



# Scar Pregnancy and Extrauterine Implants

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Cesarean scar pregnancy (CSP) is a rare occurrence consisting in the implantation of the embryo within the myometrium of a prior cesarean delivery scar. The CSP could be a dangerous condition for women because of the related complications such as placenta previa or accreta, uterine rupture, and hemorrhage. Therefore, early diagnosis and rapid treatment are crucial. Extrauterine implants or ectopic pregnancy (EP) consists in the implantation of an embryo in a site other than the endometrium of the uterine cavity. It occurs in 1%-2% of all reported pregnancies. The most common extrauterine location is the fallopian tube, which represents 96% of cases. The diagnosis of CSP and EP is based on history, clinical examination, levels of serum  $\beta$ -human chorionic gonadotropin ( $\beta$ -hCG), and ultrasonography findings. In last 20 years, new treatments were developed, varying from medical management, minimally invasive surgical approach and local treatment including systemic or local infusion of metotrexate (MTX), and uterine artery embolization (UAE). UAE has been used widely to control hemorrhage and preserve the uterus and it is considered an affective adjuvant treatment of CSP and EP, especially associated with other therapies. Semin Ultrasound CT MRI 42:46-55 © 2020 Elsevier Inc. All rights reserved.

## SCAR PREGNANCY

### Introduction

The high rates of embryo transfer, microsurgical techniques and the elevated incidence of caesarean sections shared recently in increasing rate of ectopic pregnancies.<sup>1</sup> Cesarean scar pregnancy (CSP) is a rare occurrence consisting in the implantation of the embryo within the myometrium of a prior Cesarean delivery scar.<sup>2</sup> CSP is characterized by an empty uterus and cervical canal, a gestational sac (GS) located in the anterior uterine wall with diminished myometrium between the sac and the bladder and a discontinuity in the anterior wall of the uterus adjacent to the GS.<sup>3</sup> The exact pathogenic mechanisms are still unclear but CSP is believed to occur when a blastocyst implants on fibrous scar tissue within a wedge-shaped myometrial defect in the anterior

lower uterine segment, by the site of a prior Cesarean scar; therefore the placental attachment in the lower segment may consist of merely connective tissue instead of decidua basalis and myometrium. Pathologic examination of excised CSP alone and in hysterectomy specimens demonstrated clusters of trophoblast cells as well as scattered syncytiotrophoblast cells invading the myometrium through a microscopic dehiscence tract created by a previous cesarean section procedure or other uterine surgery.<sup>4</sup> If an expectant attitude is assumed, CSP will probably transform into a pregnancy with placenta percreta in the scar and in the lower segment. Placenta accreta occurs when all or part of the placenta attaches abnormally to the myometrium. If the placenta invades into the myometrium, it is termed placenta increta. A placenta percreta invades through the myometrium to the level of the serosa or continues into adjacent organs.<sup>5</sup> CSP was first described in 1978 by Larsen and Solomon<sup>6</sup>; however, with the significant increase of Cesarean section and the development of transvaginal ultrasonography, the frequency of CSP diagnoses has increased as well, to 6.1% of all ectopic pregnancies.<sup>7</sup> The frequency of cesarean scar pregnancy is reported to be 1:1800 to 1:2226 (0.05%–0.04%) of all pregnancies. According to Rotas et al<sup>2</sup> over a half of CSP cases (52%) were found in patients after one Cesarean section only; the mean gestational age was  $7.5 \pm 2.5$  weeks and the prevailing sign was vaginal bleeding, with no pain.

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## Classifications

There are lots of classifications proposed for CSP. Vial et al<sup>8</sup> classified CSP into endogenic and exogenic types. Type I or endogenic type: CSP with progression to the cervico-isthmic space or uterine cavity; type II, exogenic type: CSP with deep invasion of a scar defect with progression toward the bladder and abdominal cavity. The endogenic type of CSP could result in a viable pregnancy but with a high risk of bleeding at the placental site. The exogenic type could be complicated with uterine rupture and bleeding early in pregnancy.<sup>9</sup> Although many interventions have been suggested, there is no consensus regarding the optimal management of the endogenic and exogenic types of CSP.<sup>10</sup> Hwang et al<sup>11</sup> also categorized CSP into 2 types: intramural and non-intramural; however, it was difficult to draw firm conclusions based on the 22 cases analyzed. Zhang et al<sup>12</sup> classified CSP into risky and stable types, in which the risky type was further categorized into type I (Ia, Ib, and Ic), type II, and type III based on the GS location and remaining myometrial thickness. This classification was shown to provide a better treatment option for different types of CSP; however, this classification is somewhat complicated for most obstetricians.

## Diagnosis

The CSP could be a dangerous condition for the women because of the related complications such as placenta previa or accreta, uterine rupture, and hemorrhage; it is a life-threatening condition, so early diagnosis and rapid treatment are crucial to reducing the risk of maternal morbidity and mortality. The classic clinical presentation of ectopic pregnancy is a triad of lower abdominal pain, vaginal bleeding, and amenorrhea.<sup>13</sup>

The diagnosis of CSP was based on history, clinical examination, increased levels of serum  $\beta$ -human chorionic gonadotropin ( $\beta$ -hCG), and ultrasonography findings. The main ultrasound criteria of CSP were: empty uterus and endocervical canal, presence of the gestation sac in the anterior part of the uterine isthmus with increased surrounding blood flow on colour Doppler, and no myometrial tissue detected between the bladder and the sac. If intrauterine pregnancy is not seen on the ultrasound, the measuring  $\beta$ -hCG levels may help in the diagnosis. For equivocal ultrasound results, magnetic resonance imaging (MRI) or computed tomography (CT) can be used to determine the location of embryonic implantation and assess the depth of intrusive growth from the gestational sac to the muscular layer; the MRI findings were concordant with sonographic findings.<sup>14</sup> Transvaginal ultrasonography has a sensitivity of at least 90% but this examination, in particular in CSP, must be carried out with caution, to avoid bleeding or major complications. The use of transvaginal US to assess early pregnancies is useful for the early diagnosis and for the planning of the management.

## Treatment

In the management of CSP, some elements must be considered: size of pregnancy, presence or absence of uterine continuity,  $\beta$ -hCG level, wish to remain fertile and, primarily,

patient's hemodynamic state.<sup>15</sup> In the past, the only treatment option for CSP was the emergency laparotomy with the risk of hysterectomy to avoid lethal haemorrhage.<sup>16</sup> However, in last 20 years, new treatments were developed, varying from medical management, minimally invasive surgical approach and local treatment including systemic or local infusion of metotrexate (MTX), and uterine artery embolization (UAE). Because of the limited number of reports with a large number of cases, there is no consensus for the treatment and management of CSP. Termination of pregnancy in the first trimester is strongly recommended to prevent life-threatening complications and to maintain the possibility of future pregnancy, as well as the patient's health and quality of life.<sup>17,18</sup> In most cases, better therapeutic effects can be obtained by combined and multi-step treatment.

## Surgical treatment

Surgical management is offered to the patients who are haemodynamically unstable or in patients who have failed with medical therapies. Laparoscopic removal of CSP is applicable when the ectopic gestation is growing toward the bladder and abdominal cavity (type II CSP). The patient should be hemodynamically stabilized, and the procedure should be performed by an experienced surgeon in an adequate facility.<sup>9</sup> A minimally invasive alternative to CSP treatment is hysteroscopy. However, there are only few small series of CSP treated with hysteroscopy alone. In a review, among 95 cases treated mainly by hysteroscopy,<sup>19</sup> major complications were encountered in 3.2% of cases, and 17% needed further interventions. Yang et al<sup>20</sup> reported a cohort of 39 cases of removal of CSP using hysteroscopy under ultrasound guidance. Uterine curettage<sup>21</sup> is also often performed, with a reported efficacy around 95% in CSP between day 31 and 67.<sup>22</sup>

## Medical treatment

The MTX, a folate antagonist, acts on the cells in active proliferation and for this reason the bone marrow, gastrointestinal mucosa, and respiratory epithelium can also be harmed. It is directly toxic to hepatocytes and renally excreted. Treatment with MTX, systemically or locally, is an option intended to preserve the uterus and fertility. Most authors used systemic methotrexate (MTX) in a single-dose approach and a second dose a week later if needed. Experience with multidose treatment similar to that for the treatment of molar pregnancy is lacking. In a review, systemic MTX treatment for CSP was found to be effective when the serum beta-human chorionic gonadotropin ( $\beta$ -hCG) levels were  $\leq 12,000$  mIU/mL (odds ratio 5.68), there was negative embryonic cardiac activity, and the gestational age was below 8 weeks.<sup>23</sup> Yet, a quarter of patients required additional treatment because of persistent fetal cardiac activity and/or increasing  $\beta$ -hCG levels, and 13% had serious complications.<sup>24</sup> This could be because of the short half-life of MTX. Exposure of MTX to the trophoblast is also limited by the presence of fibrous tissue surrounding the gestational sac. Local MTX treatment in

another option: Cok et al<sup>25</sup> reported that a local MTX injection of 50 mg/m<sup>2</sup> in 18 women with CSP was associated with a success rate of 61.1%; 22.2% of cases required additional doses of MTX, and 16.7% required surgical intervention. The variations in the success rates could be because of the different MTX protocols and variable follow-up time.

### Uterine artery embolization

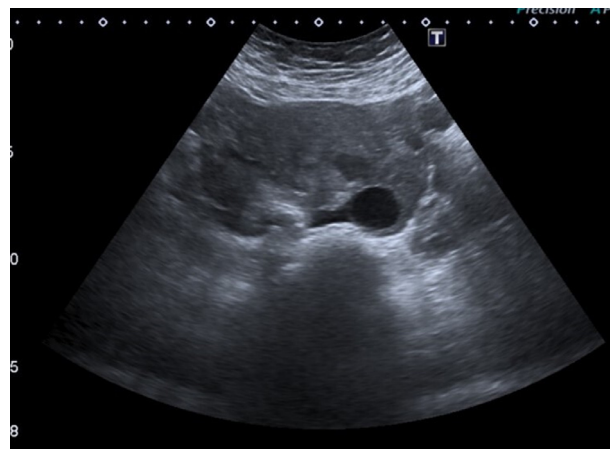
UAE treatment of CSP was first reported in 1999<sup>26</sup>; it has been used widely to control hemorrhage and preserve the uterus and it is considered an adjuvant treatment of CSP, since it minimizes bleeding, particularly in cases when the trophoblasts are deeply embedded in the myometrium. It is mainly performed in CSP patients who fulfill the following criteria: high arterial flow related to the GS, a myometrial thickness between the sac and urinary bladder is below 2 mm, serum  $\beta$ -hCG level more than 10,000 mIU/mL.<sup>16</sup>

### Technical aspects

After local anesthesia (10 ml of 2% lidocaine) and femoral or radial puncture, hypogastric arteries and bilateral uterine arteries angiograms are performed to provide the interventional radiologists an opportunity to study the vascular anatomy, anatomical variations and, in particular, some anastomosis that could complicate the procedure (Figs. 1 and 2). After catheterizing the uterine arteries, embolization is performed (Figs. 3 and 4). The most used embolized agents are the Polyvinyl alcohol particles (definitive embolic agent), and Gelfoam particles (temporary embolic agent). A review of the literature<sup>27</sup> demonstrated that the Polyvinyl alcohol particles might have superior effectiveness compared with Gelfoam particles, which are a temporary embolic agent. However, Gelfoam was used in at least 202 of 239 patients (84.5%) whereas PVA was used in only 18 patients which suggests that Gelfoam might still be the preferred embolic agent for UAE.

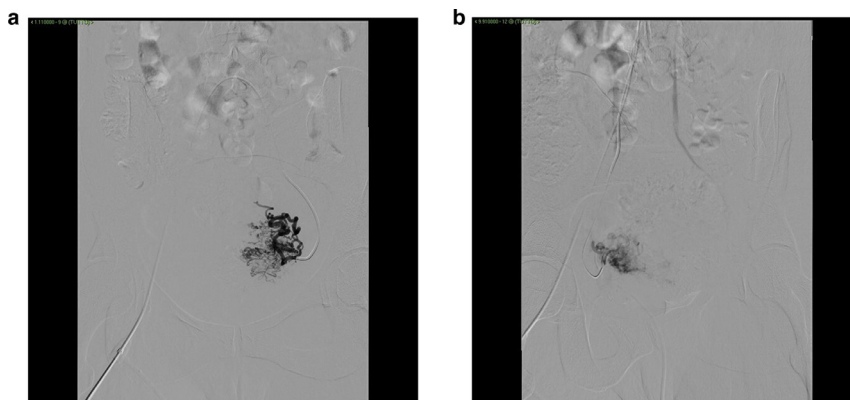
### Efficacy and complications

Emergency UAE should be recommended as the first choice to treat uncontrollable massive hemorrhage of CSP and



**Figure 1** A 41-year-old woman, at the fifth pregnancy, with 2 previous caesarean sections. Results of the ultrasound were compatible with a CSP.

preserve the uterus.<sup>27</sup> UAE is, however, an adjuvant treatment of CSP, therefore is often associated with local injection of MTX, with manual vacuum aspiration (D&S) under ultrasound guidance (UAE + D&S), with surgical laparotomic resection (UAE + Surg) or followed by uterine curettage within 24-72 hours after UAE (UAE + D&C). In the case of using UAE as first-line treatment, further intervention is needed in over 80% of cases.<sup>28</sup> However, there are a lot of studies about the efficacy of UAE to stop the bleeding and preserve the uterus. Lian et al<sup>7</sup> reported a successful treatment of 12 cases of CSP with local MTX combined with UAE. Zhang et al<sup>27</sup> performed UAE in 11 cases before curettage and in 4 cases as an emergency procedure for uncontrollable bleeding. The uterus was preserved in 14 women. In a review of 239 cases treated with the same regimen, the success rate was 99.16% even if UAE followed by curettage is associated with an overall complication rate of 10.4%.<sup>29</sup> Because UAE is an efficient treatment for bleeding prevention before curettage, Li et al<sup>17</sup> performed a randomized study where all patients, underwent suction curettage, received systemic MTX alone or UAE and MTX. The embolization particles were a gelatin sponge or polyvinyl alcohol. They found



**Figure 2** Right femoral access with 5Fr sheath. Introduction of 2.7Fr microcatheter and embolization with 500-700 micron particles of left uterine artery (A) and right uterine artery (B).



**Figure 3** Treatment of a SP. A 32-year-old woman, at the second pregnancy, with previous Cesarean sections; the diagnosis of CSP has been confirmed at CT examination.

that compared with those who received systemic MTX alone, women treated with UAE had much less bleeding during curettage, a shorter hospital stay, and remission of chorionic gonadotrophin. Concomitant use of UAE increases the success rate of the primary treatment of CSP. However, similar for uterine myoma, UAE might be associated with decreased ovarian reserve, intrauterine growth restriction, premature delivery, placental abruption, or placenta accrete. Local intra-uterine MTX infusion prior to UAE is also often performed: the main target of this combined procedure is to prolong the MTX direct action on ectopic implantation and to minimize its systemic side effects. In fact, Yang et al<sup>13</sup> stated that all 77 patients with CSP who underwent UAE with intra-arterial MTX achieved a satisfactory therapeutic effect and the  $\beta$ -hCG level decreased significantly. In a recent single institution retrospective study, Giampaolino et al<sup>30</sup> reported their experience about the combined approach UAE + D&S; they demonstrated to have a higher number (90%) of complications (profuse bleeding, hematoma, and myometrial infarction) both in lower than in high gestational age. Therefore, the authors concluded that combination of MTX + D&C appears to be the most effective and safe treatment for women in the early stages of pregnancy, whereas UAE + D&S result in a significant specific risk factor for complication independent of gestational age. UAE is not widely available in primary and secondary care hospitals, and requires the presence of a trained interventional radiologist, which significantly restricts its use in daily practice. An interesting new-generation procedure helpful in CSP management is method that utilizes high-intensity focused ultrasound (HIFU). This procedure can be performed with ablation alone or in combination with hysteroscopic D&C.<sup>31</sup> The initial procedure is performed under conscious sedation. A transducer produces the therapeutic energy required. Real-time ultrasound is used to target the area of the gestational sac and monitor the response. Additional D&C is performed in general anesthesia. During CSP treatment, it is necessary to monitor the level

of  $\beta$ -hCG as it is an indicator of treatment efficacy. This primarily concerns cases in which MTX, UAE or HIFU are applied.

## EXTRAUTERINE IMPLANTS

### Introduction

Extrauterine implants or ectopic pregnancy (EP) consists in the implantation of an embryo in a site other than the endometrium of the uterine cavity. It occurs in 1%-2% of all reported pregnancies.

The most common extrauterine location is the fallopian tube, which represents 96% of cases. Other usual non-tubal locations are cervix, ovary, peritoneal cavity, and cesarean scar.<sup>32</sup>

The pathogenesis of this condition is unknown but probably related to abnormal transportation of fertilized ovum within the fallopian tube.

The recognized risk factors include: a history of pelvic inflammatory disease, presence of intrauterine devices, previous tubal surgery (ipsilateral salpingectomy, cornual reanastomosis), cervical conization, Asherman's syndrome (an acquired condition characterized by the formation of scar tissue in the uterine cavity and/or the cervix), and in vitro fertilization.<sup>33</sup>

Diagnosis is based on a combination of clinical evaluation, transvaginal ultrasonography (findings of an embryo in addition to a gestational sac or sizes of adnexal mass) and measurement of serum  $\beta$ -hCG concentrations (increasing slower than expected)<sup>34</sup>; in some cases MRI or CT can be performed.

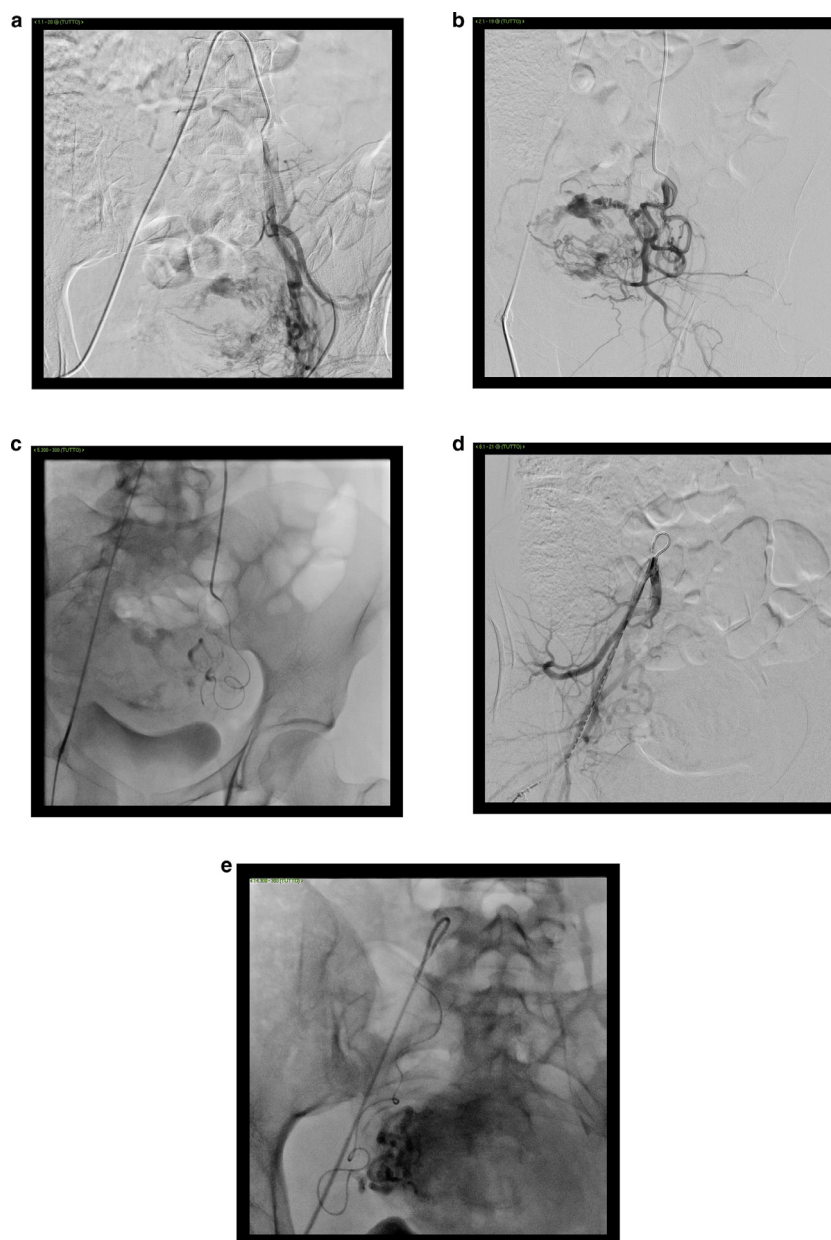
About 15%-20% of EPs are burdened by rupture with internal bleeding, which can lead to severe hemorrhages up to hypovolemic shock and often needs surgical treatment.<sup>35</sup>

### Treatment

The management of EPs has changed over the years and counts different fertility-preserving options.

*Wait-and-see approach* is suitable in asymptomatic patients with low  $\beta$ -hCG values (<1000 IU/l). Since many small and early-diagnosed EPs resolve spontaneously, these patients risk to be overtreated and should be monitored with sequential  $\beta$ -hCG measurements and sonography.<sup>36</sup>

*Medical treatment* for EP is represented by methotrexate, a folic acid antagonist that is toxic to cells undergoing rapid mitotic division. It causes lysis of fetal cells that can lead to intraperitoneal bleeding with abdominal pain in patients.<sup>37</sup> Since its intramuscular administration is associated to different severe side effects (bone marrow suppression, elevated liver enzymes, rash, alopecia areata, stomatitis, nausea, and diarrhea), single-dose regimens with a small loss of effectiveness are preferred. When used, the time to resolution of EP is 3-7 weeks.<sup>38</sup> Methotrexate seems to be effective in treatment of early EPs, occurring in well-vascularized areas, with  $\beta$ -hCG values <10,000 IU/L and a crown-rump length <10 mm.<sup>39</sup>



**Figure 4** Left hypogastric and uterine arteries angiographies (A,B). Selective catheterization of left uterine artery is performed with a 2.7 microcatheter, followed by embolization with 500-700  $\mu\text{m}$  particles (C). Angiography and embolization of right uterine artery are also performed (D,E).

After methotrexate administration, follow-up is necessary. It is based on serial serum  $\beta$ -hCG measurements at day 4, day 7 and then weekly until  $\beta$ -hCG levels decline to zero. Repeating medical treatment may be required if  $\beta$ -hCG levels do not fall.<sup>38</sup>

Among surgical procedures, laparoscopic salpingostomy, with or without fallopian tube removal, is the preferred surgical treatment in tubal EPs. The main purpose is the removal of only the ectopic gestational sac. Surgeons try not to remove all the tube in order to preserve fertility. Surgery is mandatory in case of rupture but it is also performed in some unruptured EPs with  $\beta$ -hCG values  $>2500$  IU/l. Surgical complications (pain, infection, pelvic adhesions) are possible.<sup>40</sup>

Surgery may not be suitable in management of non-tubal EPs. Cornual resection via laparotomy or laparoscopy have

been used to treat cornual EPs, causing problems of fertility or hemorrhages because of the rich vascular supply in the interstitial area.<sup>33</sup> When possible, conservative management is the favored option in women desiring future pregnancies.

*Interventional radiology.* An important role is actually played by minimally invasive interventional procedures in the treatment of EPs. Direct administration of chemicals by ultrasound-guided injection into the ectopic implant or endovascular uterine artery chemoembolization (UAE) can be performed to treat EP.

### Direct chemical injection

In the treatment of tubal EPs, US-guided direct chemical injection of the ectopic gestational sac is an important

alternative to surgery. After antibiotic prophylaxis and cleansing of vaginal vault with preparatory solution, a needle (eg, 20-Gauge Chiba type) is inserted into the amniotic sac with transvaginal US guidance. Color Doppler imaging helps to avoid vessels along the planned route. Once the needle is carried into the sac, the amniotic fluid is usually aspirated before chemical is injected in order to mechanically disrupt the sac and to prevent its overdistension and a possible leakage of the chemical.<sup>41</sup> In presence of leakage, the operator may instill Ringer's Lactate solution to dilute chemotherapeutic agent and minimize any peritoneal effect.<sup>37</sup> The chemical can be injected into the sac or directly into the fetus, depending on their sizes. The most common chemicals used in this technique include methotrexate (1 mg per kilogram of body weight), potassium chloride (1-3 mL in a 2 mEq/mL solution) and hyperosmolar glucose (50% solution).

The direct injection of methotrexate into the amniotic sac presents potential advantages as compared to intramuscular therapies. This way it is possible to reach higher local concentrations of the chemical, reducing systemic toxic effects. Direct chemical injection is also suitable in presence of a synchronous uterine implantation, which represents a contraindication to systemic treatment, if the patient desires to carry on the uterine pregnancy.

If there are any contraindications to methotrexate injection (blood dyscrasia, severe pulmonary disease, coexisting hepatic disease, breast-feeding, and immunocompromised state), other alternative chemicals may be used to treat EPs. Moreover, in presence of residual fetal cardiac activity, potassium chloride may be preferred to increase the probability of its cessation.

The only primary contraindications to direct chemical injection of EPs are hemodynamic instability and hemoperitoneum, which represent an indication to emergency surgery.<sup>41</sup> Extended follow-up after local chemical injection is similar to that after intramuscular injection of methotrexate. For this reason, this procedure is not indicated in those patients who are likely to be lost during the follow-up.<sup>33,41</sup>

The procedure of direct chemical injection is also performed in some non-tubal EPs that occur in cornu, cervix or cesarean section scar. It may be difficult in distal interstitial or isthmic pregnancies. The technique used in these cases is similar to that for injection of a tubal ectopic sac, although interventional radiologists bring adaptations in all the different cases. For example, in the treatment of a cornual pregnancy, some interventional radiologists perform an endovascular UAE immediately before chemical injection, to prevent the comparison of severe post-injection hemorrhages related to the greater vascularization in cornu.<sup>41</sup>

## Endovascular treatment

The UAE is another minimally invasive procedure used in the treatment of either tubal and non-tubal EPs.<sup>42</sup> This technique is also used to treat fibroids, myomas, uterine vascular malformations, gynecologic malignancies or postpartum hemorrhage. It consists in the injection of embolic agents directly in the uterine arteries. The embolization decreases blood

flow to ectopic sac, inducing subsequent trophoblastic degeneration.

The procedure begins with diagnostic aortography to study the ovarian artery origin and the internal iliac artery, from which the uterine artery takes origin. Once the catheter is appropriately positioned for treatment, the embolization phase starts with the injection of embolic agents individually in both the uterine arteries. The choice of the embolic agent depends on different variables and operator expertise. The most common embolic agent used is absorbable gelatin sponge, a water-insoluble gelatin that allows revascularization within 4 or 6 weeks after the procedure. The operators may proceed to the injection of permanent embolic agents, such as polyvinyl alcohol (PVA) particles or beads, for a more durable and compact vascular block (Figs. 5 and 6). It is possible to use both the embolic agents in the same procedure: some authors use PVA particles in the ipsilateral side and gelfoam in the contralateral side.<sup>43</sup> The embolic agents should be always larger than 500  $\mu\text{m}$  to avoid paradoxical embolization of the ovarian artery<sup>44</sup> (Fig. 7).

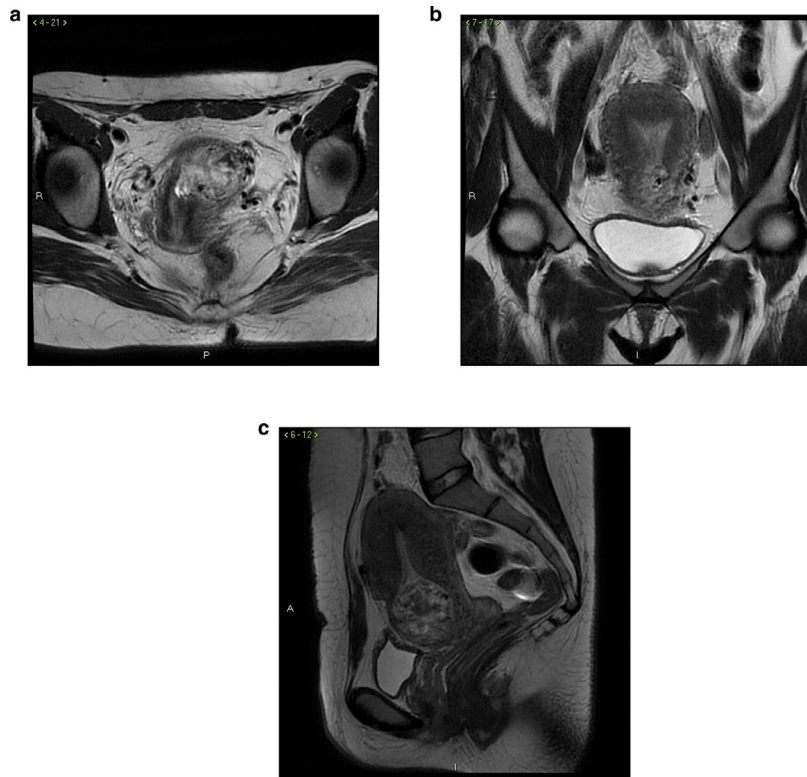
The UAE can be performed alone or in combination with other therapies. Embolization may be used in conjunction with intramuscular methotrexate therapy, or after failed methotrexate therapy, for the successful treatment of cornual and cervical ectopic pregnancies: concurrent systemic methotrexate along with UAE has been proven more effective than UAE alone. Systemic methotrexate should be administered before UAE, since the procedure reduces blood flow to the ectopic sac.<sup>45,46</sup>

It is also possible to combine UAE with transcatheter intra-arterial methotrexate infusion in cervical EPs. Before the embolization, 50 mg of methotrexate are injected in each uterine artery as close as possible to a vessel feeding the lesion. During the embolization, the operator injects the embolic agents with 5 mg of methotrexate in both the uterine arteries. After the embolization, another 5-mg dose of methotrexate is injected in the embolized uterine arteries, in order to ensure a high local concentration of the cytotoxic drug in the implantation area.<sup>15</sup> The dilation and curettage with suction or vacuum aspiration 6-8 hours after intra-arterial chemoembolization reduce the incidence of bleeding.<sup>44</sup>

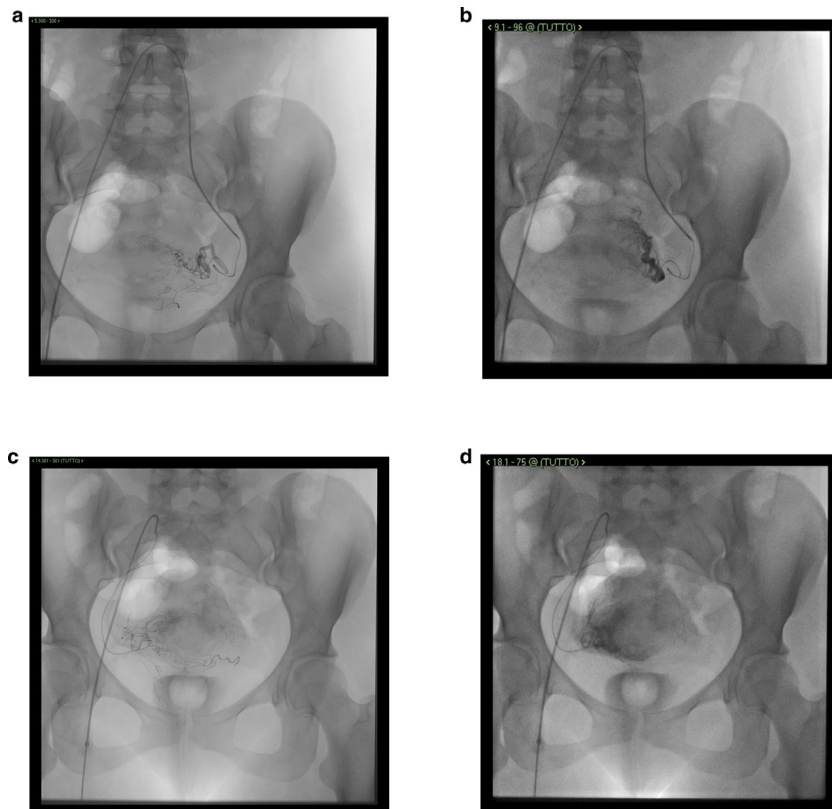
5-Fluorouracil (5-FU) is another cytotoxic drug, which induces blastocyst apoptosis by interfering with nucleotide synthesis. During UAE, 500-mg dose of 5-FU can be intra-arterially administered with methotrexate, in order to increase the rate of successful resolution of EPs.<sup>47</sup>

Emergency UAE may be performed for the treatment of severe bleeding after medical or surgical treatment. EP is burdened by a high risk of internal bleeding due to the growth of the sac in a site other than the uterine cavity. This condition is traditionally treated with surgical bilateral hypogastric or uterine artery ligation, which inevitably leads to infertility. For this reason, it is possible to perform UAE in the management of internal bleeding related to EPs in women who want to preserve fertility.<sup>48</sup>

The most common complication in UAE is the postembolization syndrome. It occurs in 50% of treated patients and is characterized by pain, fever, leukocytosis and nausea,



**Figure 5** Magnetic Resonance. T2 weighted images in axial (A), coronal (B) and sagittal planes (C) show 6 week isthmic pregnancy in a 22-year-old woman. BetaHCG: 8167 mU/mL.



**Figure 6** Right femoral access with 5Fr sheath: introduction of 2.7Fr microcatheter and embolization with 500-700 micron particles of left uterine artery (A and B) and right uterine artery (C and D). Four days after procedure Beta HCG was 22 mU/mL.



**Figure 7** A 31-year-old woman, previously submitted to surgery for a left tubal EP. CT shows a left adnexal implant in the axial arterial (A) and coronal venous (B) phase. After the introduction of a 2.7 microcatheter, 500-700  $\mu\text{m}$  particles were used to embolize the left uterine artery (C-E). Prophylactic embolization of right uterine artery was also performed (F).

starting immediately after the procedure and lasting for several days. It is treated with analgesic and anti-inflammatory medications.<sup>49,50</sup>

Other rare complications in UAE are uterine infarction or ischemia, necrosis, rupture, sepsis, tuboovarian abscess, endometritis, ischemia of adjacent tissues and ovarian failure. Different studies demonstrate that UAE may be performed in women who wish to preserve fertility, but fertility cannot be guaranteed.<sup>33,43</sup>

### Prevention of ectopic pregnancy

Interventional Radiology is required also in infertile patients with unilateral or bilateral hydrosalpinx, undergoing in vitro fertilization, before embryo transfer.

Hydrosalpinx afflicts 10%-30% of infertile patients undergoing in vitro fertilization. It is related to tubal occlusions,

leading to a reduced implantation and pregnancy rates with an increased EP and miscarriage rate.

Laparoscopic salpingectomy is the current gold standard for the treatment of this condition, even if this surgery is associated to ovarian failure due to interferences with ovarian blood flow.

In presence of high surgical risk or history of previous multiple abdominal surgeries, advanced stage endometriosis or major intra-abdominal adhesions, radiologically-guided transcervical tubal occlusion with embolization microcoils is preferred.

After a preliminary hysterosalpingography to study tubal anatomy, the Interventional Radiologist accesses the proximal fallopian tube with a 3-F catheter through a 7-F salpingogram cannula and proceeds to the injection of embolization microcoils, taking about 15-20 minutes to confirm the exact positioning via fluoroscopy. It can be advisable



to use platinum microcoils, an ideal obstruction material, with spaced synthetic fibers. The coils curl within the interstitial portion of the tube to impede migration and prevent a tubal pregnancy, while the synthetic fibers act as a foreign body, leading to adhesion for tubal occlusion.

Recent studies suggest that it is important to avoid the placement of the microcoils in uterus in order to decrease the comparison of fluid overload or reduce endometrial receptivity.<sup>51</sup>

## Summary

- CSP, a rare occurrence consisting in the implantation of the embryo within the myometrium of a prior cesarean delivery scar, could be a dangerous condition for women, so early diagnosis and rapid treatment are crucial.
- Extrauterine implants or ectopic pregnancy (EP) consists in the implantation of an embryo in a site other than the endometrium of the uterine cavity.
- The diagnosis of CSP and EP is based on history, clinical examination, levels of serum  $\beta$ -human chorionic gonadotropin ( $\beta$ -hCG), and ultrasonography findings.
- In last 20 years, new treatments, varying from medical management, minimally invasive surgical approach and local treatment including systemic or local infusion of metotrexate (MTX), and uterine artery embolization (UAE) are developed.
- It has been proven that UAE is effective and widely used to control hemorrhage and preserve the uterus and it is considered an affective adjuvant treatment of CSP and EP, especially associated with other therapies.

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