

Review Article

Contrast Ultrasonography for Tubal Patency

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ABSTRACT Evaluation of tubal patency is an essential part of a fertility workup. Laparoscopy with chromopertubation in conjunction with hysteroscopy is the gold standard in evaluation of tubal patency and the uterine cavity. In this review article we describe a newer method for evaluation of the uterus and fallopian tubes, that is, hysterosalpingo–contrast sonography (HyCoSy). Accuracy of HyCoSy for tubal patency has been shown to be comparable to that with hysterosalpingography (HSG) when compared with laparoscopic chromopertubation. Sensitivity ranges from 75% to 96%, and specificity from 67% to 100%. HyCoSy is also accurate when compared with HSG in determining tubal occlusion after hysteroscopic sterilization, with 88% of patients stating they would prefer to undergo the tubal occlusion test in their gynecologist's office. Because HyCoSy also includes evaluation of the uterine cavity with saline solution–enhanced sonohysterography, accuracy in evaluating the uterine cavity is >90% when compared with hysteroscopy. HyCoSy enables the gynecologist to complete a fertility workup in the office in the most minimally invasive way. HyCoSy is well tolerated and has been suggested in the literature to replace HSG for evaluation of tubal disease in the subfertile population. *Journal of Minimally Invasive Gynecology* (2014) 21, 994–998 © 2014 AAGL. All rights reserved.

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Evaluation of tubal patency is an essential part of a fertility workup. Laparoscopy with chromopertubation in conjunction with hysteroscopy is the gold standard in evaluation of tubal patency and the uterine cavity. Traditionally, hysterosalpingography (HSG) has been used as a less invasive way to evaluate the uterus and fallopian tubes during a fertility workup. The sensitivity and specificity of HSG in evaluating tubal patency when compared with laparoscopy has been reported as 72% to 85% and 68% to 89%, respectively [1]. Compared with hysteroscopy, HSG is less accurate, with a false positive rate of up to 30% [2]. HSG uses radiation; requires iodinated contrast medium, which can be associated with an allergic reaction; is limited in its evaluation of uterine disease (myoma and adenomyosis);

and does not enable evaluation of the ovaries. Laparoscopy and hysteroscopy are the gold standard but involve the use of general anesthesia and the associated complications of surgery. This review article describes a newer method, hysterosalpingo–contrast sonography (HyCoSy), for evaluation of the uterus and fallopian tubes. This procedure can be performed in the gynecologist's office and enables accurate and complete evaluation of the uterus, uterine cavity, fallopian tubes, and ovaries.

Contrast ultrasonography for evaluation of tubal patency was first described in 1984 by Richman et al [3], who used a diluted solution of dextran (Hyskon) and reported at least unilateral tubal patency by observing fluid in the cul-de-sac after the procedure. It was found that to more easily evaluate the fallopian tubes via HyCoSy a sonographic-enhancing positive contrast medium could be used. Such positive contrast agents outline the fallopian tubes, resulting in a hyperechoic appearance. The most simple and inexpensive contrast medium used is saline solution mixed with air. Tubal patency is observed by visualizing the hyperechoic air bubbles traversing the tubal course and surrounding the ovary and then spilling into the peritoneal cavity. The

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primary limitation of HyCoSy with saline solution and air is that it is highly observer-dependent and is accurate only when used by experienced sonographers. The fallopian tubal course is not linear and lies on different planes; thus, rapid small movements of the probe are needed to visualize the fluid passage in the entire tube during infusion. HyCoSy is not so accurate with occluded tubes, possibly because of the difficulties in differentiating saline solution and air in the tubes from air moving in the bowels. In addition, it does not provide an image of the entire tube and its course, as HSG does.

This led to the model of HyCoSy in which the entire course of the tube is visualized using ultrasound-dedicated contrast medium and real-time ultrasonography. This procedure was first described and compared with HSG and laparoscopy by Randolph et al [4] in 1986. Those investigators used a contrast agent approved in Europe for cardiac catheterization, Echovist-200 (Bayer Pharma AG, Leverkusen, Germany), a solution of D-galactose microparticles. Although their results were quite accurate (sensitivity, 98%; specificity, 100%), Echovist-200 has a short duration of visibility, therefore requiring an experienced sonographer to perform the procedure [4]. Echovist contrast medium has not been approved by the US Food and Drug Administration (FDA).

Second-generation contrast media such as SonoVue (Bracco Diagnostics, Inc., Monroe Township, NJ) and Definity (Lantheus Medical Imaging, North Billerica, MA), which use phospholipid-coated fluorane bubbles, then became available, enabling longer duration of visibility (5–10 minutes). Not only did these new media provide more accurate results, they improved operator performance by enabling longer visualization. The core gases used in Definity and SonoVue have low solubility in blood, enabling longer duration of visualization. Although the safety profile for these media is good, adverse events such as anaphylaxis, with a prevalence of <0.05%, or <1:10 000 individuals [5], the following adverse effects are included on the label when the medium is used intravenously: arthralgia, back pain, body or muscle aches, induration, urticaria, dry mouth, eosinophilia, palpitations, paresthesia, photophobia, premature ventricular contractions, pruritus, rash, irritability, hypersensitivity, tinnitus, tremor, visual blurring, wheezing, oxygen saturation decline due to coughing, discoloration at the Hep-Lock site, and burning sensation in the eyes. These contrast media have been approved by the FDA for intravenous use but are not indicated for intrauterine use in the United States.

Because of lack of an FDA-approved indication for contrast media, many providers continue to use a mixture of saline solution and air infused via a 10-mL syringe to affect a similar contrast appearance at ultrasound. In 2010 the FemVue Sono Tubal Evaluation System (Femsys, Inc., Suwanee, GA) was FDA-approved for evaluation of tubal patency using a mixture of saline solution and air. The sensitivity and specificity of this procedure have been found to be similar to contrast media in 3 studies and less accurate in 1

study [6,7]. However, was suggested in all of these studies that, because of the short half-life of the saline solution and air mixture, a quick evaluation by an experienced sonographer is necessary.

In 2007 a non(embryo)-toxic gel (ExEm-gel; GynaecologIQ, Delft, The Netherlands) containing hydroxyethylcellulose and glycerol was introduced and registered for dilation of the uterine cavity during sonography, as intrauterine medium for sonohysterography as an alternative to saline solution. When this gel is diluted and pushed rigorously through small openings in syringes or tubes, turbulence will cause local pressure decrease resulting in air dissolving in the solution, thus yielding foam that is stable for several minutes. This ExEm-gel foam is now registered and CE (European Conformity)-approved for tubal patency evaluation. Feasibility of use of this product has been demonstrated; however, its accuracy in detecting tubal occlusion has yet to be established [8,9].

Performance of HyCoSy

HyCoSy is performed in the same way as saline solution-infused ultrasonography. Before performing HyCoSy it is important to screen women for chlamydia and related pelvic infections. Exclusion criteria include ongoing pregnancy; reproductive tract cancer; pelvic and vaginal infections; presence of tubal disease (hydrosalpinx, acute salpingitis) detectable via ultrasound; presence of risks factors such as heart disease, in particular heart shunt hypertension; and ictus. HyCoSy is better and more safely performed during the proliferative phase of the cycle (day 5–10). A small catheter is placed in the uterine cavity, and the balloon is inflated. Transvaginal ultrasound is then performed with the uterus in the sagittal plane and visualizing both ovaries if possible. The contrast medium or saline solution and air mixture is then injected through the catheter and visualized going through the cornua, traversing the fallopian tube, surrounding the ovaries, and then spilling into the peritoneal cavity (Fig. 1). After tubal status has been established, the balloon is deflated, and normal saline solution is injected through the catheter and the uterine cavity is evaluated in the normal fashion. Before the procedure, ultrasonography of the uterus to detect myoma and adenomyosis and of the ovaries to detect disease can also be performed, enabling complete evaluation of the uterus and adnexae. Accuracy of HyCoSy for tubal patency has been demonstrated to be comparable to that of HSG when compared with laparoscopic chromoper-tubation. Sensitivity ranges from 75% to 96%, and specificity from 67% to 100% [10,11]. HyCoSy is also accurate when compared with HSG in determining tubal occlusion after hysteroscopic sterilization, with 88% of patients stating they would prefer to undergo the tubal occlusion test in their gynecologist's office [12]. Because HyCoSy also includes evaluation of the uterine cavity using saline solution, sonohysterogram accuracy in evaluating the uterine cavity is >90% when compared with hysteroscopy [2,11].

Fig. 1

Two-dimensional hysterosalpingo–contrast sonogram demonstrates patency of the right fallopian tube (arrow).



Although HyCoSy is operator-dependent, recent studies have suggested that with the use of contrast software and 3-dimensional (3D) volume acquisition the accuracy can be improved, even in the hands of less experienced sonographers, with sensitivity of 84% to 100% and specificity of 67% to 100% [13,14]. Contrast coded imaging is one of the technical solutions for optimization of the use of ultrasound contrast media by means of low acoustic pressure. The image displayed is based only on harmonic signals produced by contrast medium microspheres; broadband ultrasonic signals from surrounding tissue are filtered out completely. It is able to emit an ultrasound beam at a selected frequency

and to receive a narrow band of harmonic responses, preventing overlap of tissue and contrast responses. These studies also demonstrated that the ability to acquire a volume and evaluate the images allowed for use of less contrast agent, easier evaluation of tubal patency, and better tolerability of the procedure by the patient. The multiplanar view of the contrast medium in the uterus and tubes obtained during injection can be automatically converted via dedicated software to the volume image produced by the contrast medium inside the uterine cavity and the tubes. The result is a view of the uterine cavity in coronal section, with both tubes laterally, and the contrast medium that spills around the ovaries if both tubes are patent (Fig. 2). The possibility to rotate this volume more accurately shows the tubal course in space, helping to visualize tubal disease (hydrosalpinx, tubal abscesses, salpingitis). 3D volume acquisition also enables the sonographer to differentiate müllerian anomalies by visualizing the fundal profile. Accuracy of the various methods of evaluating tubal patency is given in Table 1.

In general, HyCoSy is well tolerated, and pain scores seem to be comparable to or lower than with HSG [15]. One study that evaluated use of an antispasmodic agent vs placebo before HyCoSy found no differences in pain between the 2 groups. This is likely because most of the patients (75%) in both groups reported minimal to no pain (score of 0 or 1 on the Stacey pain scale) [16]. A study by Savelli et al [17] assessed 669 women who underwent HyCoSy in their department, and the mean (SD) visual analog scale score was 2.7 (2.5), with only 20 patients (4.1%) having a vasovagal response.

A small number of studies have been performed that assessed pregnancy rates in women who underwent HyCoSy.

Fig. 2

Three-dimensional volume acquisition hysterosalpingo–contrast sonogram. Arrows point to the uterus and fallopian tube course.

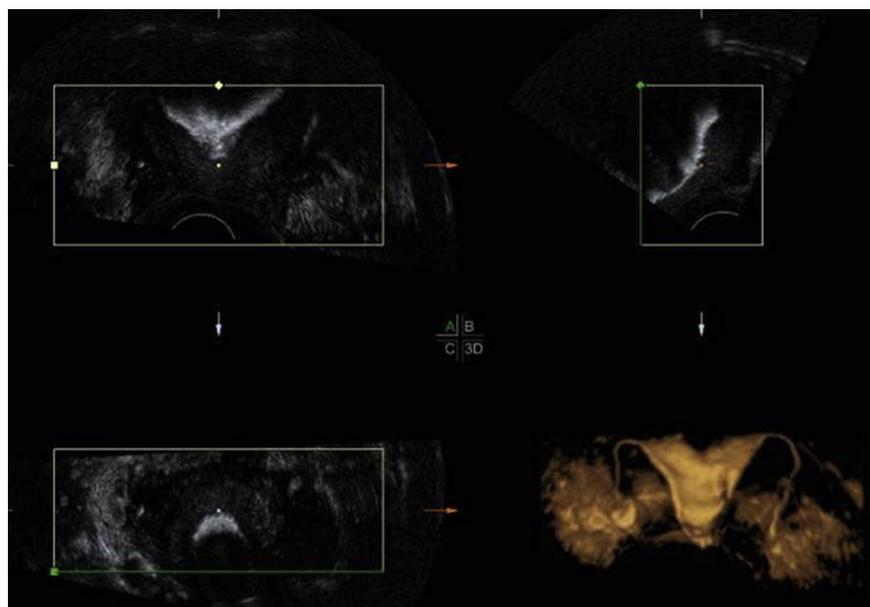


Table 1

Comparison of accuracy of various methods of determining tubal patency^a

Variable	HSG vs LC	HyCoSy vs HSG	HyCoSy vs LC	3D HyCoSy vs LC
Sensitivity	72–88	67–100	75–96	84–100
Specificity	68–89	71–100	67–100	67–100
PPV	70–94	50–100	72–94	87–100
NPV	56–76	83–100	50–96	33–100

HSG = hysterosalpingography; HyCoSy = hysterosalpingo–contrast sonography; LC = laparoscopy chromopertubation; NPV = negative predictive value; PPV = positive predictive value.

^a Values are given as percentage.

Hamilton et al [18] found similar pregnancy rates after intra-uterine insemination in women who had undergone HyCoSy vs HSG or laparoscopy for evaluation of tubal patency. In addition, no difference was observed in pregnancy rates after HyCoSy vs no tubal flushing [18]. Other studies have reported a small increase in pregnancy rates in the first 35 days after HyCoSy; however, when accounting for patient age the difference was not significant [19].

In conclusion, HyCoSy is becoming a progressively more popular way of evaluating the fallopian tubes and uterus during a fertility workup. It has the benefits of enabling complete evaluation of the uterus, uterine cavity, fallopian tubes, and ovaries in the gynecologist's office. Unlike in HSG, the contrast medium is not iodine-based, and the procedure need not be performed in the radiology department. Unlike with laparoscopy and hysteroscopy, general anesthesia and surgery, and their inherent complications, are averted. Hysteroscopy can be safely performed in the office, with good patient tolerability, and a small study by Török and Major [20]

Table 2

Comparison of the pros and cons of various methods for determining tubal patency and evaluating the uterine cavity

Variable	HSG	HyCoSy	OH	HLC
Office	No	Yes	Yes	No
General anesthesia	No	No	No	Yes
Radiation	Yes	No	No	No
Tubal patency	Yes	Yes	No ^a	Yes
Tubal disease	Yes	Yes (3D)	No	Yes
Differentiate polyp vs myoma	No	Yes	Yes	Yes
Differentiate uterine septum vs bicornuate uterus	No	Yes (3D)	No	Yes
Diagnose intramural myoma	No	Yes	No	Yes
Diagnose ovarian disease	No	Yes	No	Yes

HLC = hysteroscopy/laparoscopy chromopertubation; HSG = hysterosalpingography; HyCoSy = hysterosalpingo–contrast sonography; OH = office hysteroscopy.

^a Török and Major [20].

has suggested that hysteroscopic perturbation may also be performed to evaluate tubal patency, with similar results as with HyCoSy (sensitivity, 83%; specificity, 82%) HyCoSy is operator-dependent; however, newer contrast software and 3D volume acquisition has improved feasibility even for less experienced sonographers. HyCoSy offers similar accuracy as HSG when compared with laparoscopy for tubal patency, and with saline solution–infused sonography, superior accuracy when compared with HSG for evaluation of the uterine cavity. A summary of the pros and cons of each method is given in Table 2. HyCoSy enables the gynecologist to complete a fertility workup in the office in the most minimally invasive way. HyCoSy is well tolerated and has been suggested in the literature to replace HSG for evaluation of tubal disease in subfertile women [21].

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