Saline Infusion Sonohysterography

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Introduction

Saline infusion sonohysterography (SIS) is a procedure in which sterile saline is infused transcervically into the uterus to improve visualization of the endometrium during endovaginal ultrasonography [1]. This procedure augments the clinician's ability to detect endometrial pathology including hyperplasia, polyps, leiomyomata, adhesions, and even cancer [2]. It is easily and quickly performed in the office with minimal cost, has very few complications, and is well tolerated by patients [3]. SIS is therefore an excellent screening technique to triage patients with suspected endometrial pathology, and it can often avert more invasive diagnostic procedures when used appropriately [4].

History and Background

Transvaginal ultrasonography (TVUS) is an essential tool of the gynecologist to evaluate the pelvic cavity with high accuracy. However, the uterine cavity and the endometrial lining are often not clearly delineated using conventional TVUS. In cases where endometrial sonographic images are not clear, infusing saline through a transcervical catheter to expand the uterine cavity creates visual contrast and thereby enhances the clinician's ability to distinguish and diagnose uterine pathology. The term "sonohysterography" was coined by Parsons et al. [1]; however, the technique was described a decade prior following clearer observations of intrauterine pathology in postmenopausal women with cervical stenosis and fluid-filled cavities [5]. It has also been referred to as saline ultrasonography or SIS. Images of a normal uterine cavity during SIS are shown in Fig. 6.1. Soon after its implementation, SIS became not only a tool to enhance transvaginal ultrasound, but an attractive alternative to more invasive procedures that can be used to evaluate the uterine cavity, specifically hysterosalpingography (HSG) and hysteroscopy [6].

Supporting Data

When compared to traditional two-dimensional (2D) transvaginal sonography, SIS has been found in numerous studies to be superior in the detection of endometrial abnormalities. For example, a prospective study comparing the accuracy of TVUS and SIS in pre and postmenopausal women with abnormal uterine bleeding reported that the sensitivity and specificity of

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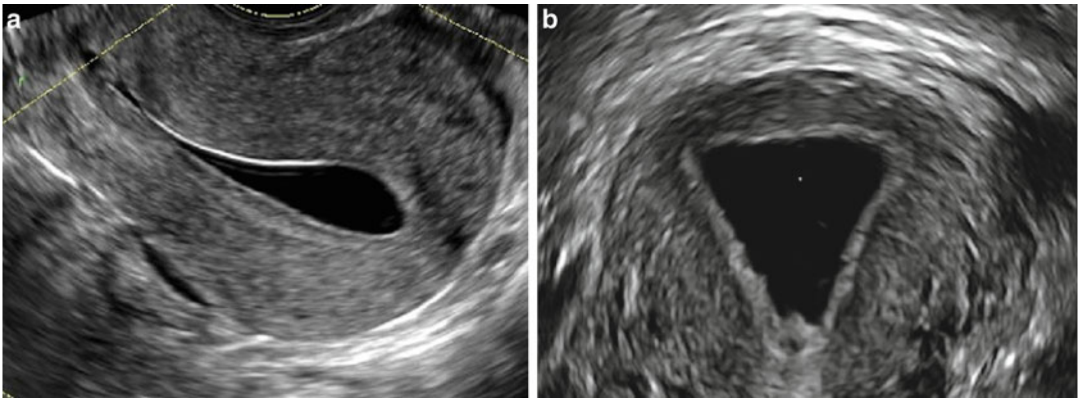

Fig. 6.1 Normal saline infusion sonohysterography (SIS). (**a**) Sagittal view. (**b**) 3D rendering

SIS for the detection of endometrial pathologies were significantly higher than that of transvaginal ultrasound (98 % and 93 %, respectively, for SIS versus 83 % and 71 % for TVUS) [7]. SIS is particularly useful in diagnosing focal endometrial abnormalities and intracavitary masses such as endometrial polyps and fibroids. In the above mentioned study, the sensitivity and specificity of SIS in the detection of endometrial polyps were 100 % and 92 %, and in the case of fibroids were 95 % and 100 %, respectively. Another prospective study of a similar patient population compared the detection of polyps and fibroids using these two techniques. This study found that the sensitivity and specificity of SIS for polyps were significantly higher than TVUS (91 and 93 % for SIS versus 65 and 88 % for TVUS) [8]. The sensitivity and specificity for the detection of fibroids between the two techniques were similar in this study (92 % and 99 % for SIS versus 96 % and 95 % for TVUS), although other studies have demonstrated a small advantage of SIS over TVUS for the detection of myomas [6, 9]. The clear visual advantage of SIS for the detection of polyps and fibroids can be seen in Figs. 6.2, 6.3, and 6.4. Figure 6.2 illustrates the typical appearance of a polyp during SIS, while Figs. 6.3 and 6.4 demonstrate leiomyomas. Numerous studies confirm that SIS improves the diagnostic utility of standard 2D transvaginal sonography [2, 6–8, 10].

It has been suggested that SIS may also serve as an alternative to HSG. HSG is often used to simultaneously evaluate the uterus and fallopian tubes. HSG is superior to SIS in the detection of tubal abnormalities, as nonpathologic fallopian tubes are not visualized ultrasonographically. While SIS can reliably identify tubal spill, all that can be concluded from the finding of free fluid on endovaginal ultrasound after SIS is that at least one of the fallopian tubes is patent. Recent adaptations to improve tubal evaluation during ultrasound include the instillation of either air bubbles or echogenic contrast media rather than saline (hysterosalpingo-contrast sonography [HyCoSy]) [11]. Although HSG remains the gold standard for evaluation of tubal pathology, SIS has higher accuracy than HSG in the detection of uterine anomalies, in particular septate and bicornuate uteri (100 % versus 81 % for HSG) [12]. The ability to assess fundal contour in the evaluation of uterine anomalies is a valuable addition provided by sonography as compared to HSG, especially when combined with 3D ultrasound images. SIS is also superior to HSG in the diagnosis of polyps and endometrial hyperplasia [13]. Both HSG and SIS have limited accuracy in diagnosing intrauterine adhesions, with high false positive rates from blood clots, shearing of normal endometrium, and mucus plugs [14]. Such uterine synechiae as visualized on SIS in a patient with Asherman's Syndrome are shown in Fig. 6.5.

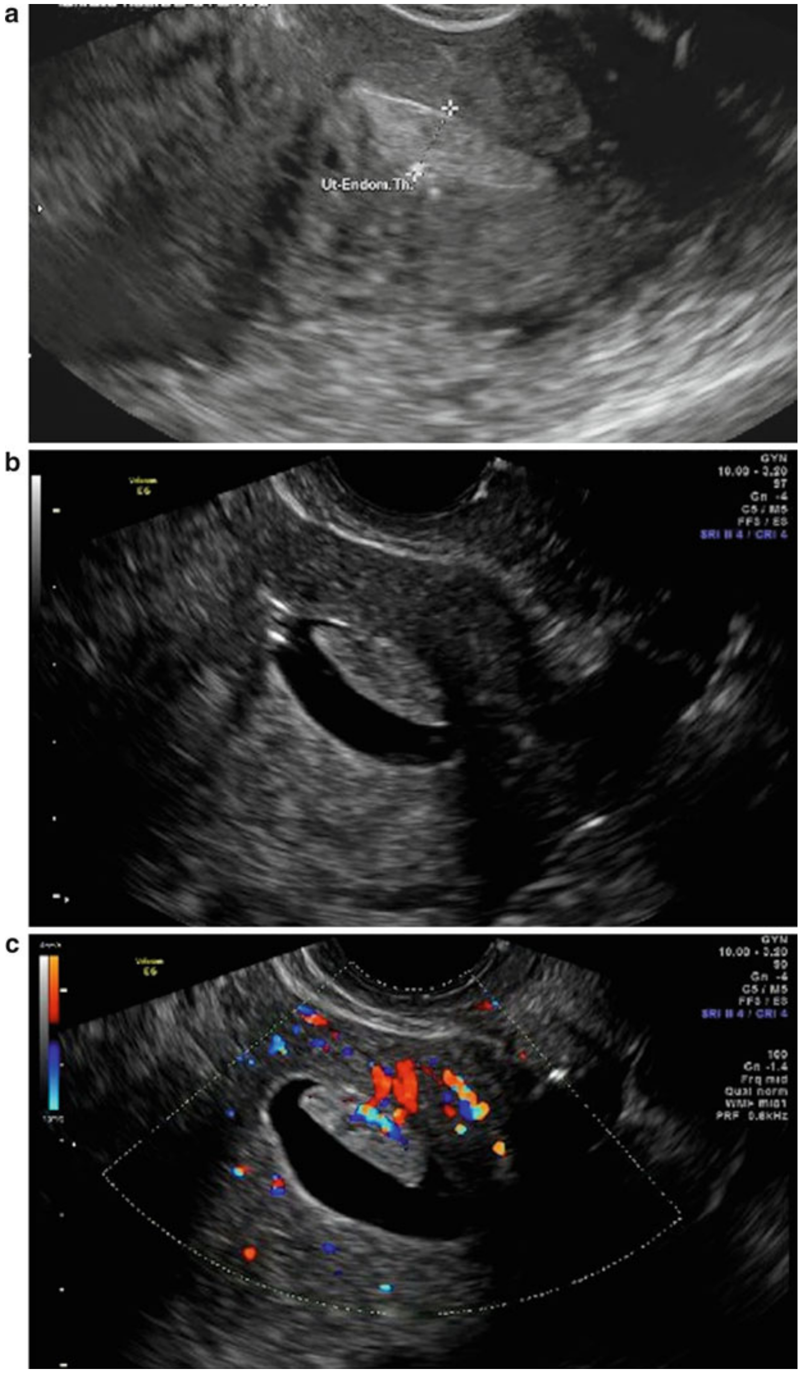

Fig. 6.2 Polyp in a perimenopausal woman with menorrhagia. (**a**) Standard 2D transvaginal imaging shows a thickened endometrial stripe. (**b**) SIS shows a 2 × 2 cm lesion of the anterior endometrium. (**c**) Color Doppler imaging shows flow within the lesion that is typical of a polyp. (**d**) 3D imaging of the endometrial cavity demonstrate two polyps on transverse view that were not apparent on original longitudinal view

Some authors have reported additional advantages of SIS which make it an appealing choice over HSG, including decreased patient discomfort, less expense, the absence of radiation exposure, and its availability in an office setting [12, 13].

Diagnostic hysteroscopy with endometrial biopsy is the gold standard to evaluate uterine d

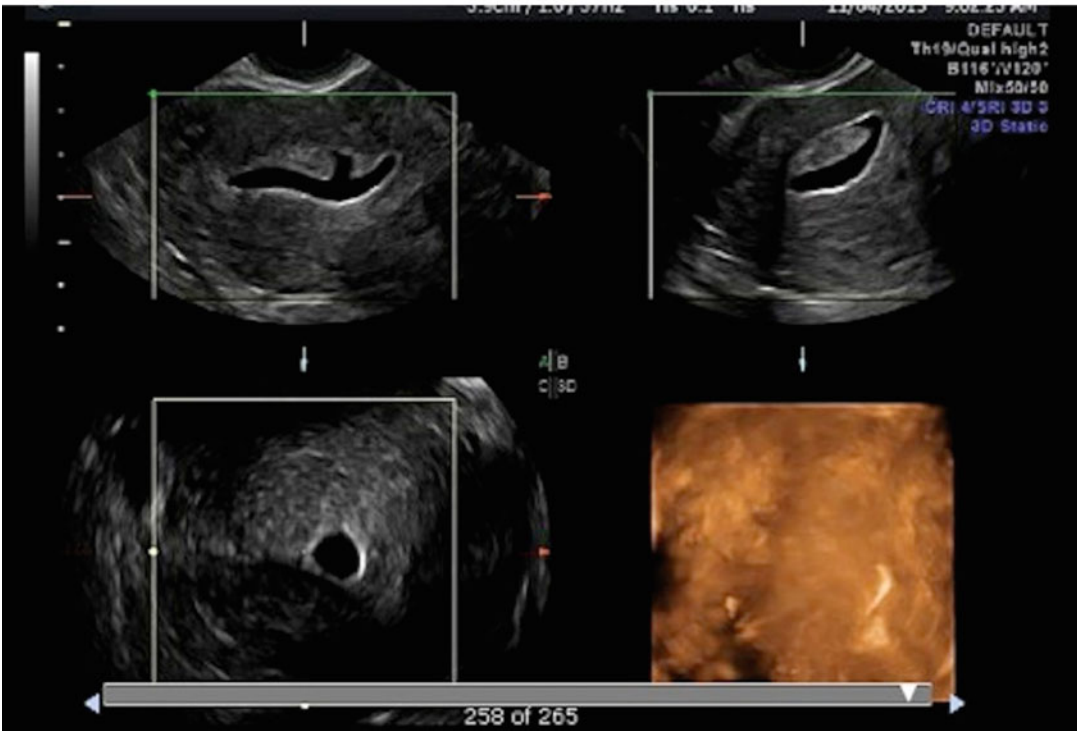

Fig. 6.2 (continued)

cavity abnormalities [6]. However, office hysteroscopy is expensive, invasive, and causes more discomfort to the patient than SIS [15, 16]. Additionally, hysteroscopy cannot visualize the myometrium and therefore cannot classify the depth of myometrial invasion of leiomyomas or carcinoma as SIS can [17]. In direct comparisons, the diagnostic accuracy for polyps, endometrial hyperplasia, and submucosal myomas with SIS has been found to be equivalent to hysteroscopy [6]. Several studies have reported that in patients with abnormalities on transvaginal ultrasound, SIS use, first-line was preferable to proceeding directly to hysteroscopy, as the latter could be avoided in 72–88 % of patients who could then be managed conservatively [4, 17, 18]. More support for this triaging method is reported in a study on cost-effectiveness which indicates that SIS as an initial screening procedure is superior to first-line diagnostic hysteroscopy [19]. Another set of authors stated that diagnostic hysteroscopy should be reserved for situations where SIS is either inconclusive or not feasible [20].

In conclusion, SIS is a safe, simple, inexpensive procedure with few side effects. It is well tolerated by patients, and it can easily be performed in the office setting [21] without the need for an operating room, extra personnel, anesthesia, or exposure to radiation. Distention of the uterine cavity with saline clearly improves upon traditional 2D transvaginal sonographic imaging of the uterine cavity, endowing SIS with greater sensitivity and specificity for the detection of endometrial pathologies. SIS is superior to HSG for the detection of uterine anomalies, and new adaptions may help SIS to overcome its longstanding inferiority to HSG in tubal evaluation. SIS is less invasive than hysteroscopy, and is cost-effective as a screening test prior to more invasive methods in investigating patients with abnormal or inconclusive transvaginal sonographic results [3, 8, 22].

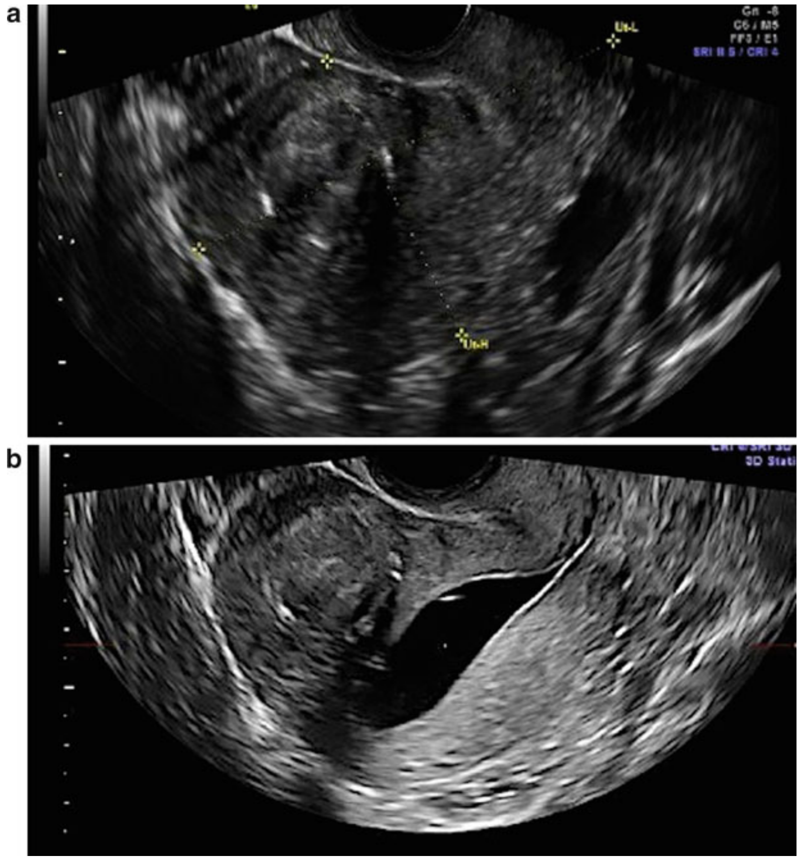

Fig. 6.3 Fibroid in a 38-year-old woman with infertility. (**a**) Gray scale images demonstrate a fibroid of the anterior uterus. (**b**) Instillation of saline demonstrates that the fibroid is intramural without distortion of the endometrial cavity. This fibroid is unlikely to interfere with implantation or pregnancy

Indications and Contraindications

SIS is indicated when the etiology of a woman's symptoms is suspected to arise from an abnormality of her endometrium or uterine cavity, and it can be useful in other situations when transvaginal ultrasound is inadequate [23, 24]. Specifically, indications for SIS include, but are not limited to, evaluation of the following:

- Abnormal uterine bleeding
- Infertility
- Recurrent pregnancy loss
- Congenital abnormalities of the uterus
- Evaluation of uterine cavity polyps, myomas, and synechiae
- Abnormalities on transvaginal ultrasound, including focal or diffuse endometrial or intracavitary abnormalities

Absolute contraindications to SIS include pregnancy, pelvic infection, and unexplained pelvic tenderness [23, 24]. SIS can be performed during menses as active bleeding is not a contraindication. However, heavy menstrual bleeding may make interpretation of the study more difficult, as blood clots are known to cause false positive examinations [23].

Although not a contraindication, a concern exists regarding sonohysterography for the patient in whom there is high suspicion of endometrial carcinoma. In this situation, there is the potential risk of disseminating malignant cells into the pelvic cavity via transtubal spill of saline. Two prospective studies performed in women with endometrial cancer found malignant or suspicious cells from SIS in 25 % of cases [25, 26]. During surgical staging for endometrial cancers, the presence of malignant cells in

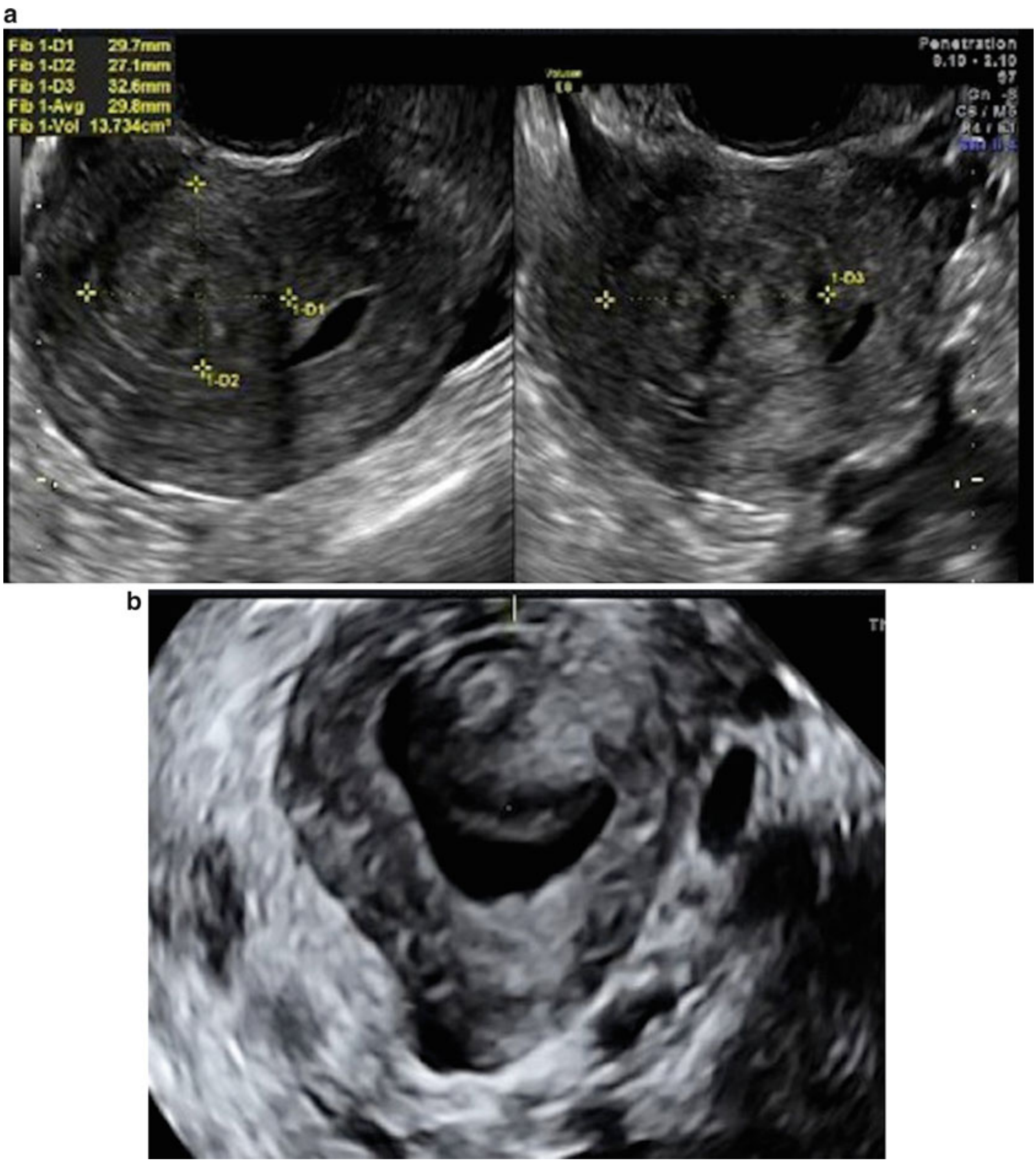

Fig. 6.4 Fibroid in a 34-year-old woman with dysmenorrhea and menorrhagia. (**a**) Gray scale images of 3 cm anterior myoma. (**b**) Saline sonohysterography reveals an intracavitary myoma. This fibroid was removed hysteroscopically with complete resolution of symptoms

peritoneal washings significantly increases the stage of disease. Both of the aforementioned studies concluded that SIS should not be performed in this population of women due to the risk of malignant cell dissemination. However, other studies have found the risk of cancer cell dissemination during this procedure to be smaller, with positive cancer cells after transtubal spill in only 2–12.5 % of patients [27, 28]. These studies concluded that SIS has a low probability of cancer cell dissemination. In addition, it is unclear whether positive peritoneal washings due to SIS have the same prognostic value as typical positive peritoneal cytology

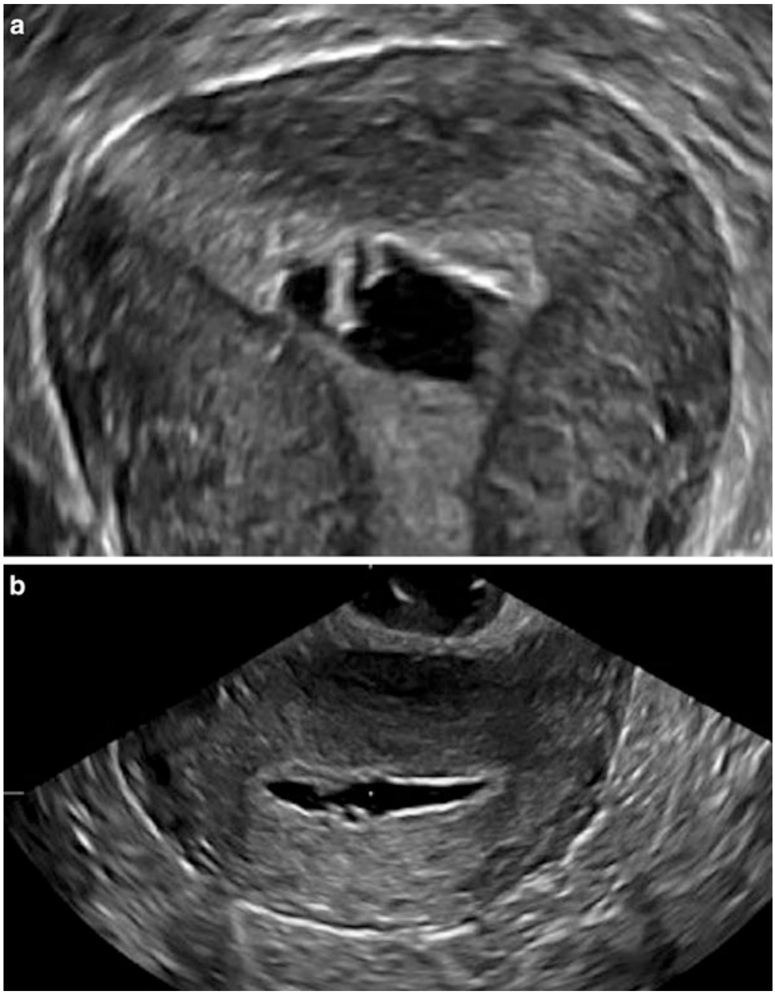

Fig. 6.5 Asherman's Syndrome in a patient with multiple intrauterine procedures. (**a**) Saline sonohysterography shows echogenic foci within the endometrium. (**b**) 3D SIS demonstrates intrauterine adhesions at the right cornual region of the uterus

encountered in endometrial cancer staging. We encourage the clinician to consider this area of controversy prior to performing SIS in populations of women at high risk for endometrial cancer, such as in women with postmenopausal bleeding. Figure 6.6 illustrates a thickened endometrium found during SIS in just such a patient with postmenopausal bleeding.

Equipment

One of the advantages of SIS is the minimal amount of equipment needed. Although many types of transcervical catheters have been proposed of various complexities, all can be effective in experienced hands [29]. The cost for specialized catheters can vary, with the most expensive approaching $100. However, even a pediatric Foley catheter, the least costly option, can be used to instill fluid into the endometrium and provide good quality images if needed. The major difference between catheters is the presence or absence of an intrauterine balloon; when inflated and positioned at or in the cervix, the balloon can prevent loss of distending fluid from the uterus. In some cases, such as the multiparous cervix, the balloon is especially useful; however, it should be noted that most studies also associate balloon use with increased discomfort during the procedure [29, 30]. Beyond the transcervical catheter, a 20–30 mL syringe with sterile saline

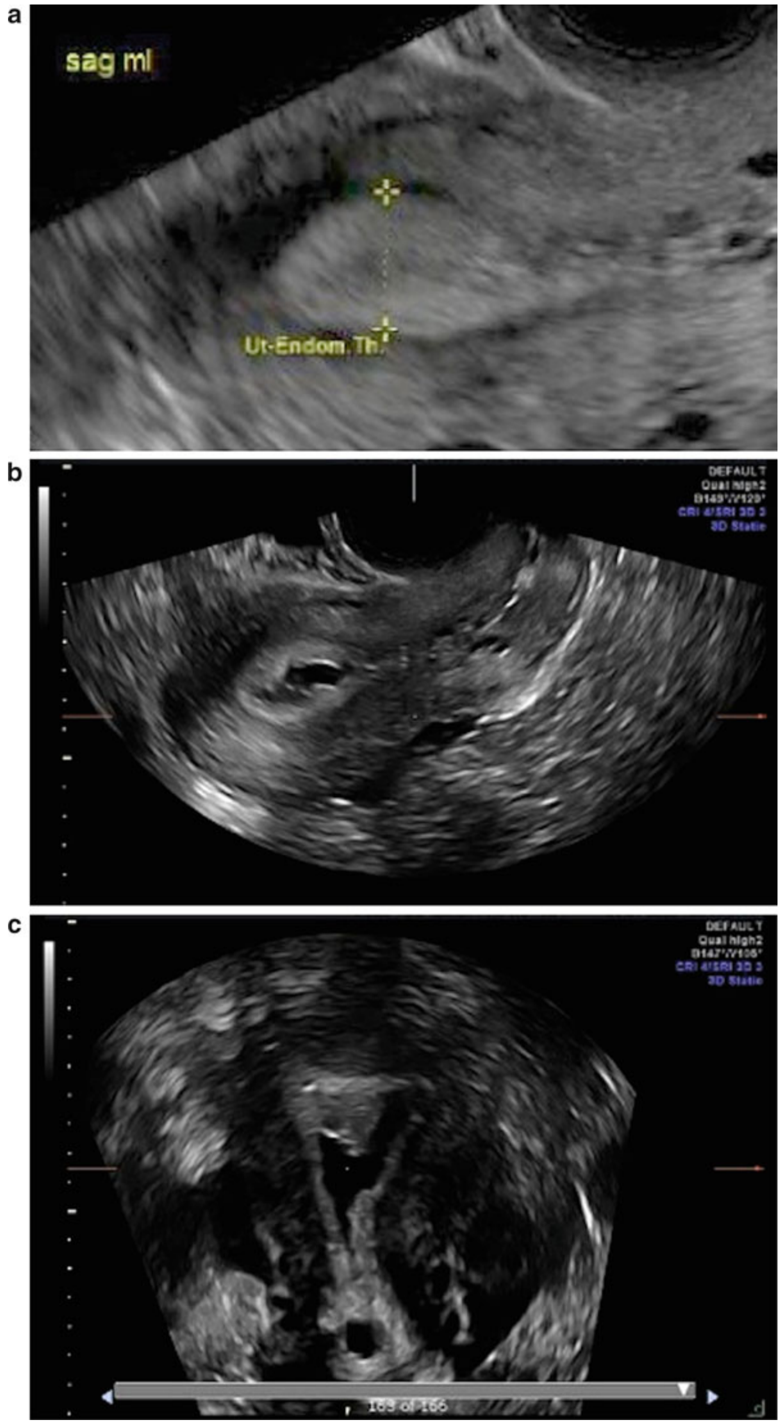

Fig. 6.6 Thickened endometrium in a patient with postmenopausal bleeding. (**a**, **b**) 2D images with and without saline demonstrate areas of irregular endometrial thickening. (**c**) 3D SIS shows with a focal area of thickening in the right fundus. The lesion was removed hysteroscopically and pathology confirmed a benign intrauterine polyp

or sterile water, a speculum and light source as well as a ring forceps or uterine forceps to assist in placement of the catheter are all necessary. Lastly, a high frequency transvaginal US probe and high resolution ultrasound machine are required to perform SIS. A cervical dilator probe and/or a single tooth tenaculum may be used in cases where passage of the catheter is difficult.

Three-dimensional (3D) sonohysterography is a useful tool to increase the sensitivity for intrauterine lesions [31] and assist in more fully evaluating Mullerian anomalies. 3D SIS does require special training other than having an ultrasound machine with 3D capabilities.

When making a distinction between anomalies (e.g., septate versus bicornuate uterus), the assessment of fundal contour with 3D imaging is invaluable and clearly superior to HSG images. Another helpful feature of modern ultrasonography is the cine loop or volume imaging, which allows rapid acquisition of images that can be manipulated or reviewed in different planes after the exam is complete. This property is beneficial when the cavity can only be distended for a minimum amount of time due to rapid fluid leakage from the cervix or in rare cases of patient discomfort.

Patient Preparation and Selection

Optimal timing of the procedure in reproductive aged women is during the first half of the menstrual cycle, after menstrual bleeding has stopped but before ovulation has occurred. For most women, this corresponds to cycle days 5–10. Performing the study during the follicular phase after cessation of normal menses helps ensure that a viable embryo is not flushed out with saline instillation. In women with irregular menstrual cycles, reliable contraception and/or a negative pregnancy test may be required before undergoing SIS. Additionally, timing the study after menses is complete ensures that bleeding and clots are not misconstrued as intrauterine pathology. In menopausal women, SIS can be scheduled at any time.

Patients should be advised that some cramping may occur during the procedure and pretreatment with nonsteroidal anti-inflammatories (NSAIDs) 30–60 min prior to SIS may help to lessen this discomfort. Patients should also be counseled that the cervix is cleaned with betadine or other appropriate antiseptic solution to decrease the small risk of pelvic infection associated with SIS [32]. In addition, routine transvaginal ultrasound should be performed prior to instillation of saline so that hydrosalpinx may be identified and antibiotic treatment considered. The complete series of steps required to perform SIS are listed in Table 6.1.

Helpful Tips

Although most SIS procedures are easily completed, the two most common technical issues relate to difficulties with transcervical catheter placement and acquisition of optimal images. A few simple strategies can help to overcome these obstacles while performing the SIS exam.

When placing the transcervical catheter, remember that the path from cervix to uterus is rarely straight; with patience and gentle repositioning, the catheter will often find its course. Careful placement of the speculum to orient the cervix to midposition can also straighten the cervix and uterus and facilitate easier passage of the catheter. Therefore, knowing whether the uterus is anteverted or retroverted before beginning the procedure can be helpful. For a mobile cervix, either a long cotton swab or a catheter guide can be used to stabilize the cervix while inserting the catheter. As a last resort, a single-toothed tenaculum (with or without cervical lidocaine injection) can be placed at the 12- or 6-o'clock position to provide traction against which the catheter can be gently introduced. For a stenotic cervix, pretreatment with misoprostol or gentle use of cervical dilators during the procedure can be beneficial. On the other hand, for a patulous cervix, use of a balloon type catheter is often required and the balloon

Table 6.1 Steps for SIS

Steps of procedure	Notes
1. Obtain consent and perform appropriate time out procedure as indicated	Risks of bleeding, discomfort, and infection should be discussed
2. Position patient in semi-upright dorsal lithotomy	Ensure buttocks are slightly beyond end of examination table
3. Perform Bimanual examination	Assess for pelvic tenderness, which may signal pelvic infection and need to postpone procedure
4. Survey with transvaginal (TV) ultrasound	Obtain and record measurements of the endometrium, uterus, and ovaries, and look for pelvic free fluid
5. Place speculum vaginally and clean external cervical os	Note any pain, cervical lesions, or purulent discharge which may signal pelvic infection and need to postpone procedure
6. Introduce 5 or 7 French catheter through cervix into uterus using aseptic technique and slowly inflate intrauterine balloon (if applicable) with 1–2 mL of saline; ring forceps or uterine forceps may be used to guide the catheter	Flush catheter prior to procedure to reduce air bubbles entering the uterus. If using a balloon, it should be deflated at the end of the procedure to fully view the lower uterine segment.
7. Remove speculum, reintroduce the TV probe, and manually instill sterile fluid into the uterine cavity slowly while acquiring real time images of the endometrial canal and cervix	Slow introduction of a minimal amount (usually <10 mL, but can range 5–30 mL) of sterile normal saline or water will reduce discomfort
8. Consider obtaining 3D images if possible	3D imaging coupled with SIS minimizes procedure time and can provide more complete information about intrauterine pathology
9. Remove the transvaginal probe and the transcervical catheter after deflating the balloon when appropriate	Review expectations after the procedure such as watery discharge, spotting, and cramping

may need to be held in place during the procedure to ensure a complete seal for better distention of the cavity.

Transvaginal imaging of enlarged uteri or uteri with multiple myomas may not yield satisfactory visualization. Instead, a lower-frequency transabdominal approach during SIS may produce better images of the endometrium. Another factor which frequently affects image quality is the presence of air in the uterine cavity; air is introduced unintentionally through the catheter at the start of the exam or when changing syringes. Air appears ultrasonographically as bright echoes inside the cavity and can either be mistaken for pathology or obscure abnormal findings. This problem can be alleviated by flushing the catheter prior to starting the procedure, careful syringe changes, and inflating the catheter balloon (if employed) with fluid rather than air. If using a balloon with a catheter, the balloon should be deflated at the conclusion of the procedure to ensure complete evaluation of the lower uterine segment. Rapid image acquisition with cine loop or volume imaging at this point can be helpful before the cavity loses distention.

A final impediment to proper visualization is the presence of blood or clot within the uterine cavity. Although SIS is ideally performed after cessation of menstrual flow, blood in the endometrial cavity may be unavoidable during SIS for women being evaluated for continual or unpredictable bleeding patterns. In these cases, the clinician should assess whether the lesion appears to be mobile, as would be expected of a blood clot. In these cases, it can even be completely dislodged with more forcible injection of fluid or with the catheter itself. Color Doppler imaging can also be used in these cases to determine whether the lesion has a vascular pedicle, a finding which would be typical of an intrauterine polyp rather than a blood clot.

AIUM Guidelines

Saline sonohysterography should be carried out according to the SIS guidelines set forth by the American Institute of Ultrasonography in Medicine (AIUM) [24]. For documentation of the study, both precatheterization images (in at least two planes) should be recorded to demonstrate both normal and abnormal findings. The thickest measurement of the endometrial stripe should be captured in the sagittal view whenever possible. Images from the SIS that represent normal or abnormal findings should also be saved and stored once the cavity is distended with fluid. If using a transcervical catheter with a balloon, the balloon should be deflated at the end of the study to allow images of the lower endometrial and endocervical canals to be obtained. Images using 3D sonohysterography or Doppler flow should also be recorded. For documentation purposes, normal and abnormal images should be permanently archived with appropriate labeling and an interpretation provided. Images of abnormalities should include measurements. Patient identification, facility, date, and side (right or left) should be clearly indicated with the name of the structure (ovary, uterus, fibroid) if possible. The final report with the interpreting physician's official findings should be entered into the patient's permanent medical record. The AIUM Practice Guideline recommendations for documenting an ultrasound examination should be followed [33].

Complications and Post-procedure Instructions

SIS is a safe procedure, with few, mild side effects and a very low incidence of serious complications. Most commonly, patients may experience cramping pain after the procedure that is best treated with NSAIDS. They may also expect to have some spotting and watery discharge [21]. An advantage of SIS is that patients may return home and resume their normal activities following the procedure.

The most common serious complication following SIS is pelvic infection. This occurs less than 1 % of the time, and appears more commonly in women with preexistent fallopian tube disease [21]. Warning signs include fever, persistent or worsening pain, or a change in the amount or type of vaginal discharge the day or two after returning home. Patients should be instructed to call their health care provider if they develop any of these symptoms following their procedure.

Conclusions

SIS is a procedure that that is simple, inexpensive, low-risk, and easy to perform in the office. It provides valuable information to the clinician on a wide range of gynecologic pathologies such as polyps, leiomyomata, adhesions, anomalies, and endometrial hyperplasia or cancer, all without the invasiveness of HSG or hysteroscopy. SIS clearly offers additional information beyond standard 2D transvaginal sonography. When coupled with newer modifications such as 3D sonography or tubal patency evaluation, it becomes an even more powerful tool. In sum, SIS is an essential imaging technique for gynecologists in their evaluations of the female reproductive system.

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