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**HYSTEOSALPINGOGRAPHY:  
TECHNIQUE AND APPLICATIONS (VIEW)**

Hysterosalpingography (HSG) remains an important radiologic procedure in the investigation of infertility. HSG demonstrates the morphology of the uterine cavity, the lumina, and the patency of the fallopian tubes. In this review article, we present the technical parameters of the examination, indications, contraindications, and possible complications of HSG. We also illustrate a variety of abnormalities of the uterus and fallopian tubes that can be detected accurately with HSG.

**Key words:** hysterosalpingography, fallopian tube, infertility.

Гістеросальпінгографія (ГСГ) є важливою рентгенологічною процедурою в розслідуванні безпліддя. ГСГ демонструє морфологію порожнини матки в просвіті і прохідності маткових труб. У цій статті ми представляємо технічні параметри експертизи, показань, протипоказань і можливих ускладнень ГСГ. Ми також ілюструємо різні аномалії розвитку матки та маткових труб, що може бути точно виявлено за допомогою ГСГ.

**Ключові слова:** гістеросальпінгографія, маткові труби, безпліддя.

Гистеросальпінгография (ГСГ) является важной рентгенологической процедурой в расследовании бесплодия. ГСГ демонстрирует морфологию полости матки в просвете и проходимости маточных труб. В этой статье мы представляем технические параметры экспертизы, показаний, противопоказаний и возможных осложнений ГСГ. Мы также иллюстрируем различные аномалии развития матки и маточных труб, что может быть точно обнаружено с помощью ГСГ.

**Ключевые слова:** гистеросальпінгография, маточные трубы, бесплодие.

Hysterosalpingography (HSG) is the radiographic evaluation of the uterine cavity and fallopian tubes after the administration of a radio-opaque medium through the cervical canal. The first HSG was performed in 1910 and was considered to be the first special radiologic procedure. A properly performed HSG can detect the contour of the uterine cavity and the width of the cervical canal. Further contrast medium injection will outline the cornua isthmic and ampullary portions of the tubes, and will show the degree of spillage. If a properly performed HSG shows no uterine cavity abnormality, it is very unlikely that other modalities would do so. Although this procedure is considered diagnostic, there may also be a possible therapeutic benefit from the flushing effect.

#### **Indications and Contraindications**

HSG is used predominantly in the evaluation of infertility. Despite the arrival of newer imaging modalities, HSG still remains the best procedure to image the fallopian tubes. Although evaluating feminine infertility, with or without the presence of repeated miscarriages, is the main indication for this method, it can also be used in other cases, such as pain in the pelvis tract, congenital or anatomic abnormalities, anomalies of the menstrual cycle, and abnormal menses. Also, it is sometimes used as a preoperative control for women who are about to have uterine or tubal surgery. Soares and coworkers showed that HSG had a sensitivity of 58% and a positive-predictive value of 28.6% for polypoid lesions, and a sensitivity of 0% for endometrial hyperplasia. The same study showed HSG to have a sensitivity of 44.4% for uterine malformations, and a sensitivity of 75% for the detection of intrauterine adhesions. The main contraindication of the examination is possible pregnancy. This contraindication can be avoided by performing the examination before the ovulation phase, between the 7th to 10th day of the menstrual cycle. Because of the scattering risk, the examination should be avoided when there is active intrapelvic inflammation. Another contraindication is vaginal or uterine bleeding because of the risk of unrestrained bleeding, which could lead to transfusion or surgical recovery procedures. Finally, the examination should not be performed in cases of severe cardiac or renal deficiency, or in cases of recent uterine or tubal surgery.

#### **Technique**

##### *Patient Preparation*

The procedure is performed in the first half of the menstrual cycle following cessation of bleeding. The endometrium is thin during this proliferative phase, which facilitates better image interpretation and should also ensure that there is no pregnancy. The patient is asked to refrain from unprotected sexual intercourse from the date of her period until after the investigation to be certain there is no risk of pregnancy. Examination in the second half of the cycle is avoided because the thickened secretory-phase endometrium increases the risk of venous intravasation and may cause a false-positive diagnosis of cornual occlusion.

Antibiotics might be required 1 day before and for a few days after the examination if previous inflammations are present in the patient's clinical history.

Antibiotics are required after the examination when the maneuvers are fairly sanguineous or if the fallopian tubes present a certain degree of dilation. The suggested antibiotic regimen is metronidazole 1 g rectally at

the time of the procedure, plus doxycycline 100 mg twice daily for 7 days. Steroid (prednisolone) premedication is prescribed in asthmatics when intravenous contrast is used; therefore, it is reasonable to do the same for HSG because intravasation is also possible from this procedure.

##### *Catheterization Technique*

For the catheterization technique, the patient is placed on the fluoroscopic machine in a gynecologic examination position. After cleaning the external genital area with antiseptic solution, the vagina is dilated by a gynecologic dilator. The cervix is localized and cleansed with iodine solution. Afterward, the uterine cervix is straightened by one (at the 12 o'clock position) or two (at the 9 and 3 o'clock positions) surgical forceps exercising a degree of pulling. Next, the outside uterine cervix ostium is catheterized. The catheterization can be performed in two ways. In the authors' country, a salpingographer with a bell-shaped end (diameter depends on the case) is pushed through the vagina and fits in the external uterine cervix ostium. In the second technique, the salpingographer has a plastic cup-shaped end that is fitted to the external uterine cervix ostium, creating a void phenomenon. In both techniques, there is a syringe with iodinated hydrosoluble contrast medium at the other end of the salpingographer. The vagina dilator is taken off after catheterization of the external uteri cervix ostium and before administration of the contrast medium.

##### *Contrast Media*

In the past, oil-soluble contrast media were mainly used. Today, we use all available iodinated hydrosoluble contrast media. According to international literature, the use of oil-soluble contrast media increases the pregnancy rate and contributes to a decrease in conception time after the salpingography is performed. However, Spring and coworkers found that there is no evidence that the choice of the contrast material affects the rate of term pregnancy. Moreover, they reported that oil-soluble contrast media may promote granulomatous inflammation in the presence of obstructed or inflamed fallopian tubes.

##### *Radiological Views*

One conventional radiograph of the pelvis (on a 24–30 cm radiologic film) is necessary before the contrast medium is administered into the uterine cavity so that possible intrapelvic masses or calcifications will not complicate interpretation of the images. A metallic marker is placed over one side of the pelvis to indicate the right or left side of the patient. Next, the examination is performed under fluoroscopic control so that radiographs can be taken during the filling of the uterine cavity (usually 2–3 cm of contrast medium is sufficient) and again during the filling of the fallopian tubes. Finally, after the removal of the salpingographer, we radiographically check the presence of contrast medium in the peritoneal cavity. The total amount of injected contrast medium should not exceed 10 mL. Additional spot radiographs are obtained to document any abnormality that is seen. Before the first radiograph, we also fluoroscopically check the reflux of the contrast medium.

##### *Complications*

The two most common complications of HSG are pain and infection. These and other complications and side effects are summarized below.

- Uterine contractions and discomfort due to the introduction of contrast medium into the uterine cavity: The most common type of pain referenced is subabdominal colic caused by dilation of the uterine cavity. A more diffuse pain, caused by irritation of the peritoneum due to the contrast medium, has also been reported. Pain can be minimized by slowly injecting the contrast medium and using isosmolar contrast agents.

- Postprocedural infection: Spreading and generalization of intrapyloric inflammation may happen in cases of chronic inflammation and hydrosalpinges, or after severe uterine injury caused by the examination maneuver.

- Vasovagal reaction: A possible reaction to manipulation of the cervix or inflation of a conclusion balloon in the cervical canal.

- Traumatic elevation of endometrium by the inserted cannula: A complication which does not cause significant consequences.

- Uterine perforation and tubal rupture: These complications are very rare.

- Venous or lymphatic intravasation of contrast media: With a water-based contrast medium there is no adverse effect on the patient, but it can make interpretation of the image difficult. It occurs more commonly in the presence of fibroids or tubal obstruction. Extravasation of the contrast medium could occur if the contrast medium is administered too quickly, if the endometrium is injured during the catheterization, or if the examination is performed during menstruation. Extravasation is also possible when common or special inflammations of the endometrium are present due to the intercourse rate between the uterine vein and the ovarian veins.

- Allergic reaction to contrast media: Such a reaction is very uncommon with the use of the low-osmolar nonionic contrast agents currently available.

- Radiation exposure to the ovaries: Exposure is minimal and can be reduced if the proper technique is utilized.

#### Normal Findings

On face radiographs, the uterine cavity has a normal trigonal shape and the apex of the triangle corresponds to the isthmus, which is nearly 3.7 cm wide. The apex is pointed downwards and connected to the internal ostium of the cervix uteri, which is 2.5 cm in total length. The base of triangular uterine cavity is the fundus, which can be concave, flattened, or slightly convex. On both sides of its base, in the area of the lateral horns, the two fallopian tubes are drowned. The fallopian tubes are separated into three segments: isthmus (attached to the uterus, not imaged in several cases), ampullary (in the middle, the longest and widest segment), and bell-shaped (to the distal end). There are two ostiums: the internal or uterine, and the external or abdominal. From the abdominal ostium, the contrast medium disperses and diffuses into the peritoneal cavity. Remaining contrast medium in the furrows of the peritoneum can be observed up to 3 hours after administration. Very often, the contrast medium in the rectouterine pouch of the peritoneum (Douglas' space) can demonstrate the profile of the coordinate ovary.

#### Congenital Uterus Anomalies

Congenital uterus anomalies are caused by incomplete junction of the paramesonephric ducts (Muller ducts), or Extravasations of the contrast medium.

The true incidence and prevalence of mullerian duct anomalies are difficult to assess. Examination of different patient populations, nonstandardized classification systems, and differences in diagnostic data acquisition has resulted in widely disparate estimates, with a reported prevalence that ranges from 0.16 to 10%. As a result of selection bias, a prevalence of 8 to 10% has been reported in women being evaluated with HSG because of recurrent pregnancy loss. The overall data suggest that the prevalence both in women with normal fertility and in women with infertility is approximately 1%, and the prevalence in women with repeated pregnancy loss is approximately 3%.

While the majority of women with mullerian duct anomalies have little problem conceiving, they have higher associated rates of spontaneous abortion, premature delivery, and abnormal fetal position and dystocia at delivery. Most studies report an approximate frequency of 25% for associated reproductive problems, compared with 10% in the general population. Primary infertility in these women usually has an extra uterine cause and is not generally attributable to mullerian duct anomalies alone. Additionally, cervical incompetence has been reported to be associated with these anomalies.

According to the American Society of Reproductive Medicine, there are seven different classes of mullerian duct anomalies:

Class I: Segmental agenesis or variable degrees of uterovaginal hypoplasia. The anomaly can be detected, because of the amenorrhea, before HSG is performed.

Class II: Unicornuate uteri that represent partial or complete unilateral hypoplasia. In rare cases of degeneration of the mesonephric duct, the uterine cavity appears monococular when imaged, placed right or left of the middle line. The unicornuate uterus contacts only the coordinate fallopian tube.

Class III: Didelphys uterus. This is a rare abnormality that results from complete nonfusion of the mullerian ducts, and includes the duplication of the uterine cavity, cervix neck, and vagina. Rarely, this uterus has a single vagina.

Class IV: Bicornuate uterus that demonstrates incomplete fusion of the superior segments of the uterovaginal canal. The uterine cavity is divided in two; each half has a narrow-length shape and stands apart from the other.

Class V: Septate uteri that represent partial or complete nonresorption of the uterovaginal septum.

Class VI: Arcuate uterus resulting from nearly complete resorption of the septum. Along with the previous anomaly, these are the most common congenital anomalies (50%) in cases detecting female infertility.

Class VII: Anomalies that comprise sequelae of in utero diethylloestradiol exposure.

Another congenital anomaly, caused by inadequate hormonal stimulation as a fetus, is small uterine cavity size with normal vaginal length. This is a common finding in cases of female infertility.

#### Abnormal Findings

##### *Fibromyomas*

While fibromas are diagnosed by suprapubic ultrasound, submucosa fibromyomas are imaged as smooth filling defects in the uterine cavity. Differential diagnosis must be made from endometrial polyps or possible

pregnancy. Small intramural fibromyomas do not distort the endometrial cavity and are not visualized on HSG. Subserous fibromyomas can provoke smooth filling defects or smooth repression of the fallopian tubes only if they are located in the lateral walls of the uterus.

#### *Endometrial Polyps*

Endometrial polyps are focal overgrowths of the endometrium. They usually manifest as well-defined filling defects and are best seen during the early filling stage. Small polyps may be obscured when contrast material completely fills the uterine cavity and may be indistinguishable from a small submucosal myoma. Sonohysterography has become the preferred method of imaging endometrial polyps.

#### *Internal Endometriosis (Adenomyosis)*

Adenomyosis is caused by the presence of ectopic islets of active endometrium in the muscularis wall of the uterus. It is usually imaged as a pointed projection of 2 to 3 mm length, perpendicular to the uterine wall after contrast medium administration. Rarely, this is imaged as a sack-shaped projection filled by contrast medium, 4 mm to 1 cm in length. Differential diagnosis should include the hyperplasia of the endometrium and the entrance of the contrast medium in the myometrium or in the nutrient arteriole of submucosa fibromyomas.

#### *Uterine Cancer*

Uterine cancer manifests as an irregular filling defect, but is rarely diagnosed by the HSG method.

#### *Intrauterine Adhesions*

Intrauterine adhesions are most commonly caused by endometrial trauma of curettage. They are also seen in patients with chronic endometriosis due to tuberculosis. Genital tuberculosis primary affects the fallopian tubes, and 50% of patients with tubal disease also have a uterine abnormality. Intrauterine adhesions manifest as irregular filling defects, most commonly as linear filling defects arising from one of the uterine walls.

#### *Hydrosalpinx*

HSG is the best method for visualizing and evaluating the fallopian tubes. Hydrosalpinx is a common finding that results from a previous inflammation of the fallopian tubes (salpingitis). This is usually the sequelae of distal tubal occlusion, leading to dilation of the proximal segment. The radiologic image shows a dilated lumen in one or more spots, and the contrast medium will not make its way to the peritoneal cavity

#### *Tuberculated Salpingitis*

This entity usually causes distant fallopian tube end obliteration. In extensive infections, multiple constrictions along the course of fallopian tube can form, resulting in areas of dilation and stenosis. Abnormal uterine and vaginal profiles are observed in cases of widespread infection.

#### *Salpingitis Isthmica Nodosa*

Salpingitis isthmica nodosa is a disease of unknown etiology, characterized by multiple small outpouchings or diverticula affecting one or both fallopian tubes. It is presumably caused by pelvic inflammatory disease or endometriosis and is associated with ectopic pregnancy and infertility.

#### *Nondrawing of the Fallopian Tubes*

This is the most common finding during the examination and is usually caused by poor technique, spasm, or obliteration of the fallopian tube. Poor technique includes imperfect straightening of the external cervical ostium or an inadequate amount of contrast medium in the uterine cavity. The cornual portion of the fallopian tube is encased by the smooth muscle of the uterus and, if there is a spasm of the muscle during HSG, one or both tubes may not fill. Using radiography, tubal spasm cannot be distinguished from tubal occlusion. This could be avoided by progressive administration of the contrast medium or, when the spasm occurs, administration of a spasmolytic agent to relieve spasm, helping differentiate cornual spasm from true occlusion. Obliteration is usually caused by previous inflammation or uterine surgery and manifests as nonopacification or abrupt cutoff of the fallopian tube with no free intraperitoneal spillage.

#### *External Adhesions*

External adhesions occur secondary to previous inflammation or surgery, similar to the causes of tubal occlusion. Peritubal adhesions prevent contrast material from flowing freely around the bowel loops as seen in normal cases, and most commonly manifest as loculation of the contrast material around the ampullary portion of the tube.

**Conclusion.** HSG remains the front-line imaging modality in the investigation of infertility. It is an accurate means of accessing the uterine cavity and tubal patency, but has a

low sensitivity for the diagnosis of pelvic adhesions, which is why it cannot replace laparoscopy. It requires knowledge of the female anatomy as well as skillful technique in order to avoid pitfalls and misinterpretations.

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## **АДГЕЗИВНА АКТИВНІСТЬ ШТАМІВ МІКРООРГАНІЗМІВ, ІЗОЛЬОВАНИХ ВІД ХВОРИХ З СЕЧОКАМ'ЯНОЮ ХВОРОБОЮ**

Вивчено особливості прояву адгезивних властивостей (АВ) штамів Enterobacteriaceae, ізольованих від хворих з сечокам'яною хворобою для розуміння механізму відбору епідемічно значущих патогенів з подальшою розробкою нових терапевтичних підходів до прогнозування та лікування хворих. Найбільші показники адгезії визначені для *Escherichia coli*, *Klebsiella pneumonia*, *Enterobacter cloacae*.

**Ключові слова:** сечокам'яна хвороба, адгезивна активність, мікроорганізми.

Изучены особенности проявления адгезивных способностей (АС) штаммов Enterobacteriaceae, изолированных от больных мочекаменной болезнью для понимания механизма отбора эпидемично значимых патогенов с дальнейшей разработкой новых терапевтических подходов к прогнозированию и лечению больных. Самые большие показатели адгезии были получены для *Escherichia coli*, *Klebsiella pneumonia*, *Enterobacter cloacae*.

**Ключевые слова:** мочекаменная болезнь, адгезивная активность, микроорганизмы.

The features of display adhesive properties (AV) strains of Enterobacteriaceae, isolated from patients with urolithiasis for understanding the mechanism of selection of relevant epidemiological pathogens, followed by the development of new therapeutic approaches to predicting and treating patients. The highest rates of adhesion determined for *Escherichia coli*, *Klebsiella pneumonia*, *Enterobacter cloacae*.

**Key words:** urolithiasis, adhesive activity.

Етіопатогенез розвитку сечокам'яної хвороби (СКХ) до цього часу остаточно не встановлений. Механізм утворення каменів пов'язаний з порушенням процесів обміну на рівні клубочково-канальцевої системи, з утворенням білково-полісахаридної «матриці». Подальше зростання сформованого мі-

кроліту залежить від порушення пасажу сечі, запального процесу в нирках, в умовах посиленої седиментації солей, ступеня іонно-електролітного дисбалансу [1, 2].

В розвинених країнах світу із 10 млн. населення 400 тис. страждають на СКХ. В деяких районах хво-