

Ultrasound in the evaluation of tubal patency – A case study

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Introduction

Some degree of tubal pathology, resulting in the occlusion of one or both tubes, is found in one in three infertile women, making the evaluation of tubal status an initial step in the diagnostic workup of infertile women. Transvaginal ultrasound is presented as a diagnostic tool which may be used to evaluate various pelvic conditions that can be responsible for infertility, such as ovarian and uterine factors (uterine malformations, endometrial pathology), but it does not permit evaluation of the patency of the fallopian tubes. Ultrasound imaging is a valued technique for evaluating infertility due to it being non-invasive, inexpensive, quick and easy to perform and provides information on both pelvic disorders. Hystero-Salpingo-Contrast-Sonography (HyCoSy) may be performed as part of infertility workups to assess tubal patency.

HyCoSy technique

This procedure is indicated for:

1. Evaluating tubal patency or occlusion in patients with infertility;
2. Testing tubal status in patients who have undergone previous tubal surgery (ectopic pregnancy, endometriosis, adhesiolysis);
3. Confirming tubal occlusion in patients undergoing permanent hysteroscopic tubal sterilization.

Patient exclusion criteria:

1. Ongoing pregnancy
2. Reproductive tract cancer
3. History of pelvic infection
4. Vaginal infections
5. Patients with tubal pathology, detectable by ultrasound (hydrosalpinx, acute salpingitis)
6. Patients with risks factors such as heart disease, especially heart shunt hypertension, ictus etc.
7. Vaginal bleeding

Before performing HyCoSy it is important to screen women for Chlamydia and related pelvic infection. HyCoSy is better and safer performed during the proliferative phase of the cycle (day 5-12). In order to perform these procedures in other phases of the cycle, couples should also be advised to avoid intercourse or to use barrier methods of contraception prior to the exam. A negative pregnancy test offers insufficient reassurance and the procedure should be delayed if there is any possibility that the patient may be pregnant. After inserting a speculum, a 5Fr salpingographic balloon catheter is placed in the uterine cavity and filled with 1 to 2 ml of air. This step ensures that the cervical canal is closed, preventing leakage of fluid and keeping the catheter in position. The vaginal ultrasound probe is then inserted and a transversal section of the uterus is taken to localize the interstitial part of the tube. When the intrauterine injection of contrast fluid is visualized by ultrasound, the contrast media first is seen in the tube, if proximally patent, before spilling into the abdominal cavity, if distally and totally patent. Where there is tubal occlusion, however, the contrast medium remains concentrated only in the uterus or in the

tubes. Where the contrast medium fails to spill into the abdominal cavity then further solution is injected slowly and with constant pressure. Should the procedure become intolerable, or at the patient's request, then the examination is interrupted for a short period to allow the tubal spasm to pass. The process of scanning and searching for salpinges during injection should be methodical and constant. It seems reasonable to start at the uterine cornua in a plane that also visualizes the interstitial part of the tubes before scanning laterally. Finally the contrast media can be detected around the ovaries. Salpinges are examined separately with 2D HyCoSy, or together with the uterus as a volume using 3D acquisition during injection. Common adverse effects include pelvic pain and cramps, for which analgesic drugs are administered after the procedure. Vaginal reactions, with symptoms including nausea, bradycardia, sweating and hypotension, are rare.

2D HyCoSy

HyCoSy involves the introduction of fluid into the uterine cavity and the fallopian tubes, which can be seen by TVS. Usually the fluid is introduced into the uterine cavity using a salpingographic catheter filled with air or saline to ensure cervical canal occlusion (Figure 1). HyCoSy, which was introduced in the early 1980s for studying tubal patency, is a simple, easy outpatient technique rarely requiring premedication or hospitalization. It can be performed in the same setting and at the same time as transvaginal ultrasound to obtain additional information on tubal patency. In initial studies, saline solution was applied transcervically before

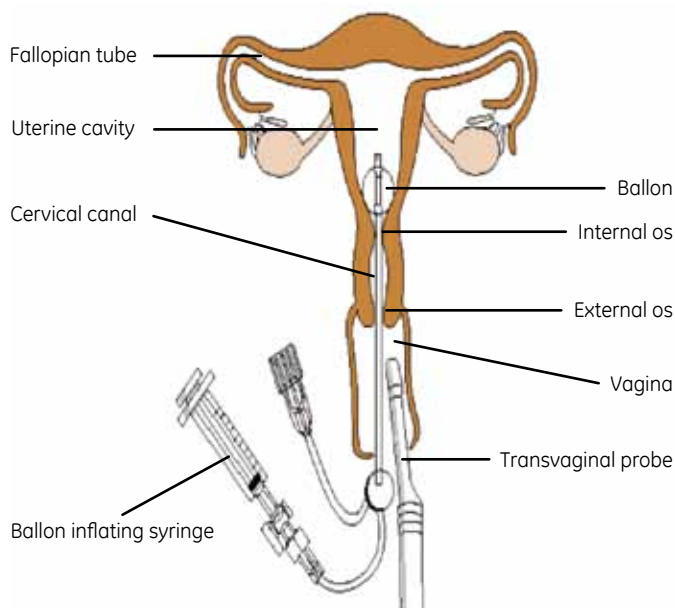


Figure 1: Salpingographic balloon catheter.

performing transabdominal sonography¹. Having found free fluid in the pouch of Douglas, these authors indirectly deduced patency of at least one tube. Saline solution has the advantage that no adverse reactions are known and being inexpensive.

However, although it is excellent for visualizing intrauterine pathology (sonohysterography), it does not seem to be particularly accurate in determining the state of fallopian tubes and their patency². Combining transvaginal ultrasonography with color Doppler sonography and/or ultrasound positive contrast media increases the accuracy of this method.

HyCoSy with saline solution and air bubbles

Finally it was found that a sonographic-enhancing positive-contrast agent can be used to evaluate fallopian tubes with HyCoSy. These positive-contrast agents outline the fallopian tubes, giving a hyperechoic appearance. The most simple and inexpensive contrast medium used is saline solution mixed with air. When this solution is shaken, it generates a suspension of air bubbles which are easily identified sonographically after injection into the uterine cavity and the fallopian tubes (Figure 2). HyCoSy with saline and air is a very accurate and feasible method of evaluating tubal status³: several authors^{4,5} have shown a similar concordance rate (80-90%) between HSG and dye test and HyCoSy and dye test, demonstrating that HyCoSy and HSG are equally effective in diagnosing tubal patency. HyCoSy has been established as the

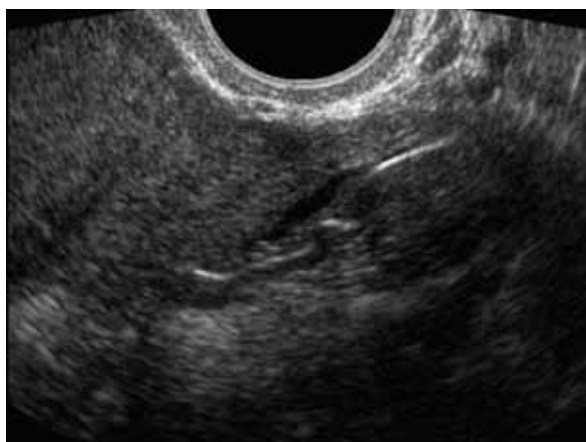


Figure 2: HyCoSy with air bubbles: visualization of tubal course, note the overlapping with the surrounding tissues

initial method for evaluating infertile patients, its positive predictive value being 85-95% when compared to laparoscopic chromoper-turbation. HyCoSy with air and saline does have limitations. It is a highly observer-dependent technique and only accurate in the hands of experienced investigators. The fallopian tubal course is not linear and lies on several planes, making rapid probe movements necessary in order to visualize the fluid passage in the entire tube during infusion. The method is not as accurate on occluded tubes from air moving in the bowels; Finally, unlike HSG, it does not provide an image of the entire tube and its course.

HyCoSy with gel foam

In 2007 a non embryo-toxic gel, containing hydroxyethylcellulose and glycerol, was introduced and registered for the dilatation of the uterine cavity during sonography as an intrauterine medium for sono-hysterography and as an alternative to saline⁶. When this gel is diluted and forced through small openings in syringes or tubes, the turbulence this generates causes a local decrease in pressure. This, in turn, results in air dissolving in the solution, yielding foam which is stable for several minutes. This hyperechoic positive foam improves visualization of the contrast passage within the tubes, thereby increasing the accuracy of HyCoSy diagnosis, however an experienced sonographer is still required, one able to quickly manipulate the TVS probe during the fluid injection in order to visualize the entire tubal course (Figure 3).

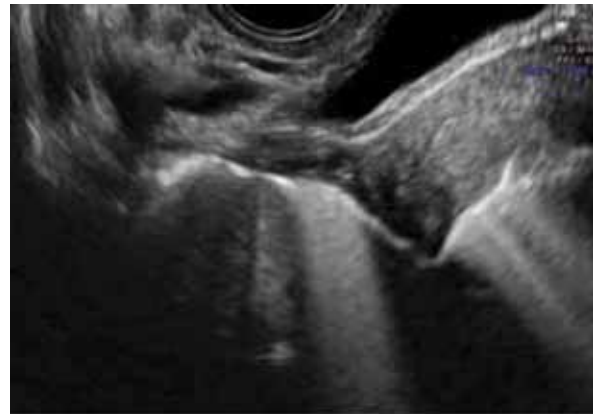


Figure 3: HyCoSy with gel foam: visualization of tubal course with and without Contrast Tuned Imaging

2D HyCoSy limitations

However, due to occasional tubal spasm and partial obstructions or overlapping ultrasound images of other organs (i.e. bowel, ovaries, etc) it is not always possible to visualize the entire tube with this hyperchoic, positive contrast medium. The false positive rate for tubal occlusion remains 5-10%. These results may indicate that HyCoSy can identify tubal patency more easily than obstruction. An explanation might be that tubal occlusions are being caused by spasms, leading to a false diagnosis with HSG. With HyCoSy, in contrast, tubal patency can be recognized by reinjecting the solution after the tubal spasm has passed. One of the main advantages of HyCoSy seems therefore to be that it allows continuous, repeatable, and direct real-time examination of the fallopian tubes. However, it requires a well-trained sonographer with experience in the procedure.

Ideally it is possible to follow the flow of air bubbles through the tube and to visualize air and saline solution near the ovary in the abdominal cavity, which is a sure sign of tubal patency. In some cases it is not possible to scan the entire tube, and only the distal part near the ovary is visible, or only air bubbles around the ovary can be seen. Learning to differentiate between a real occlusion and a temporary spasm requires patience and experience. Where tubal occlusion is diagnosed using HyCoSy, then laparoscopy should be considered as a secondary procedure.

3D CCI HyCoSy

In order to overcome the problems associated with conventional 2D HyCoSy, involving various contrast media and ultrasound techniques, two ultrasound technologies have been combined. The first, Coded Contrast Imaging (CCI), detects the signals coming from the contrast medium. The second, three dimensional (3D) sonography, acquires a volume of the fallopian tubes.^{7,8,9}

GE Healthcare has developed dedicated 3D CCI HyCoSy software which can reconstruct the tubal course, acquiring the volume of the uterus and tubes with CCI during foam injection. The result is a view of the uterine cavity in coronal section, the tubes displayed laterally, and with the contrast medium spilling around the ovaries where both tubes are patent. Rotating this volume offers a 3D image of the tubal course. The software used in volume acquisition procedures can also be used during gel foam injection (3D HyCoSy) to obtain similar uterine and tubal images. (Figure 4-6).

A major advantage of TVS HyCoSy with automated 3D CCI is the ability to obtain images of the uterus and tubal course. These images can also be easily shared with other clinicians, whereas 2D HyCoSy is a dynamic real-time exam in which the fluid passage is seen only by the ultrasound examiner and images are difficult to interpret. Moreover, the acquired volumes can be stored and analyzed at a later date, reducing patient examination times. 3D HyCoSy is simple and reproducible, and can be performed in the office. Therefore infertile patients need only one scan during the proliferative phase of the cycle to obtain information about uterine and adnexal morphology, as well as tubal patency (One-stop Infertility Clinic)^{10,11}.

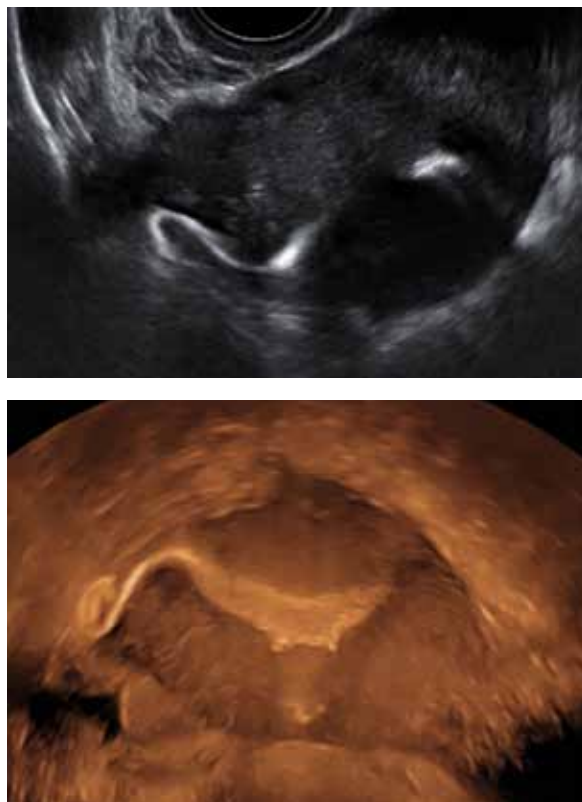


Figure 4: Automated 3D CCI HyCoSy with gel foam: 2D and multi-planar volume view of the foam in the uterus and tubes

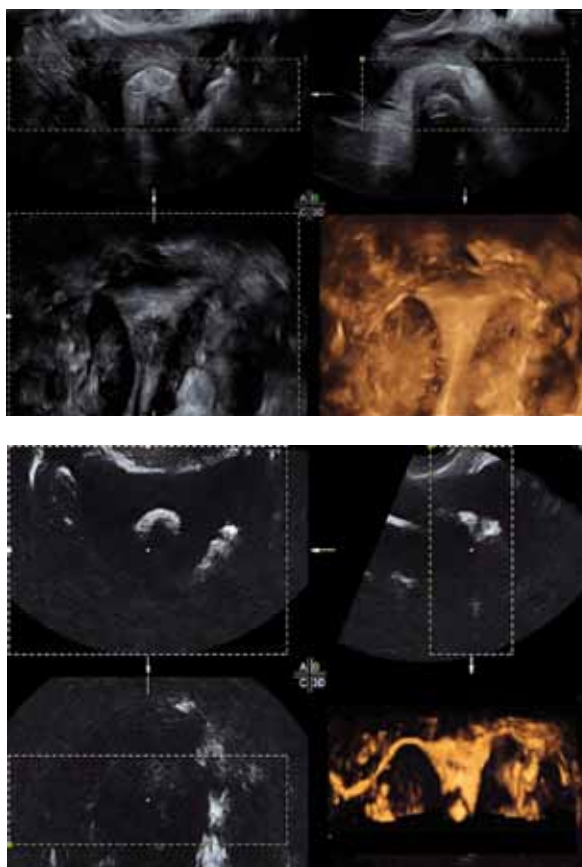


Figure 5: Automated 3D CCI HyCoSy: multiplanar volume view of the gel foam in the uterus and tubes with and without Coded Contrast Imaging (CCI) and automated reconstruction of the volume

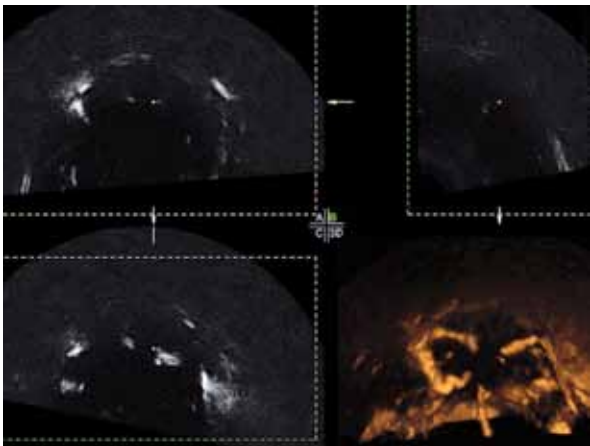
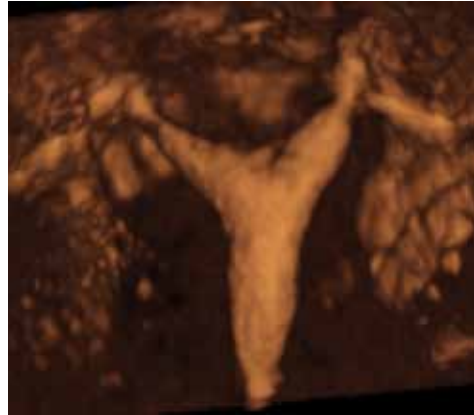
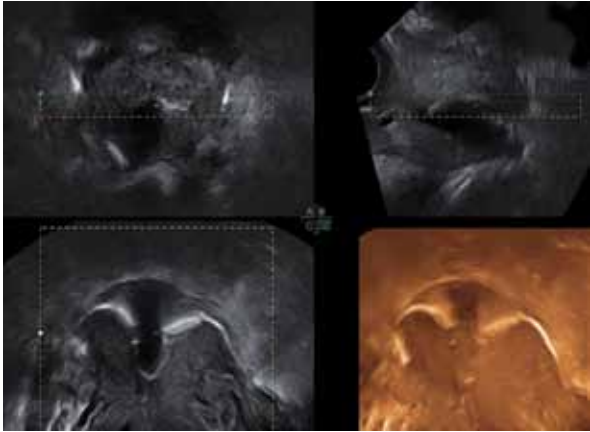
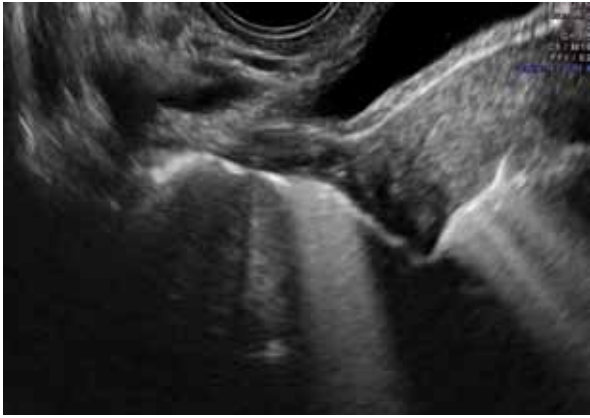


Figure 6: HyCoSy and gel foam with different ultrasound techniques

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Reference

1. Richman TS, Viscomi GN, de Cherney A, et al: Fallopian tubal patency assessed by ultrasound following fluid injection. *Radiology* 152:507–510, 1984
2. Boudghene FP, Bazot M, Robert Y, et al: Assessment of fallopian tube patency by HyCoSy: Comparison of a positive contrast agent with saline solution. *Ultrasound Obstet Gynecol* 18:525–530, 2001
3. Exacoustos C, Zupi E, Carusotti C, Lanzi G, Marconi D, Arduini D, Hysterosalpingo-Contrast Sonography Compared with Hysterosalpingography and Laparoscopic Dye Pertubation to Evaluate Tubal Patency. *J Am Assoc Gynecol Laparosc* 10(3): 29-32, 2003
4. Volpi E, Zuccaio G, Patriarca A, et al: Transvaginal sonographic tubal patency testing using air and saline solution as contrast media in routine infertility clinic setting. *Ultrasound Obstet Gynecol* 7:43–48, 1996.
5. Dijkman AB, Ben WJ, Van der Veen F, et al: Can hysterosalpingocontrast-sonography replace hysterosalpingography in the assessment of tubal subfertility? *Eur J Radiol* 35:44–48, 2000
6. Exalto N, Stappers C, van Raamsdonk LAM, Emanuel MH. Gel Instillation Sonohysterography: first experience with a new technique. *Fertil Steril* 87:152-155, 2007.
7. Exacoustos C, Di Giovanni A, Szabolcs B, Binder-Reisinger H, Gabardi C, Arduini D. Automated sonographic tubal patency evaluation with three-dimensional coded contrast imaging (CCI) during hysterosalpingo-contrast sonography (HyCoSy). *Ultrasound Obstet Gynecol* 34: 609-612, 2009.
8. Exacoustos C, Di Giovanni A, Szabolcs B, Romeo V, Romanini ME, Luciano D, Zupi E, Arduini D. Automated three-dimensional coded contrast hysterosalpingocontrast-sonography: feasibility in office tubal patency testing. *Ultrasound Obstet Gynecol*. 2012 May 30. doi: 10.1002/uog.11200. [Epub ahead of print]
9. Zhou L, Zhang X, Chen X, Liao L, Pan R, Zhou N, Di N. The value of three-dimensional hystero-salpingo-contrast sonography with Sulfur hexa-fluoride gas microbubbles in the assessment of tubal patency. *Ultrasound Obstet Gynecol* 2012 online
10. Lim CP, Hasafa Z, Bhattacharya S, Maheshwari A. Should a hysterosalpingogram be a first-line investigation to diagnose female tubal subfertility in the modern subfertility workup? *Hum Reprod*. 26: 967-971, 2011.
11. Kelly SM, Sladkevicius P, Campbell S, Nargund G. Investigation of the infertile couple: a one-stop ultrasound-based approach. *Hum Reprod*. Dec;16(12):2481-4, 2001.



GE imagination at work