12 Sonohysterography (SHG) in Reproductive Medicine

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Introduction

In this chapter, we will review the indication and contraindication for SHG, existing practice guidelines, and describe the optimal technique for it. The main focus will be on diagnosis of intrauterine abnormalities through SHG rather than their treatment thereafter. This will include a discussion on how to make the procedure pain-free for women by using flexible catheters, gentle movements, inflating the balloon inside the cervix rather than the uterus, and injecting the saline slowly. Practice guidelines conclude that SHG is a safe, cost-effective, accurate, and easy to perform procedure, for patients as well as for physicians, to evaluate intrauterine pathology and can be used as the primary diagnostic tool for such cases.

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Practice Guidelines for SHG

The American College of Obstetrics and Gynecology (ACOG) published a technology assessment on SHG, in collaboration with the American Institute of Ultrasound in Medicine (AIUM), the Society for Reproductive Endocrinology and Infertility (SREI), an affiliate of the American Society for Reproductive Medicine (ASRM), and the American College of Radiology [1]. The reader is highly encouraged to review the published guidelines [2–5]. They describe the technique, the indications and contraindications, and the qualifications and responsibilities of the physician performing the SHG. The authors of this chapter have found it easy to adhere and to comply with the above guidelines in their practices and have incorporated them into this review.

Indication and Contraindication

The ACOG and AIUM guidelines [1, 2] describe the indications and contraindications for SHG. The most common indication for SHG is pre- and postmenopausal abnormal uterine bleeding (AUB) [6–11]. Screening of the uterine cavity prior to ART and for the evaluation of infertility and habitual abortions is the second most common indication. SHG may be performed for the evaluation of congenital or

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acquired (fibroids, polyps, and synechiae) uterine anomalies and preoperative and postoperative evaluations of the uterine cavities. SHG may also be performed for further diagnosis of any suboptimal imaging of the endometrium and when focal or diffuse endometrial thickening or abnormalities are seen on a regular TVUS.

The two main contraindications for SHG are pregnancy and pelvic infection or unexplained pelvic tenderness. Abnormal uterine bleeding (AUB) is not a contraindication, though it may make the interpretation of the findings more challenging [7]. Tur-Kaspa et al. [6] have prospectively analyzed SHG with 409 consecutive patients with AUB and have found 37.2% of intracavitary abnormalities, mainly polyps and submucosal fibroids. Goldstein [9] has suggested "ultrasound first" as an approach to women with postmenopausal bleeding. SHG may be used for triage by identifying patients with no disease vs. those with focal or global abnormalities. Furthermore, patient acceptability and diagnostic capability of SHG are high, and it reduces demand for hysteroscopy [8]. SHG-guided endometrial biopsy provided an accurate pathological diagnosis in 89% of patients compared to 52% with blind endometrial sampling [8, 12].

SHG Procedure [1, 2, 6, 13]

Menstrual dating should be documented, and pregnancy should be ruled out before performing SHG. The best timing for performing SHG is after the menstrual flow and prior to ovulation, in cycle days 5–10. This is when the endometrial lining is most symmetrical and precludes the chance for an early pregnancy. During the luteal phase, the lining is thickened and more echogenic and may be associated with a higher false-positive rate of polyps. Using birth control pills may assist in scheduling this test at any day of the menstrual cycle.

Patients should be informed of alternative procedures and the possible risks and complications of SHG (mainly discomfort, low risk of infection, and bleeding) and then sign a consent form. Pretreatment antibiotic is not recommended routinely unless the patient has a history of gynecologic infections or tubal factor infertility [14]. Several RCTs, using different analgesics, have failed to demonstrate benefits of using any drug to significantly reduce pain during or after SHG [15–18]. Unless indicated, no analgesics or sedatives are routinely needed before, during, or after SHG, since it may be considered as a pain-free procedure [6, 19].

Prior to SHG, TVUS is performed with routine evaluation and measurement of the uterus, endometrium, and ovaries. The presence of fluid in the cul-de-sac should be noted, and any pelvic abnormal findings such as hydrosalpinx should be documented. If a patient had a baseline TVUS on day 3 of her period and returns for SHG a few days later, then a quick scan for the evaluation of the uterine cavity and of fluid in the cul-de-sac may be performed after the insertion of the catheter before the injection of the saline.

A speculum is placed in the vagina to visualize the cervix. After cleansing the external os with betadine or equivalent solution, the SHG catheter is inserted into the cervical canal. The SHG catheter should be pre-filled with saline in order to avoid infusing air bubbles into the uterine cavity. There are many catheter options, including HSG/SHG curved catheters, intrauterine insemination catheters, and balloon SHG/HSG catheters. Any rigid catheter, which requires grasping the cervix with a tenaculum, may induce significant pain for the patient. If a balloon catheter is used, it is preferred to inflate the balloon intracervically rather than intrauterine, and the appropriate position of the catheter may be confirmed by pulling it slightly. An RCT recently showed a significant less fluid used for SHG and significantly less pain felt by patients when the balloon was inflated inside the cervix rather than in the lower uterine segment [20]. Furthermore, by inflating the balloon intracervically, one may avoid balloon hyperinflation inside the uterine cavity, which may displace and obscure a pathological finding, such as endometrial polyp. Next, the speculum is removed, and the TVUS probe is inserted into the vagina. Physiological saline solution is then slowly injected to distend the endometrial lumen under direct real-time visualization. Injecting the fluid slowly is mandatory to avoid abrupt uterine distension and pain. Documentation should include images of the endometrial cavity, including the lower segment and the upper cervical canal in at least two planes, longitudinal and transverse (Fig. 12.1). The reader is encouraged to read the official guidelines set by ACOG and AIUM [1, 2].

SHG for Congenital Uterine Anomalies

SHG is a cost-effective method available in an outpatient setting which is highly accurate in identifying uterine anomalies, especially septate and bicornuate uterus [21–23]. Müllerian anomalies are congenital defects in the development of the uterus and the upper vagina. The ability of 2D

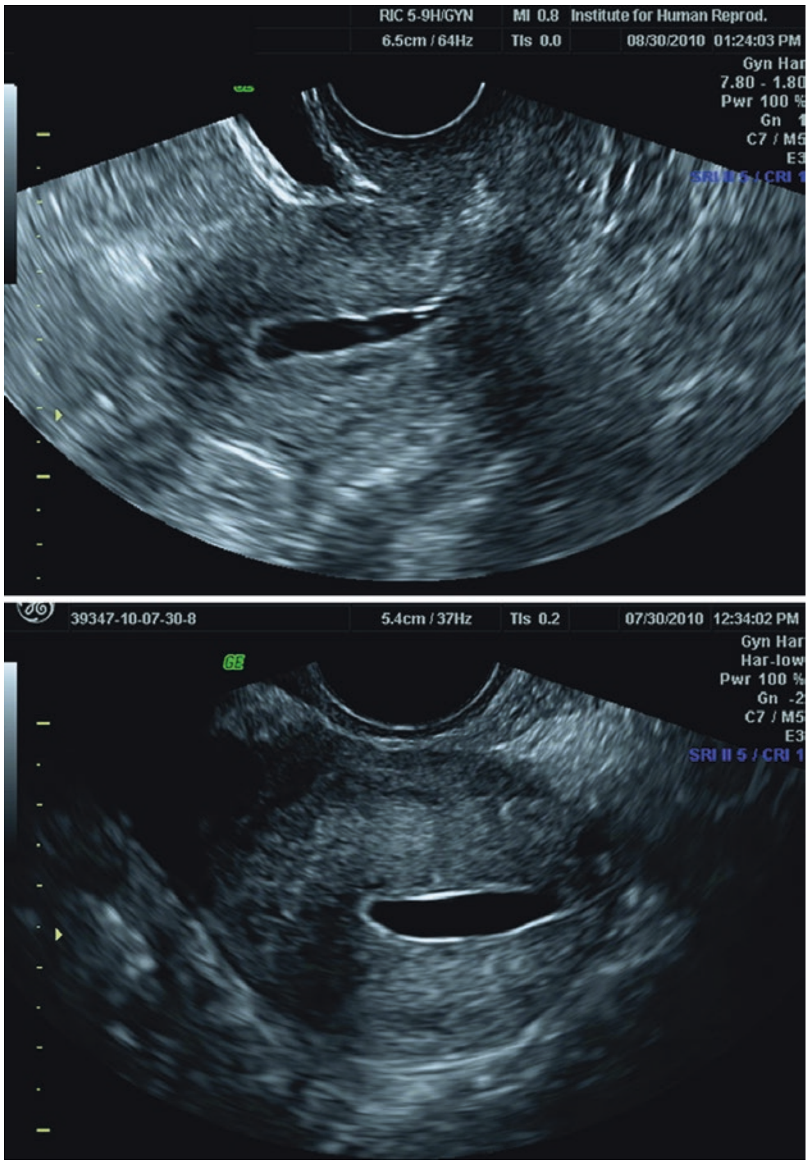

Fig. 12.1 2D longitudinal (upper image) and transverse (lower image) images of the uterus showing adequate distention of the endometrial canal with saline during SHG

US to distinguish between different types of uterine anomalies is limited and operator-dependent. The finding of a uterine anomaly may affect the management of the infertile and/or pregnant woman and the pregnancy outcome. In a recent meta-analysis [24], including 94 observational studies comprising 89,861 women, the prevalence of uterine anomalies diagnosed by optimal tests was 5.5% (95% CI, 3.5–8.5) in unselected population, 8.0% (95%CI, 5.3–12) in infertile women, 13.3.% (95% CI, 8.9–20.0) in women with a history of miscarriage, and 24.5% (95% CI, 18.3–32.8) in women with miscarriage and infertility.

Congenital uterine anomalies are associated with poor reproductive outcome [25]. All uterine anomalies are associated with an increase incidence of fetal malpresentions at delivery. Unification defects do not reduce fertility, but some defects, in particular bicornuate uteri, are associated with aberrant outcomes throughout the course of pregnancy. Canalization defects appear to reduce the chance of clinical pregnancy and to increase risk of preterm delivery. These are more profound in cases of septate uteri. Arcuate uteri, while previously considered to have no reproductive sequelae, are specifically associated with poor outcomes in late pregnancy, i.e., second-trimester miscarriage and malpresentation [25].

Uterine anomalies are defined by the criteria outlined by the American Society of Reproductive Medicine [26]. The visualization of the uterine fundus at the coronal plane is necessary for classifying uterine shape. SHG has been shown to have superior diagnostic ability compared to HSG and 2D US for the evaluation of uterine malformation. Tur-Kaspa et al. [6] studied prospectively the prevalence of uterine anomalies diagnosed by SHG in 600 consecutive infertile patients compared to 409 patients with AUB. While the prevalence of septate uterus was 3% in each group, arcuate uterus was significantly more common among the infertile patients (15% vs. 6%, respectively). All other anomalies had <1% frequency in either group. We [6], as well as others [1, 27–31], concluded that SHG is an excellent method for the evaluation of congenital uterine anomalies. 3D SHG may be needed in some cases to assist in the final diagnosis.

SHG for Acquired Uterine Abnormalities

SHG can serve as a first-line test for the evaluation of acquired intrauterine abnormalities such as adhesions (Fig. 12.2), polyps (Fig. 12.3), and fibroids [3, 10, 11, 32]. Tur-Kaspa et al. [6] have

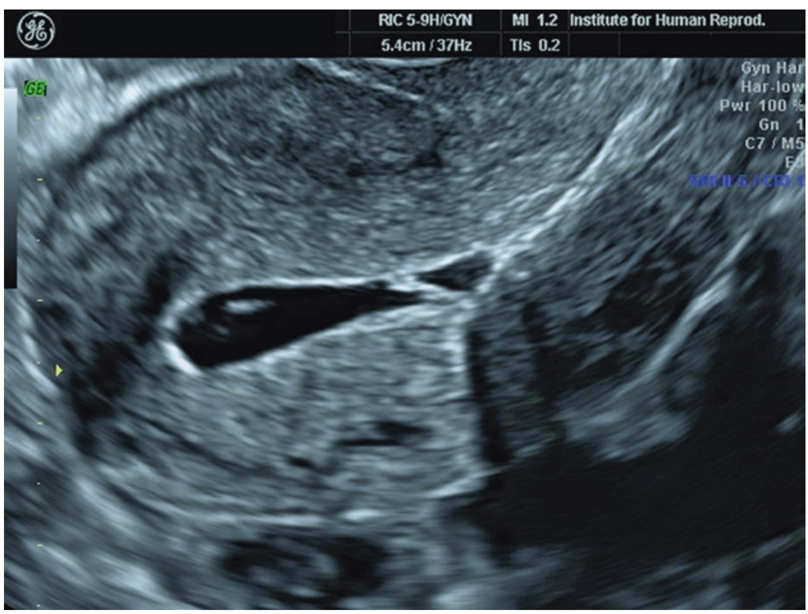

Fig. 12.2 2D longitudinal image of SHG demonstrating intrauterine adhesion at the lower uterine segment, connecting the anterior and the posterior walls of the uterus

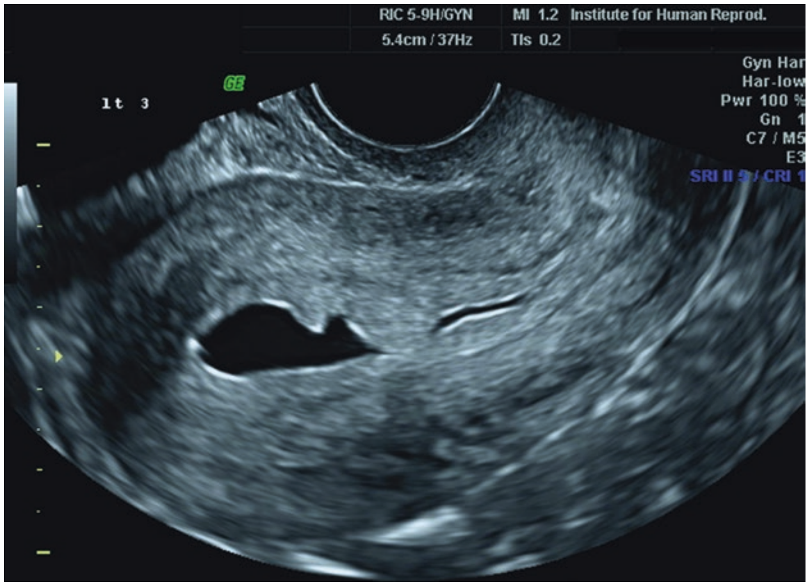

Fig. 12.3 2D longitudinal image of SHG demonstrating two polyps protruding into the uterine cavity

documented that intracavitary abnormalities are significantly more frequent among patients with AUB than with infertility. Polyps were the most common finding both among patients with AUB and infertile women (30% and 13%, respectively) [6, 33]. In addition to the negative effect a polyp may have on fertility, systematic review and meta-analysis demonstrated that the prevalence of premalignant or malignant polyps was 1.7% (68 of 3997) in reproductive-aged women (relative risk 3.86; 95% CI 2.92–5.11) compared to 5.4% (214 of 3946) in postmenopausal women [33]. Both symptomatic vaginal bleeding and postmenopausal status in women with endometrial polyps are associated with an increased risk of endometrial malignancy [33].

Submucosal fibroids were found in 9% of the AUB group and 3% among infertile women [6]. Submucosal fibroids have been shown by meta-analysis to significantly lower pregnancy rates in ART and should be removed by operative hysteroscopy [34, 35]. Besides infertility, the submucosal fibroids may cause bleeding and miscarriages. The European Society of Hysteroscopy has developed a classification system for fibroids which can also assist in the surgical approach. A Type 0 submucosal fibroid has no myometrial invasion, while a T1 has <50% extension and T2 has more than 50% extension into the myometrium. The T0 and T1 are appropriate for the hysteroscopic approach, while the T2 may require more than one procedure or be removed laparoscopically.

2D Versus 3D SHG

When the option of having a 3D SHG scan is available, it may shorten the procedure and the volume of the saline used [36]. 3D SHG vs. 2D SHG is more accurate for diagnosing congenital uterine anomalies [21]. For acquired uterine anomalies, in experienced hands, 3D will not improve the accuracy but may assist in better imaging (Figs. 12.4 and 12.5) [9, 37–41]. For the evaluation of postmenopausal bleeding, 2D and 3D SHG have similar diagnostic accuracy as hysteroscopy with higher patient acceptability of SHG [42, 43].

A 3D US in comparison to a 2D US allows for the visualization of the entire uterine cavity in the coronal view; it can detect the exact placement of uterine fibroids, polyps, and synechiae in the cavity, as well as the mean diameter of different tissues [9, 39–41, 44]. A 3D US examination comprises approximately four steps: (1) data acquisition, (2) volume calculation, (3) image animation, and (4) data storage and transfer. The scans can be obtained

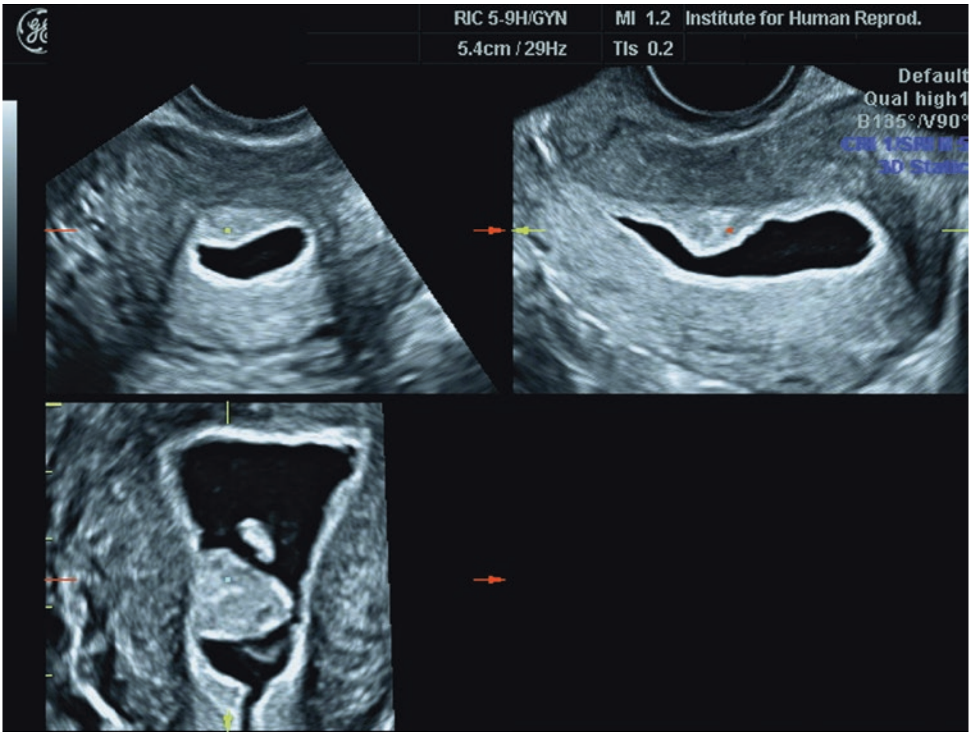

Fig. 12.4 3D SHG images of a uterine polyp. They are able to show the size and location of the stalk of the polyp more accurately in preparation for operative hysteroscopy and for consulting the patient

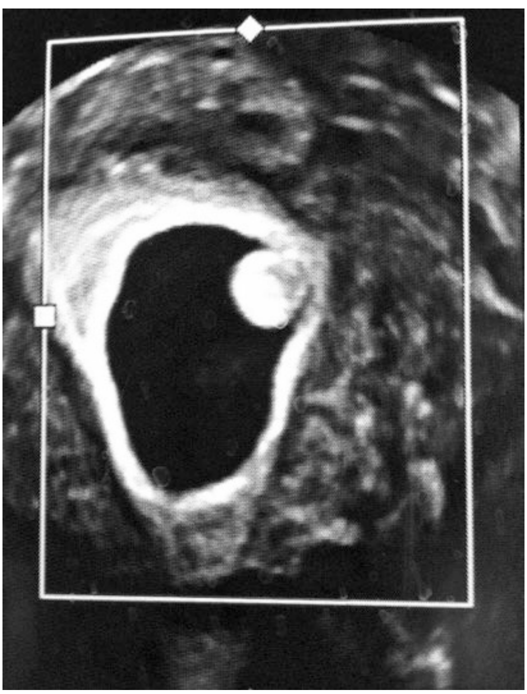

Fig. 12.5 3D SHG image of a corneal uterine polyp providing excellent information for the practitioner and patient on the size and location of the polyp

either freehand, by manual movement through the region of interest (ROI), or automatically, by sweeping through the ROI. 3D US needs post-processing of the received data. Data can be stored and visualized in various displays such as multiplanar with navigation through the planes or surface-rendering mode. For more details on 3D US technique, the reader is referred to Chap. 2.

A saline infusion enhances the contrast in a 3D US and can facilitate the accurate diagnosis of congenital uterine anomalies, especially the arcuate uterus (Fig. 12.6) compared with the septate uterus (Fig. 12.7) and the bicornuate uterus. The serosal edge and the fundal indentation can be clearly seen. Through TUI tomographic imaging, a series of images can visualize the leiomyomata protruding into the uterine cavity vs. deviating the endometrial cavity.

3D adds value to 2D SHG by improving with visualization of the uterine fundus [41, 45]. Others suggest that when the SHG is performed by an experienced examiner, 3D does not add additional value to the 2D SHG [46]. It is the

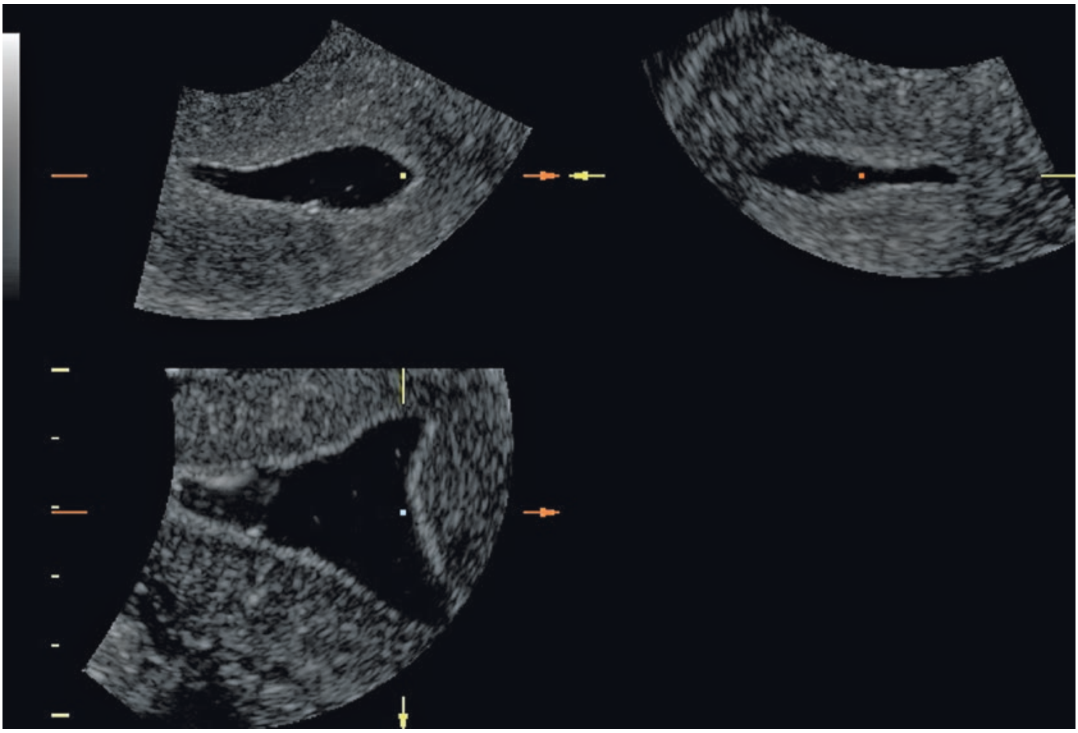

Fig. 12.6 3D SHG demonstrating an arcuate uterus. The visualization of the fundal area at the coronal plane and the ability to measure the depth of the anomaly can easily define arcuate uterus and rule out a septum

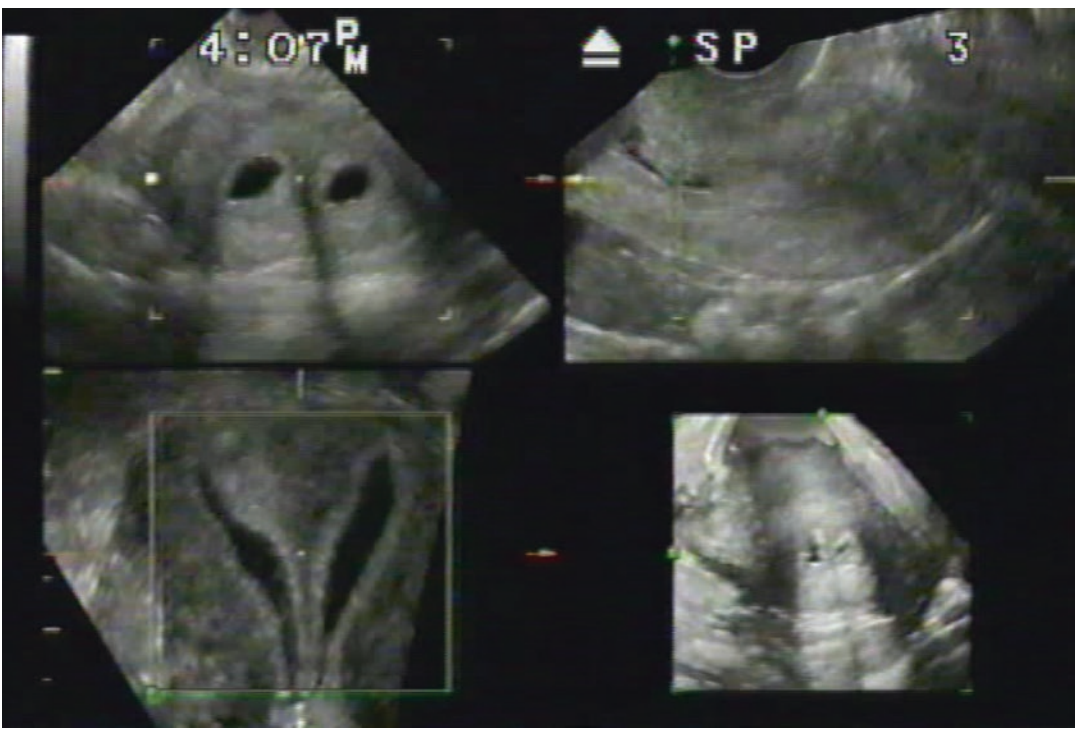

Fig. 12.7 3D SHG demonstrating a completely septated uterus. The 3D reconstruction at the coronal plane leaves no space for imagination, providing definite diagnosis and assisting in planning the surgical treatment needed as well as consulting with the patient

opinion of the authors that adding a 3D US to a 2D SHG will allow the exam to be completed faster with the same or better accuracy [39]. Still, in most cases, 2D SHG is adequate for diagnosing abnormal intracavitary finding.

Gel Instillation SHG

Gel SHG uses hydroxyethyl cellulose gel instead of saline as its medium. This is done in order to try to simplify the technique of artificial uterine cavity distension for SHG [47]. The gel provides a more stable filling of the uterine cavity, allowing a high-quality ultrasonographic visualization of intrauterine pathology by 2D and 3D US [48–53]. Still, most centers will use saline for SHG.

NO Pain with SHG

Tur-Kaspa [19] has recently summarized data supporting that SHG, as well as HSG and hysterocontrastsonography (HyCoSy), should be considered pain-free procedures. Hysterosalpingography (HSG) has a long-standing reputation of being a painful procedure. The use of modern thin catheters and nonionic media that significantly reduces pain during and after HSG [54–58] was unable to affect significantly HSG's "reputation." SHG and HyCoSy, the modern ultrasound-based procedures that are currently used instead of HSG for the evaluation of the uterine cavity and/or the fallopian tubes, "inherited" this high level of fear of pain. It is possible that this stigma discourages patients and leads them to believe that the procedure should be painful when it does not have to be. Several recent randomized controlled trials (RCT) have failed to demonstrate a significant benefit of various pharmacological strategies available to reduce pain during these procedures, suggesting that the pain is more psychological than physical [15–18]. It is the author's opinion, based on evidence data and the experience of performing thousands of these tests, that they can be pain-free for women.

One of the primary ways to make SHG a pain-free procedure is using gentle movements with a thin flexible catheter. Using a rigid catheter, which requires grasping the cervix with a tenaculum, will promote pain. If a balloon catheter is used, it is preferred to inflate the balloon intracervically rather than intrauterine, and the appropriate position of the catheter may be confirmed by pulling it slightly. An RCT recently showed significantly less fluid used for SHG and significantly less pain felt by patients when the balloon was inflated inside the cervix rather than in the lower uterine segment [20]. Warming the saline solutions to body temperature before instillation is another way of reducing patients' discomfort. It is crucial to introduce the saline solution *slowly* into the cavity to prevent abrupt overdistention of the uterus, which would induce immediate pain. While women naturally may feel embarrassed, stressed, and discomfort, as with any medical and gynecological examination, there should be no more fear of pain from procedures such as SHG, HyCoSy, and HSG [19].

SHG Versus Hysteroscopy

Sonohysterography (SHG) was first described in 1986 by Randolph et al. [59]. Randolph et al. instilled saline into the uterus to provide contrast during transabdominal US and compared the SHG findings in 61 women to hysterosalpingography (HSG) and laparoscopy/hysteroscopy. They concluded that real-time US with fluid installation provides an accurate alternative to HSG in screening for uterine abnormalities and tubal patency. Syrop and Sahakian were the first to describe transvaginal SHG in 1992, followed by Parsons and Lense in 1993 [60, 61].

For a long time, hysteroscopy with direct visualization of the intrauterine cavity was considered the gold standard for diagnosing uterine abnormalities [27–31, 34, 35, 62–64]. The percentage of intracavitary abnormalities in women screened by SHG or hysteroscopy for infertility range from 11% to 45% and with polyps range between 6% and 25% [6, 62]. In the last 15 years, accumulating evidence-based data, including randomized control trials, systematic reviews, and meta-analyses, has demonstrated that SHG has comparable sensitivity, specificity, and accuracy in diagnosing intrauterine abnormalities as hysteroscopy [7, 27–31, 63–72]. Therefore, SHG and other ultrasonography techniques may be used as effectively as hysteroscopy for diagnosing intracavitary abnormalities [28, 30, 31]. Pre-IVF SHG was shown to be effective at limiting cycle cancellations caused by endometrial polyps [73], and it was shown to be highly valuable as a first line office-based diagnostic tool for patients with recurrent IVF implantation failure [74]. These data may explain why most of the high-performing IVF programs in the US use SHG for the evaluation of uterine cavity before ART [75].

In addition, cost analysis comparing SHG vs. hysteroscopy screening prior to IVF showed that using SHG is more cost-effective. While hysteroscopic screening is cost-effective [76], Kim and Rone [77] have shown that SHG is more cost-effective than hysteroscopy. They calculated the average cost per patient of SHG screening (n = 229) and hysteroscopy in the subset of patients who have significant and/or correctable abnormalities (n = 35; 15.3%). The cost per patient using SHG screening with additional hysteroscopy as needed was $645. If hysteroscopy was used to screen the same group of patients instead of SHG, the cost per patient would have been $1281.

Conclusion

SHG can serve as a first-line test for screening and evaluation of the uterine cavity for the diagnosis of infertility and before ART. SHG is a simple, cost-effective, safe, and easy to perform procedure for the evaluation of congenital and acquired uterine abnormalities. While using thin flexible catheters, placing them inside the cervix, and injecting the saline slowly, this procedure can be pain-free. Published guidelines on SHG by ASRM, AIUM, and ACOG are easy to implement in routine gynecological and reproductive medicine practice.

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