond it superiorly and inferiorly, and the empty uterus. Signs of fetal maceration, such as Spalding's sign, an irregular cerebral cortex, ascites and pleural effusions were also demonstrated. An important observation was the presence of irregular heterogeneous margins for the anterior wall of the uterus and hyperintense fluid with air-fluid levels and an irregular tract communicating with the endometrium. This air in the lower abdomen precluded optimum visualization of the pelvic structures on ultrasonography. This patient had a history of previous caesarean section. It is possible that the irregularity was the site of scar dehiscence, which had allowed the developing fetus to escape into the abdomen. The air-fluid level and presence of hemorrhagic fluid on laparotomy indicated that the vigorous attempts to deliver the dead fetus via inducing agents and cervical dilators must have led to further separation of the scarred anterior uterine wall, causing iatrogenic hemorrhage and the introduction of air. However, this conclusion could not be ascertained with certainty. The use of fast imaging sequences, such as turbo inversion recovery with magnitude display (TIRM) and true fast imaging with steady state precession (TrueFISP), reduces the scan time and shows excellent details with a greatly increased signal-noise ratio (13).

The identification of the extent of placenta on the posterior surface of the anterior abdominal wall on MRI directed the operating obstetrician to open the abdomen via a right parasagittal infraumbilical incision rather than a traditional midline incision, thereby avoiding a catastrophic hemorrhage had the placental bed been incised.

After delivering the fetus, the management of the residual placenta poses a surgical dilemma. If the placenta and membranes are left behind, they undergo autolytic necrosis and may pose a potential nidus for infection, eventually leading to abscesses, adhesions, secondary hemorrhaging, or consumptive coagulopathy, among other complications. Surgical removal of the placenta poses grave risks of catastrophic hemorrhage and must be avoided (10). Considering the extent of the implantation, the placenta was left intact in our case. Although this does carry a risk of later complications, it was in the best interests of the patient at the time of the surgery. A follow-up ultrasound of the same patient four weeks later showed minimal free intra-peritoneal fluid. The thickness of the placenta was reduced, and no significant signs of necrosis were noted. However, some small bowel loops were fluid filled, prominent and sluggishly peristaltic. The patient may have been going into subacute intestinal obstruction, although she did not have any adverse symptoms.

We suggest a management protocol that can be used to approach a suspected case of abdominal pregnancy depending on the trimester (Fig. 6). The absolute indications for an MRI in such case would be as follows: localization of an extrauterine placenta on the screening ultrasonography; non-visualization of a myometrial layer around the fetus; and an intact, non gravid uterus.

The following are the most important elements that a radiologist must look for and comment upon in the final report when evaluating an MRI for cases of suspected abdominal pregnancy:

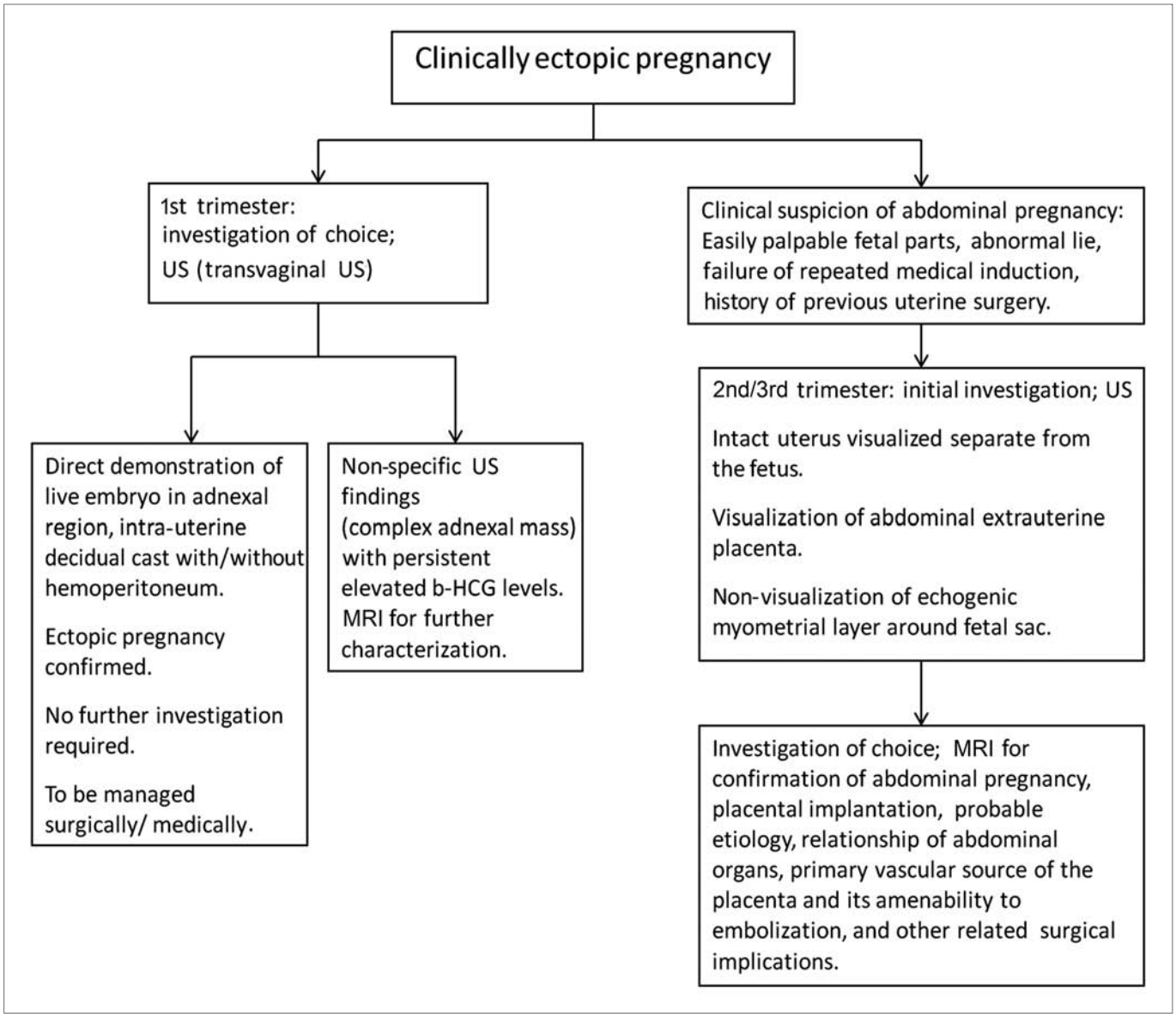

Figure 6. Proposed imaging protocol for diagnosing an abdominal pregnancy. US, ultrasonography; MRI, magnetic resonance imaging.

1) Fetus: definite diagnosis of extra-uterine intra-abdominal fetal presence; lie, orientation, and relation to the uterus; congenital abnormalities and signs of fetal demise/maceration/hydrops.
2) Placenta: site of implantation, extent of implantation, relationship of abdominal organs, most likely source of arterial supply, presence of retro-placental bleed, and umbilical cord anomalies.
3) Uterus: integrity of the myometrium tubes, cervix, and endometrial cavity and probable site of exit of the embryo/fetus.
4) Nature of the intra-abdominal fluid: hemorrhagic or clear amniotic fluid and based on its appearance in various MRI sequences, specific attention to the Pouch of Douglas and its contents.
5) Any associated incidental maternal pathology detected.

An abdominal pregnancy can be suspected on ultrasound with considerable credibility. However, certain points have to be kept in mind to avoid the catastrophic error of missing an abdominal pregnancy. We propose that the first structure that should be visualized in any routine obstetrical scan is the cervix. The cervical walls must then be traced superiorly as they continue around the fetus as the echogenic myometrium, and the endocervical canal must lead into the amniotic cavity. Any deviation from this normal pattern strongly evokes the suspicion of an abdominal pregnancy, especially in the second and third trimester. Incorporating this simple technique can identify possible cases of abdominal pregnancy.

As a conclusion, by using MRI, we were able to accurately diagnose an abdominal pregnancy and explain the probable mechanism by which secondary intra-abdominal deposition of the fetus might have occurred. We advocate using MRI to help improve the surgical approach and outcome in cases of suspected abdominal pregnancies.

Conflict of interest disclosure

The authors declared no conflicts of interest.

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