

Hysterosalpingography Overview and its Role in the diagnosis of tubal patency

Abdul Magid Mahmoud Sarhan¹, Youssef Aboelwan Elsayed¹, Ghada Abdel-moaty Abdel-salam Elsamanoudy², Mohamed Ramadan Ali¹

¹ Department of Obstetrics and Gynecology, Faculty of Medicine, Zagazig University, Egypt

² Resident of Obstetrics & Gynecology, Almahalla General Hospital

Corresponding Author: Ghada Abdel-moaty Abdel-salam

Email: Ghadaelsamanoudy10@gmail.com

Abstract

Background: Primary infertility is defined as the inability to conceive within one year of exposure to unprotected intercourse among women in the child bearing period. Secondary infertility refers to the inability to conceive following a previous pregnancy. Tube blockage is one of the most frequent causes of infertility in women. One third of infertility cases are due to anatomical abnormalities of the female reproductive tract such as tubal blockage. The degree of tubal pathology determines the possibility for fertility. The evaluation of the fallopian tube is necessary to determine the management plan of infertility. A number of diagnostic tests are being used in clinical practice to assess tubal patency as part of the work-up for subfertility. The most commonly used tests are hystero salpingo-graphy (HSG) and laparoscopy. The HSG is a contrast enhanced fluoroscopic and flat plate study used to evaluate the uterine cavity and fallopian tubes. It has been a test in the workup of infertile couples as a minimally invasive method of evaluating tubal patency and is performed as the first line approach for assessing tubal pathology. Whereas laparoscopy is considered the clinical reference test for diagnosing tubal pathology.

Keywords: Hysterosalpingography, tubal patency

Background

Infertility is a medical issue that can affect a patient's mental, physical, mental, spiritual, and medical well-being. This medical ailment is unique in that it affects both the patient and the patient's partner as a couple. One must understand normal fecundability, the probability of achieving pregnancy in one menstrual cycle, to understand infertility. This basic understanding will help the healthcare team properly counsel the patient on referrals and provide basic education and understanding of this medical condition. (1)

Multiple times, the scientific community has produced a fecundability rate, which has aided in the diagnosis of infertility by establishing typical pregnancy rates. According to the largest study, 85 percent of women will conceive within a year. According to the findings of this study, fecundity is 25% for the first three months of unprotected intercourse and then drops to 15% for the next nine months. The American Society of Reproductive Medicine (ASRM) used this data to determine when a couple should receive an infertility examination. In women younger than 35 years, the ASRM recommends starting an infertility evaluation after failing to conceive after 12 months of unprotected intercourse or therapeutic donor insemination, or after 6 months in women older than 35 years. (2)

Hysterosalpingography

The radiographic examination of the uterine cavity and fallopian tubes after the introduction of a radio-opaque material through the cervical canal is known as hysterosalpingography (HSG). In 1910, the first HSG was done, and it was regarded as the first unique radiologic procedure. A well done HSG can reveal the uterine cavity's contour as well as the diameter of the cervical canal. Further injections of contrast material will highlight the cornua isthmic and ampullary parts of the tubes, as well as the extent of spillage. If a correctly done HSG reveals no uterine cavity abnormality, other modalities are unlikely to reveal one. The flushing effect may have a therapeutic advantage, despite the fact that this technique is deemed diagnostic. (3)

Indications and Contraindications:

HSG is mostly utilised in the diagnosis of infertility. Despite the introduction of newer imaging technologies, HSG is still the best way to scan the fallopian tubes. Although the major reason for this approach is to evaluate feminine infertility, with or without the existence of repeated miscarriages, it can also be utilised in other circumstances, such as pelvic pain, congenital or anatomic abnormalities, menstrual cycle irregularities, and abnormal menses. It's also sometimes used as a preoperative control for women undergoing uterine or tubal surgery. (4)

HSG had a sensitivity of 58 percent and a positive-predictive value of 28.6 percent for polypoid lesions, and a sensitivity of 0 percent for endometrial hyperplasia, according to Soares and coworkers. HSG had a sensitivity of 44.4 percent for uterine abnormalities and

a sensitivity of 75 percent for intrauterine adhesions, according to the same study. The examination's main contraindication is the possibility of pregnancy. The inspection can be performed before the ovulation period, between the 7th and 10th day of the menstrual cycle, to prevent this contraindication. When there is active intrapelvic inflammation, the examination should be avoided due to the danger of scattering. Vaginal or uterine haemorrhage is also a contraindication due to the possibility of uncontrolled bleeding, which could necessitate a transfusion or surgical recovery operations. Finally, the examination should not be performed in cases of severe cardiac or renal deficiency, or in cases of recent uterine or tubal surgery. (5)

Technique

- Patient Preparation

Following the cessation of bleeding, the operation is conducted in the first part of the menstrual cycle. During this proliferative period, the endometrium is thin, making picture interpretation easier and ensuring that there is no pregnancy. To ensure that there is no chance of pregnancy, the patient is asked to refrain from unprotected sexual intercourse from the start of her period until the conclusion of the study. Because the thickened secretory-phase endometrium increases the probability of venous intravasation and can lead to a false-positive diagnosis of cornual occlusion, examination in the second half of the cycle is avoided. (6)

If the patient has a history of past inflammations, antibiotics may be required one day before and for a few days following the examination. When the manoeuvres are fairly sanguineous or if the fallopian tubes have a degree of dilatation, antibiotics are indicated after the examination. Metronidazole 1 g rectally at the time of the surgery, plus doxycycline 100 mg twice daily for 7 days is the recommended antibiotic regimen. When intravenous contrast is utilised, asthmatics are given steroid (prednisolone) premedication; it is fair to do the same for HSG because intravasation is a possibility with this treatment. (7)

- Catheterization Technique :

The patient is positioned in a gynecologic examination posture on the fluoroscopic machine for the catheterization method. A gynecologic dilator is used to dilate the vagina after washing the external genital area with antiseptic fluid. Iodine solution is used to cleanse and localise the cervix. After that, one (at the 12 o'clock position) or two (at the 9 and 3 o'clock

locations) surgical forceps are used to draw the uterine cervix straight. The ostium of the outer uterine cervix is then catheterized. There are two methods for catheterization. A salpingographer with a bell-shaped end (diameter varies depending on the case) is put into the vagina and into the external uterine cervix ostium in the authors' country. The salpingographer uses a plastic cup-shaped end that is connected to the external uterine cervix ostium in the second procedure, causing a void. At the opposite end of the salpingographer is a syringe filled with iodinated hydrosoluble contrast material in both procedures. After catheterization of the external uterine cervix ostium and before injection of the contrast media, the vagina dilator is removed. **(8)**

- Contrast Media:

Oil-soluble contrast media were commonly utilised in the past. We now employ all iodinated hydrosoluble contrast media that are available. The use of oil-soluble contrast media following salpingography boosts the pregnancy rate and adds to a reduction in conception time, according to worldwide research. Spring and colleagues, on the other hand, discovered that the contrast material used has no effect on the rate of term pregnancy. Furthermore, they discovered that in the presence of obstructed or inflamed fallopian tubes, oil-soluble contrast medium may increase granulomatous inflammation. **(9)**

- Radiological Views:

Before the contrast medium is administered into the uterine cavity, a conventional radiograph of the pelvis (on a 24 30 cm radiologic film) is required to ensure that any intrapyloric masses or calcifications do not confuse picture interpretation. To designate the patient's right or left side, a metallic marker is placed over one side of the pelvis. The exam is then done under fluoroscopic control so that radiographs can be taken during the filling of the uterine cavity (typically 2-3 cm³ of contrast medium suffices) and the filling of the fallopian tubes. Finally, after removing the salpingographer, we radiographically inspect the peritoneal cavity for the presence of contrast material. The total volume of contrast medium injected should not exceed 10 mL. Extra spot radiographs are taken to document any abnormalities that are discovered. We also fluoroscopically examine the contrast medium reflux before the first radiograph. **(10)**

Complications:

Pain and infection are the two most common HSG consequences. The following is a list of these and additional problems and side effects.

- Uterine contractions and discomfort as a result of the contrast medium being injected into the uterine cavity: The most prevalent type of discomfort mentioned is subabdominal colic, which is caused by uterine cavity dilation. A more generalised discomfort has also been described, induced by peritoneal irritation produced by the contrastmedium. Slowly injecting the contrast medium and utilising isosmolar contrast agents can help to reduce pain. **(11)**
- Postprocedural infection: In cases of persistent inflammation and hydrosalpinges, or after severe uterine injury produced by the inspection technique, intrapyelic inflammation can spread and generalise.
- Vasovagal reaction: A possible reaction to cervix manipulation or the inflating of a cervical canal conclusion balloon.
- Traumatic elevation of the endometrium caused by the implanted cannula: A minor complication with no long-term implications.
- Uterine perforation and tubal rupture: These are extremely unusual consequences.
- Intravasation of contrast media through the venous or lymphatic system: A water-based contrast medium has no harmful effects on the patient, but it can make picture interpretation challenging. It is more common when fibroids or tubal blockage are present. Extravasation of the contrast medium (Fig 1) can happen if the contrast medium is given too quickly, if the endometrium is damaged during the catheterization, or if the exam is done during menstruation. Because of the intercourse rate between the uterine and ovarian veins, extravasation is also conceivable when common or specific endometrial inflammations are present. **(12)**
- 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.

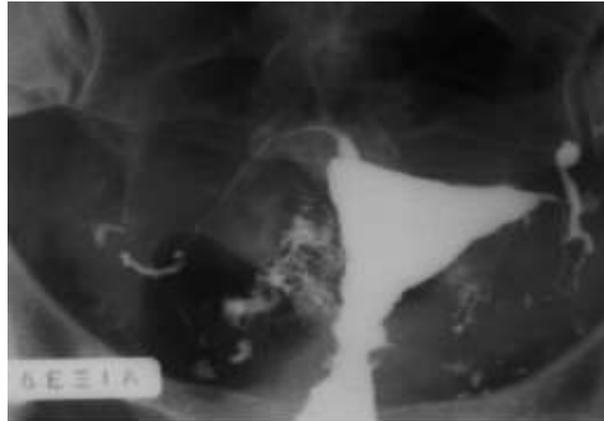


FIG 1. Extravasations of the contrast medium. Presence of contrast medium in the peritoneum.

Normal Findings:

The uterine cavity seems to be a regular trigonal shape on face radiographs, with the apex of the triangle corresponding to the isthmus, which is about 3.7 cm broad. The apex is directed downwards and attached to the 2.5-cm-long internal ostium of the cervix uteri. The fundus, which can be concave, flattened, or slightly convex, is the base of the triangular uterine cavity. The two fallopian tubes are flooded on both sides of its base, in the location of the lateral horns. The fallopian tubes are divided into three segments: isthmus (connected to the uterus and not imaged in certain circumstances), ampullary (the longest and widest segment in the middle), and bell-shaped (in the middle) (to the distal end). The uterine cavity seems to be a regular trigonal shape on face radiographs, with the apex of the triangle corresponding to the isthmus, which is about 3.7 cm broad. The apex is directed downwards and attached to the 2.5-cm-long internal ostium of the cervix uteri. The fundus, which can be concave, flattened, or slightly convex, is the base of the triangular uterine cavity. The two fallopian tubes are flooded on both sides of its base, in the location of the lateral horns. The fallopian tubes are divided into three segments: isthmus (connected to the uterus and not imaged in certain circumstances), ampullary (the longest and widest segment in the middle), and bell-shaped (in the middle) (to the distal end). **(13)**



FIG 2. Normal hysterosalpingography. Uterus in right inclination. Full-length drawing of the vagina, the uterus cavity, and the fallopian tubes.

Abnormal Findings :

- Fibromyomas

Suprapubic ultrasound is used to identify fibromas, however submucosa fibromyomas are seen as smooth filling defects in the uterine cavity. Endometrial polyps or probable pregnancy must be distinguished from the diagnosis. Small intramural fibromyomas are not seen on HSG because they do not deform the uterine cavity. Only if the fibromyomas are positioned in the uterus's lateral borders can they cause smooth filling deficiencies or smooth repression of the fallopian tubes. **(14)**

- Endometrial Polyps:

Endometrial polyps are endometrial overgrowths that occur in clusters. They usually appear as well-defined filling flaws and are most visible in the early stages of filling. When contrast material entirely fills the uterine cavity, tiny polyps can become indistinguishable from a small submucosal myoma. The primary approach of visualising endometrial polyps is sonohysterography. **(15)**

- Internal Endometriosis (Adenomyosis) :

The presence of ectopic islets of active endometrium in the muscularis wall of the uterus causes adenomyosis. After contrast medium administration, it is frequently seen as a 2 to 3 mm long pointed projection perpendicular to the uterine wall. Rarely, a sack-shaped protrusion filled with contrast media, measuring 4 mm to 1 cm in length, is photographed.

Hyperplasia of the endometrium and contrast medium entry in the myometrium or nutritive arteriole of submucosa fibromyomas should be included in the differential diagnosis. **(16)**

- Uterine Cancer:

The HSG procedure is infrequently used to diagnose uterine cancer, which presents as an irregular filling defect. **(17)**

- Intrauterine Adhesions:

Endometrial damage from curettage is the most common cause of intrauterine adhesions. They're also noticed in patients with tuberculosis-related chronic endometriosis. The fallopian tubes are the predominant site of genital TB, and 50 percent of tubal disease patients also have uterine abnormalities. Intrauterine adhesions cause irregular filling defects, the most common of which are linear filling defects emerging from one of the uterine walls. **(18)**

- Hydrosalpinx :

For seeing and analysing the fallopian tubes, HSG is the best approach. A typical finding is hydrosalpinx, which is caused by a previous fallopian tube irritation (salpingitis). This is frequently the result of distal tubal blockage, which causes proximal segment dilatation. The contrast medium will not reach the peritoneal cavity because the radiologic picture shows a dilated lumen in one or more places. **(19)**

- Tuberculated Salpingitis:

Distant fallopian tube end obliteration is the most common symptom of this condition. Multiple constrictions along the course of the fallopian tube can arise in the event of a severe infection, resulting in areas of dilatation and stenosis. In cases of extensive infection, abnormal uterine and vaginal profiles are detected. **(11)**

- Salpingitis Isthmica Nodosa:

Salpingitis isthmica nodosa is a condition that affects one or both fallopian tubes and is characterised by many tiny outpouchings or diverticula. It's thought to be caused by pelvic inflammatory disease or endometriosis, and it's linked to infertility and ectopic pregnancy. (20)

- Nondrawing of the Fallopian Tubes:

The most common finding during the examination is obliteration of the fallopian tube, which is usually caused by inadequate technique, spasm, or obliteration. Improper straightening of the external cervical ostium or an insufficient amount of contrast media in the uterine cavity are examples of poor technique. The smooth muscle of the uterus encases the cornual section of the fallopian tube, and if the muscle spasms during HSG, one or both tubes may not fill. Tubal spasm and tubal occlusion cannot be separated by radiography. This might be prevented by gradually introducing the contrast medium or, if a spasm arises, using a spasmolytic drug to ease the spasm, which would help distinguish cornual spasm from real occlusion. Obliteration is characterized by nonopacification or abrupt cutoff of the fallopian tube with no free intraperitoneal leaking, and is frequently induced by past inflammation or uterine surgery. (10)

- External Adhesions:

Similar to the causes of tubal blockage, external adhesions develop as a result of past inflammation or surgery. Peritubal adhesions restrict contrast material from freely moving through the bowel loops as observed in normal cases, and most typically manifest as contrast material loculation around the ampullary part of the tube. (21)

Hystero salpingo-graphy in the diagnosis of tubal patency:

Hysterosalpingography (HSG) and laparoscopy are the most usual tests. The HSG is a fluoroscopic and flat plate technique that uses contrast to examine the endometrial cavity and fallopian tubes. It has been used as a first-line strategy for diagnosing tubal disease in the workup of infertile couples as a minimally invasive method of testing tubal patency.

Laparoscopy, on the other hand, is the clinical reference test for tubal pathology diagnosis. The existence of endometriosis and peri-adnexal adhesions can be seen with laparoscopy, which cannot be done with HSG. (22)

In a 2013 study, **Foroozanfard et al. (23)** compared the tubal patency findings of HSG and laparoscopy in infertile women. When the criterion of tubal occlusion was reduced to bilateral no patency, the estimated sensitivity and specificity for HSG were 92.1 percent and 86.7 percent, respectively. The results showed that HSG is more accurate in the diagnosis of tubal bilateral no patency when no tubal patency was defined as any anomaly of tubal patency (unilateral or bilateral no patency), with sensitivity and specificity of 77.8% and 52.9 percent, respectively. These findings are similar to those of a number of other studies. (23) When tubal occlusion was defined as any anomaly of tubal patency, sensitivity of 84.1 percent and specificity of 59.1 percent were calculated in a study. The sensitivity and specificity of tubal occlusion were 89.5 percent and 90 percent, respectively, when the criteria was confined to two-sided occlusion. (7)

In a study of 102 infertile women, the diagnostic usefulness of HSG and laparoscopy was assessed, and concordant findings by HSG and laparoscopy were identified in 61.5 percent of unilateral tubal blockage cases and 70.4 percent of bilateral tubal blockage cases. In tubal obstruction, 100% concordant findings by HSG and laparoscopy were identified in 65.7 of cases ; the findings of the two studies above are congruent with our findings. In a meta-analysis, the accuracy of HSG was assessed using laparoscopic data as a reference. HSG had a sensitivity and specificity of 53% and 87 percent for any tubal pathology, and 46% and 95% for bilateral tubal pathology, respectively. Medical records of women admitted to a local Iranian hospital were also examined in another retrospective investigation. In terms of tubal blockage, the results were compared. The accuracy of HSG reports in relation to laparoscopy was found to be 75%, with HSG specificity and sensitivity of 0.92 and 0.70, respectively . Results reported as normal or abnormal findings, as well as bilateral or unilateral no patency, were not examined in this investigation. (24)

Eighty-two infertile patients were studied in a cohort study to examine tuboperitoneal variables using HSG and laparoscopy. Pathological results were found in 45.1% of HSG cases and 65.85% of laparoscopy cases. The sensitivity and specificity of HSG were 63 percent and 89.3%, respectively, with a 92% positive predictive value, a 55% negative predictive value, and a 72% accuracy ratio . In another study, sixty-eight individuals in the early stages of infertility treatment had their tubes evaluated with Hysterosonosalpingography and gold-standard laparoscopy. For the assessment of tubal

patency using positive contrast, the method has shown 100% sensitivity and 77% specificity, the negative predictive value and positive predictive value were 100% and 70% . (25) Hysterosonosalpingography was used as a contrast ultrasound method in this study, which may produce different outcomes than HSG. Fifty patients were first diagnosed with either unilateral or bilateral tubal obstruction using HSG, which was used to evaluate and compare the diagnostic value of HSG and laparoscopy. Laparoscopy was used to check tubal patency six to eight weeks later. In 40.5%, 35.1%, and 13.5% of patients, HSG found bilateral proximal, bilateral distal, and mixed tubal blockage. HSG had a lower positive predictive value in this study, notably for bilateral proximal tubal blockage. In this study, patients were initially diagnosed with either unilateral or bilateral no tubal patency using HSG later evaluated by laparoscopy. (26)

Another study found that HSG and laparoscopic findings on normal tubes were in agreement in 22.9% of the time. The sensitivity of HSG in detecting proximal tubal blockage was reported (78%). HSG was found to have high specificity in the identification of mixed occlusions (96 %). (10)

. Tubal spasm and endometrial polyp in the area of the uterine opening of the tubes, as well as anatomic changes in the tubes, could be the cause of the discrepancy in results.

HSG is a simple approach for examining female sterility, a more cost-effective and basic method for evaluating tubal diseases, and it appears to be effective in detecting some congenital uterine defects. The benefit of laparoscopy is the ability to see various pelvic abnormalities that may be the cause of infertility but are not visible with HSG, such as endometriosis, adhesions, and TB. . However, one weakness of this study was that the interpretation of HSG pictures is dependent on the radiologists' expertise and ability.

In conclusion, these two approaches are complementary rather than alternative in the diagnosis of tubal patency. (23)

Evaluation of Diagnostic Hysteroscopy as a Tool for Diagnosis of Tubal Factor of Infertility in Comparison to Diagnostic hystero salpingo-graphy and Laparoscopy

In a study of **Hefny et al.**, (27) about Evaluation of Diagnostic Hysteroscopy as a Tool for Diagnosis of Tubal Factor of Infertility in Comparison to Diagnostic Laparoscopy showed that Fallopian tube obstruction plays a role in 12-33 % of subfertile couples. Therefore, the assessment of the patency of fallopian tubes is a significant part of subfertile couple's work . For this purpose, several tests are available including hysterosalpingography (HSG), laparoscopy and dye test, selective salpingography and hysterosalpingo-contrast

sonography (HyCoSy). Each of these tests varies in inter and intra-observer reliability, diagnostic accuracy for predicting blockage or other tubal disease, prognostic information for independent pregnancy treatment, possible complications and costs . **(27)**

The dye hydrotubation, dye insufflation, dye pertubation, chromopertubation, or chromolaparoscopy test (also known as dye hydrotubation, dye insufflation, dye pertubation, chromopertubation, or chromolaparoscopy) is commonly considered the gold standard test for tubal patency study. It can also detect peritubal illness, adhesions, and endometriosis. As a result, the National Institute for Health and Clinical Excellence (NICE) in the United Kingdom has recommended that women with comorbidities (such as endometriosis and pelvic inflammatory disease) undergo laparoscopy to examine pelvic and tubal pathology. The disadvantage of laparoscopy is that it is an invasive procedure. An operating room, anaesthetic, and laboratory testing are all required for this procedure. The cost of using the operating room, staff salaries, test costs and anaesthesiology consultation fees increase the total cost of the procedure . **(28)**

Hysterosalpingography is a traditional minimally invasive procedure for evaluating tubal patency; nevertheless, when compared to laparoscopy, hysterosalpingography has 72 percent to 85 percent sensitivity and 68 percent to 89 percent specificity in tubal patency diagnosis. Furthermore, HSG has disadvantages such as X-ray exposure, radio-contrast material, and infection risk. It's also an intrusive operation that necessitates the assistance of a radiologist. **(29)**

In hysteroscopy, new procedures for measuring tubal patency have recently been developed. The goal was to develop a method for checking tubes with the same level of precision as laparoscopy, but with less intrusion, expense, and physical stress for the patient. Diagnostic hysteroscopy is a good diagnostic test since it is simple, straightforward, minimally invasive, convenient, inexpensive, rapid, safe, and accurate, and it is extensively utilised by infertility-interested gynaecologists in everyday practice. **(30)**

Saline directly going through the ostia during diagnostic hysteroscopy might be difficult to see unless there is a non-translucent substance, such as mucus or blood, that contrasts with saline. Many gynaecologists have seen air mix inadvertently with their media of distention and spread through the ostia, and they wonder if this is truly tubal patency. For tubal patency testing, air and saline are purposefully combined with sonosalpingography. If one imagined a sonosalpingography while executing a hysteroscope (as if there was a camera at the tip of the sonosalpingography catheter), air bubbles would disperse in the patency setting through the ostia while remaining in the occlusion cavity. **(31)**

The goal of this study was to see if diagnostic hysteroscopy can predict tubal patency properly. The diagnostic hysteroscopic bubble test has 91.9% sensitivity and 90.9% specificity in detecting tubal patency in the current investigation. Our findings are consistent with those of two earlier studies that looked at the accuracy of the diagnostic hysteroscopic bubble test in detecting tubal patency. Parry performed a prospective study to see if saline-filled air bubbles used during flexible diagnostic hysteroscopy may accurately predict tubal patency. The hysteroscopic technique offers 98.3% sensitivity and 83.7% specificity in detecting tubal patency, according to the authors. The diagnostic accuracy of the diagnostic hysteroscopy bubble test, HSG, and laparoscopy were evaluated in a prospective trial of 85 infertile patients. The diagnostic hysteroscopic bubble test was successful in 78 patients (91.7%). On the right and left sides, patent tubes were diagnosed by diagnostic hysteroscopy, HSG, and laparoscopy in 91% and 88.5%, 92.3% and 91%, and 93.6% and 93.6 %, respectively. Diagnostic hysteroscopy and Gynecology laparoscopy agreements were 78% , whereas tubal patency testing agreements were 84% between HSG and laparoscopy. The diagnostic indices of diagnostic hysteroscopy and HSG were extremely similar. The addition of diagnostic hysteroscopy to HSG had no effect on diagnosis accuracy. (27)

References.

1. **Vander Borcht, M., & Wyns, C. (2018).**Fertility and infertility: Definition and epidemiology. *Clinical biochemistry*, 62, 2-10.
2. **Walker, M. H., & Tobler, K. J. (2020).**Female Infertility. *StatPearls* [Internet].
3. **Gharib, M., Samani, L. N., Panah, Z. E., Naseri, M., Bahrani, N., & Kiani, K. (2015).**The effect of valerian on anxiety severity in women undergoing hysterosalpingography. *Global journal of health science*, 7(3), 358.
4. **Egbe, T. O., Ngombiga, M. D. N., Takang, W. A., Manka'a, E. W., Egbe, D. N., Fon, P. N., & Tendongfor, N. (2020).** Findings of Hysterosalpingography in Women Who Underwent Gynaecologic Imaging in a Tertiary Hospital in Douala, Cameroon. *Advances in Reproductive Sciences*, 8(02), 113.
5. **Parhar, D., Budau-Bymoan, A., Peterson, V., Shi, G., Thakur, Y., & Yong-Hing, C. J. (2020).**Unsuspected Pregnancies in Hysterosalpingography: Implementation and Review of a Multi-Institutional Pre-Procedural Pregnancy Screening Protocol. *Canadian Association of Radiologists Journal*, 0846537120921509.

6. **Kilcoyne, A., O'Shea, A., Gervais, D. A., & Lee, S. I. (2020).**Hysterosalpingography in endometriosis: performance and interpretation. *Abdominal Radiology*, 45(6), 1680-1693.
7. **Volondat, M., Fontas, E., Delotte, J., Fatfouta, I., Chevallier, P., & Chassang, M. (2019).**Magnetic resonance hysterosalpingography in diagnostic work-up of female infertility—comparison with conventional hysterosalpingography: a randomised study. *European radiology*, 29(2), 501-508.
8. **Capobianco, G., Crivelli, P., Piredda, N., Maiore, M., Cherchi, P. L., Dessole, M., ...& Meloni, G. B. (2015).** Hysterosalpingography in infertility investigation protocol: is it still useful?. *Clin Exp Obstet Gynecol*, 42(4), 448-451.
9. **Bhoil, R., Sood, D., Sharma, T., Sood, S., Sharma, J., Kumar, N., ...& Sood, S. (2016).** Contrast intravasation during hysterosalpingography. *Polish journal of radiology*, 81, 236.
10. **Duan, N., Chen, X., Yin, Y., Wang, Z., & Chen, R. (2020).**Comparison between magnetic resonance hysterosalpingography and conventional hysterosalpingography: direct visualization of the fallopian tubes using a novel MRI contrast agent mixture. *Acta Radiologica*, 61(7), 1001-1007.
11. **Szymusik, I., Grzechocińska, B., Marianowski, P., Kaczyński, B., & Wielgoś, M. (2015).**Factors influencing the severity of pain during hysterosalpingography. *International journal of gynecology & obstetrics*, 129(2), 118-122.
12. **Roest, I., van Welie, N., Mijatovic, V., Dreyer, K., Bongers, M., Koks, C., & Mol, B. W. (2020).**Complications after hysterosalpingography with oil-or water-based contrast: results of a nationwide survey. *Human reproduction open*, 2020(1), hoz045.
13. **Wadhwa, L., Rani, P., & Bhatia, P. (2017).**Comparative prospective study of hysterosalpingography and hysteroscopy in infertile women. *Journal of human reproductive sciences*, 10(2), 73.
14. **Cipolla, V., Guerrieri, D., Pietrangeli, D., Santucci, D., Argirò, R., & de Felice, C. (2016).**Role of 3.0 Tesla magnetic resonance hysterosalpingography in the diagnostic work-up of female infertility. *Acta Radiologica*, 57(9), 1132-1139.
15. **Pereira, N., Petrini, A. C., Lekovich, J. P., Elias, R. T., & Spandorfer, S. D. (2015).**Surgical management of endometrial polyps in infertile women: a comprehensive review. *Surgery research and practice*, 2015.
16. **Shah, H. U., Sannananja, B., Baheti, A. D., Udare, A. S., & Badhe, P. V. (2015).** Hysterosalpingography and ultrasonography findings of female genital tuberculosis. *Diagnostic and Interventional Radiology*, 21(1), 10.
17. **Dreyer, K., Van Rijswijk, J., Mijatovic, V., Goddijn, M., Verhoeve, H. R., Van Rooij, I. A., ...& Mol, B. W. (2017).** Oil-based or water-based contrast for hysterosalpingography in infertile women. *New England Journal of Medicine*, 376(21), 2043-2052.

18. **Hooker, A., Fraenk, D., Brölmann, H., & Huirne, J. (2016).**Prevalence of intrauterine adhesions after termination of pregnancy: a systematic review. *The European Journal of Contraception & Reproductive Health Care*, 21(4), 329-335.
19. **Harb, H. M., Ghosh, J., Al-Rshoud, F., Karunakaran, B., Gallos, I. D., & Coomarasamy, A. (2019).**Hydrosalpinx and pregnancy loss: a systematic review and meta-analysis. *Reproductive biomedicine online*, 38(3), 427-441.
20. **Barkwill, D., & Tobler, K. J. (2020).**Salpingitis Isthmica Nodosa. *StatPearls* [Internet].
21. **Bhatt, S., Sumbul, M., Rajpal, R., & Radhakrishnan, G. (2017).**Value of “three dimensional multidetector CT hysterosalpingography” in infertile patients with non-contributory hysterosalpingography: a prospective study. *Journal of reproduction & infertility*, 18(3), 323.
22. **Cohen, S. B., & Bouaziz, J. (2018).**Management of Proximal Tubal Occlusion. In *Hysteroscopy* (pp. 677-682). Springer, Cham.
23. **Foroozafard, F. and Sadat, Z., 2013.**Diagnostic value of hysterosalpingography and laparoscopy for tubal patency in infertile women. *Nursing and midwifery studies*, 2(2), p.188.
24. **Gharekhanloo, F., & Rastegar, F. (2017).**Comparison of hysterosalpingography and laparoscopy in evaluation of female infertility. *Medical Research Archives*, 5(6).
25. **Seshadri, S., El-Toukhy, T., Douiri, A., Jayaprakasan, K., & Khalaf, Y. (2015).**Diagnostic accuracy of saline infusion sonography in the evaluation of uterine cavity abnormalities prior to assisted reproductive techniques: a systematic review and meta-analyses. *Human reproduction update*, 21(2), 262-274.
26. **Chen, S., Du, X., Chen, Q., & Chen, S. (2019).** Combined real-time three-dimensional hysterosalpingo-contrast sonography with B mode hysterosalpingo-contrast sonography in the evaluation of fallopian tube patency in patients undergoing infertility investigations. *BioMed research international*, 2019.
27. **Hefny, M. E. Z., & Ragab AbdelAziz, B. (2020).**Evaluation of Diagnostic Hysteroscopy as a Tool for Diagnosis of Tubal Factor of Infertility in Comparison to Diagnostic Laparoscopy. *Al-Azhar International Medical Journal*, 1(3), 230-235.
28. **Moro, F., Tropea, A., Selvaggi, L., Scarinci, E., Lanzone, A., & Apa, R. (2015).** Hysterosalpingo-contrast-sonography (HyCoSy) in the assessment of tubal patency in endometriosis patients. *European Journal of Obstetrics & Gynecology and Reproductive Biology*, 186, 22-25.
29. **Jagannathan, D., & Hithaya, F. (2019).**Conventional and magnetic resonance hysterosalpingography in assessing tubal patency—A comparative study. *The Indian journal of radiology & imaging*, 29(2), 163.

30. **van Rijswijk, J., van Welie, N., Dreyer, K., van Hooff, M. H., de Bruin, J. P., Verhoeve, H. R., ... & Mijatovic, V. (2018).** The FOAM study: is Hysterosalpingo foam sonography (HyFoSy) a cost-effective alternative for hysterosalpingography (HSG) in assessing tubal patency in subfertile women? Study protocol for a randomized controlled trial. *BMC women's health*, 18(1), 1-7.
31. **Lee, F. K., Lee, W. L., & Wang, P. H. (2017).** Is hysterosalpingography a good tool to confirm the patency of tubes?.