Transvaginal salpingosonography for the assessment of tubal patency in infertile women: methodological and clinical experiences

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Objective: To evaluate the advantages and accuracy of transvaginal salpingosonography in the assessment of tubal patency with regards to laparoscopic chromoperturbation.

Setting: Infertility clinic of the hospital

Design: Thirty-one women suffering from infertility were examined with transvaginal salpingosonography using air and saline as a contrast medium. The results were compared with those obtained with laparoscopic chromoperturbation.

Results: Altogether 61 fallopian tubes were examined with both transvaginal salpingosonography and laparoscopic chromoperturbation. Concordance was 85%. Of the tubes investigated by transvaginal salpingosonography, 45 were found to be patent and 16 were found to be occluded. In chromoperturbation, 50 of 61 tubes were patent and 11 were occluded. Bilateral tubal patency was found by transvaginal salpingosonography in 17 cases and by laparoscopy in 22 cases. Unilateral tubal patency was found in 11 and 6 cases, respectively. Bilateral occlusion was found in three cases using either technique.

Conclusion: Transvaginal salpingosonography with the combination of air and saline is a low-cost, reliable, safe, and comfortable examination method. It can be used for the primary investigation of infertility on an outpatient basis.

Key Words: Infertility, transvaginal ultrasound, salpingosonography, tubal patency

Tubal factors account for approximately 25% to 30% of infertility, which makes the examination of tubal patency essential in any examination protocol for infertile women. To date, hysterosalpingography (HSG) and laparoscopic chromoperturbation have been the “gold standards” in the assessment of tubal patency. Hysterosalpingography, however, is associated with an increased risk of radiation, infection, and pain whereas chromoperturbation is an invasive procedure requiring general anesthesia and hospitalization. Therefore, a simple, reliable, and easily repeatable bedside method that can be performed as a primary examination for the assessment of tubal patency on the patient’s first visit to the infertility clinic is required.

Salpingosonography was first introduced in the early 1980s and it opened up new vistas in the area of tubal patency studies. It does not require any pre-medication or hospitalization and is relatively painless for the subject. The original studies were performed transabdominally, but with the advent of transvaginal ultrasonography, the accuracy of the method has increased (1–5). The aim of the present study was to evaluate the methodological practice and potential advantages of transvaginal salpingosonography as well as to obtain some preliminary data concerning the accuracy of the method in the assessment of tubal patency as compared with laparoscopic chromoperturbation.

MATERIALS AND METHODS

Thirty-one women were recruited for the study between September 1993 and April 1994. Primary in-
fertility was diagnosed in 25 cases whereas the remainder were found to suffer from secondary infertility. One patient had been treated previously with salpingectomy due to ectopic pregnancy. The mean age ± SD of the subjects was 32 ± 5 years (range: 22 to 45 years). The mean length ± SD of the menstrual cycle was 29 ± 2 days.

All transvaginal salpingosonographies were performed by one of two authors (E.V. and H.H.). The study protocol was approved by the Ethical Committee of the Medical Faculty of Oulu University.

Two grams of tinidazole were administered orally as a prophylactic antibiotic. No other premedication was administered. All patients were examined in the lithotomy position. Vaginal disinfection was carried out using chlorhexidin and natrium acetate (Travanex, Baxter Healthcare Ltd., Norfolk, United Kingdom). Three different catheters were used: a Cook catheter with a Sholkoff balloon for hysterosalpingography (Cook Urological Inc., Spencer, IN), a Foley silicone catheter of two different diameters (Ch 8, 10; Sewoon Med Co., Ltd., Seoul, Korea), and a Zinnanti uterine injector (Z.U.I. 2.0 mm; Zinnanti Surgical Instruments, Chatsworth, CA). The catheter was inserted into the cervical canal and the balloon was filled with 1 to 2 mL of saline. If the catheter slipped out of position, as was the case in many patients with earlier vaginal deliveries, it was placed in the lower part of the uterine cavity. After catheterization, correct catheter positioning was ensured with a transvaginal ultrasound (US) control. The equipment used in this study was either Toshiba (SSA-270A, 6.5 MHz vaginal probe; Toshiba, Tokyo, Japan) or Aloka (SSD-680, 5.0 MHz vaginal probe; Aloka, Tokyo, Japan). The uterine position, endometrium thickness, and adnexes were all examined regularly. The presence of any fluid in the fossa Douglas was noted and an overview of the periovian space was obtained.

Two 20-mL syringes were filled with 10 mL of saline solution and 10 mL of air, which acts as a contrast medium in this study, as normal salpinges normally cannot be visualized with ultrasonography. A longitudinal view of the uterus was obtained before beginning the injection of air to visualize the uterine cavity (Fig. 1). Slight traction was placed on the catheter if the balloon was in the uterine cavity. The air was injected very slowly. By rotating the probe through 90°, a trans-section of the uterus was taken then to localize the uterine-tubal junction. The broadest magnification was used to visualize the salpinges. Air was injected continuously and slowly through the catheter and any undue pressure felt during the injection was noted. The tube was followed as distally as possible by slowly tracing the probe over it and simultaneously distending the uterus to straighten the salpinges (Fig. 2). A backscatter effect sometimes can be observed when air bubbles are in motion in the salpinx (Fig. 3). If the tube was visualized satisfactorily with the air bubbles, the ovary then was located and any air bubble flow or backscatter near it was noted (Fig. 4). Saline then was injected to cause the air bubbles to flow more visibly through the tube. Both salpinges were examined separately.

Color Doppler was used in some cases with slow flows to visualize better the flow in the distal tube. In addition, by using color Doppler, in some cases it is possible to analyze flow patterns more accurately and thereby discriminate between free flow, reduced flow, and tubal occlusion. With transvaginal salpingosonography without Doppler, the speed of flow is defined based on empiric observations. In this study, it was classified as fast when the movement of air bubbles was seen easily or slow if it was necessary to wait for the air bubbles to start moving slowly.

Finally, the presence or absence of fluid and air

Figure 1. Ultrasonograph (longitudinal) of the uterus at the start of injection of air. The three large arrows near the center show the effect of the air in the uterine cavity. The smaller arrows indicate the position of the balloon of the catheter in the cervical canal. UT, uterus.

Figure 2. The arrows highlight the effect caused by the passage of air through the right salpinx.
Transvaginal salpingosonography was performed during the follicular phase of the same menstrual cycle on days 3 to 16 (mean days 12 ± 5), except for three cases in which it was performed on days 18, 25, and 29. The principal aim was to perform transvaginal salpingosonography in the beginning of the menstrual cycle to ensure that the endometrium was as thin and as least vascular as possible. The mean endometrium thickness on the day of the transvaginal salpingosonography study was 7 ± 2 mm.

The transvaginal salpingosonography procedure took approximately 15 to 30 minutes. Patient compliance was good. The procedure was easy to perform in 24 cases and was slightly difficult in 8 cases due to technical problems: either the catheter slipped out of the canal or the patient complained of discomfort. No patient had any infection or suffered any other complication, such as bleeding or pain after transvaginal salpingosonography. Approximately 1 to 2 mL of air was required to visualize the entire uterus cavity. No abnormalities in the uterine cavity were found in these transvaginal salpingosonography examinations. Correct positioning of the catheter was ensured and reflux back into the vagina was ruled out before continuing the examination.

Transvaginal salpingosonography and chromoper- tubation findings with respect to the tubal patency are shown in detail in Table 1. Forty-five tubes were patent in transvaginal salpingosonography, with fast flow in 38 and slow flow in 7. Of the tubes suspected to be occluded, a proximal occlusion was surmised in 12 of 16 tubes. In 3 of these 16 cases, the transvaginal salpingosonography result was unsure; i.e., it was difficult to say if the tube was occluded or only in the midst of a forceful spasm.

Laparoscopic findings were abnormal in 20 patients. Endometriosis was found in nine patients and peritubal and/or periovarian adhesions were found in nine cases. There was one case of bilateral and

RESULTS

Altogether, 61 fallopian tubes were examined by transvaginal salpingosonography in 31 patients. One patient previously had had an ectopic pregnancy and thus had only one tube left after salpingectomy. Basic US findings in the uterus and adnexes were abnormal in three patients only. Two patients had endometriotic cysts and one had polycystic-like ovaries. The control laparoscopic chromoper- tubation study usually was performed within 2 days after transvaginal salpingosonography.

Figure 3 The backscatter effect in the proximal area of the right salpinx: the four arrows in the center of the figure indicate the area of most pronounced backscatter. The large arrows indicate the air visible in the tubal lumen.

was noted in the abdominal cavity near the ovary. If the procedure became painful, the examination was interrupted for a short period to allow any possible tubal spasm to ease up. If the pain became intolerable, the examination was discontinued. Hard pressure felt during the injection of the air and fluid was regarded as a sign of muscle spasm. If this did not decrease in any measure and no air was seen to flow from the tube through the uterine-tubal junction, the tube was considered to be occluded.

The criteria for tubal patency using transvaginal salpingosonography were as follows: [1] The uterine-tubal junction must be visualized with either fast or slow flow; [2] flow must be seen in the tube, especially in its distal part where it fans out; and [3] a flow of air and fluid into the abdominal cavity should be seen around the ovary.

Laparoscopy was performed under general anesthesia. A Foley catheter was inserted into the uterine cavity and 1 to 2 mL of Methyl blue injected to test tubal patency during the laparoscopy.

Figure 4 Air bubbles escaping from the distal end of the right salpinx are visualized near the center of the figure below the right ovary (arrows) OV, ovary.

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Table 1 A Comparison Between Transvaginal Salpingosonography and Chromopertubation With Special Respect to Tubal Patency

<table>
<thead>
<tr>
<th>Findings of chromopertubation</th>
<th>Findings to transvaginal salpingosonography</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Not patent</td>
</tr>
<tr>
<td>Not patent</td>
<td>9</td>
</tr>
<tr>
<td>Patent</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>16</td>
</tr>
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one of unilateral hydrosalpinx. One patient had endometriotic cysts in both ovaries as well as myomas.

A detailed comparison between transvaginal salpingosonography and chromopertubation results is shown in Table 2. Bilateral tubal patency was found with chromopertubation in 22 patients. In one of these patients the result was unsure. Bilateral occlusion was found in three patients and unilateral patency was found in six patients. All in all, 50 tubes were patent, with slow flow in 7. In comparison with these results, the sensitivity of transvaginal salpingosonography in predicting tubal occlusion was 82% and its specificity in predicting tubal patency was 86%. There were seven false positive and two false negative results. The concordance of transvaginal salpingosonography with laparoscopic chromopertubation was 85%. Concordance is the accuracy with which the techniques agreed in their diagnosis. The positive predictive value was 56% and the negative predictive value was 96%.

At the date of submission of this article, two patients had conceived. One of these had shown unilateral tubal patency in laparoscopic chromopertubation and transvaginal salpingosonography and the other one showed bilateral tubal patency with both techniques.

DISCUSSION

According to the preliminary findings of this study there is a correlation of 85% between transvaginal salpingosonography and laparoscopic chromopertubation. Our results are similar to those reported earlier for both transvaginal salpingosonography and laparoscopic chromopertubation (3, 6–8). On the other hand, the results for correlation between HSG and chromopertubation have been reported to be approximately 75% (9) and between transvaginal salpingosonography and HSG to be approximately 69% (3).

A patent tube is easy to visualize with transvaginal salpingosonography whereas the reliable diagnosis of an occlusion is more difficult. Learning to differentiate between a real occlusion and a temporary spasm can be demanding and requires patience and experience. Technically, transvaginal salpingosonography is simple to perform when conditions are ideal. It should be performed in the follicular phase of the menstrual cycle for many reasons. A thick endometrium might disturb visibility and patency testing at the uterine-tubal junction. Also, the catheter may better remain in place in the cervical canal because of the smaller amount of mucous than during the secretory phase. The catheter must be thin, flexible, and also be of reasonable price. For the proper analysis of the uterine cavity, the catheter should be in the cervical canal. If the patient has had vaginal deliveries, this may be too loose in some cases for the catheter to remain in place. In such cases, the catheter should be inserted into the lower part of the uterine cavity and should be fixed well in place before starting, as the ultrasonic vaginal probe moves and pushes against the cervix during the examination.

There are some technical details that must be mastered for the proper execution of the transvaginal salpingosonography procedure. The uterus should not be too distant from the probe. The tube can be stretched straight by manipulating the uterus with the free hand and probe for a better view. In the ideal case, it is possible to follow the flow of air bubbles in the tube and to see free air and saline solution near the ovary in the abdominal cavity as a sure sign of tubal patency. In such cases, no further examination is required if the patient is otherwise healthy, i.e., endometriosis or other fertility-imparing disease is not suspected.

It is not always possible to scan the entire tube. The uterine-tubal junction often can be visualized, with fast or slow flow, but the rest of the tube cannot be seen fully because of distortion of the salpinx, for example, or an abnormal position of the uterus. In these cases, flow might be visible only in the distal part of the tube near the ovary or more air may be visible in that area than before. In such a situation, it can be inferred indirectly that the tube must be patent. In some cases high pressure was experienced when injecting the air and saline, while the patient prompted the procedure to be stopped.

Table 2 Unilateral or Bilateral Tubal Patency as Detected by Transvaginal Salpingosonography and Chromopertubation

<table>
<thead>
<tr>
<th>Findings</th>
<th>Transvaginal salpingosonography</th>
<th>Chromopertubation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bilateral tubal patency</td>
<td>17</td>
<td>22</td>
</tr>
<tr>
<td>Unilateral tubal patency</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>Bilateral tubal occlusion</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>31</td>
<td>31</td>
</tr>
</tbody>
</table>
complained of pain at the same time on one side. We
presumed that this is due to a muscle spasm. We
therefore discontinued the injection for a short pe-
period and waited. A spasm should pass in a minute
or two. If the pain continued, it was presumed to be
ocluded. In cases of bilateral occlusion, the patient
experienced much more pain than otherwise.

In this study we used air as a contrast medium
with good success. It is easy to use, and risks—such
as air embolism—are minimal. Air embolism theo-
retically may occur if a cannula is inserted acciden-
tially into a vein. The volume of air regarded as theo-
retically being required for a fatal embolism in sub-
clavian catheterization is approximately 150 to
250 mL (10). The amount of air used in this study
was only 10 to 20 mL and it is injected very slowly
during the examination. The endometrium is less
vascular in the follicular phase and the chances of
an IV injection occurring are therefore minimal,
which is a further reason to perform the transvagi-
nal salpingosonography procedure during this phase.
Combining the saline solution with air facilitates the
visualization and flow of air bubbles. Sometimes, the
uterine-tubal junction is difficult to visualize. In
such cases, it is very useful to inject a small am-
ount of saline solution after the air to help visualize the
correct area and to see if the air bubbles begin to
move forward. The maximum amount of saline used
is approximately 10 to 20 mL; this amount can be
injected safely without causing excessive pain to the
patient. The combination of air and saline as a con-
trast medium seems to be as useful and satisfactory
as Echovist (SHU 454; Schering AG, Berlin, Ger-
many), while the use of air and saline is much
cheaper. Also, Echovist is not available at present in
all countries.

Patients often complain that HSG is a painful and
unpleasant experience. In this study there were
seven patients who had undergone earlier HSG and
they all preferred the transvaginal salpingosonogra-
phy examination to HSG. If further studies were to
be necessary, they stated that they would prefer to
undergo transvaginal salpingosonography than HSG. It is not, however, a totally painless method.
Many patients are nervous about any form of exam-
ination connected with infertility and often are over-
excited. During the examination they often felt a
mild or moderate menstrual-like pain above their
symphysis, especially when the saline solution was
injected. We regarded this as being due to a contra-
tion of the uterine muscle wall and to the pressure
the fluid caused in the uterus cavity.

No infection was seen in this group after the pro-
dure. After transvaginal salpingosonography some
patients complained of pain or some other unpleas-
ant sensations in the right shoulder due to irritation
of the phrenic nerve either at the end of the proce-
dure or approximately 10 to 15 minutes later. This
indirectly can be regarded as a sign of tubal patency
as at least one tube therefore must be open.

Transvaginal salpingosonography has many in-
herent advantages. It does not require anesthesia in
any form and the risk of complications appears to be
minimal. If, however, a patient requires it, analgesic
medication such as IM pethidin hydrochloride or the
shorter-acting IV alfentanyle can be given before or
during the procedure to relieve pain. Transvaginal
salpingosonography generally can be performed
with no specific preparations and on an outpatient
basis. It provides immediate results and can be re-
dated easily. The long waiting lists and higher costs
associated with laparoscopic procedures also are re-
gated in most cases. If a patient has symptoms indi-
cative of endometriosis or she has had many pelvic
inflammatory diseases, which increase the incidence
of adhesions, a supplementary laparoscopy is essen-
tial, however, for the final diagnosis. Only laparo-
copy can identify the filmy peritubal or periovarian
adhesions that cannot be visualized with transvagi-
nal salpingosonography. In our material, adhesions
were found in approximately 29% of cases and endo-
metriosis also was found in 29% of cases. Thus, la-
paroscopy cannot be replaced totally by transvagi-
nal salpingosonography. If, however, the tubes prove
to be patent in transvaginal salpingosonography, the
patient has had no gynecological diseases such as
endometriosis or pelvic inflammatory diseases nor
gynecological operations, and the US findings of the
uterus and adnexes are normal, a laparoscopic pro-
cedure with chromoperturbation is not deemed to be
necessary. In light of our present findings, we pre-
sume that laparoscopy provides no additional infor-
mation on the etiology of infertility in these cases.
Therefore, suitability for laparoscopy can be deter-
mained largely according to the results obtained with
transvaginal salpingosonography. Laparoscopic chro-
momuperubation is approximately four times more ex-
ensive than transvaginal salpingosonography and
the time required for it is at least twice as much
is as required for transvaginal salpingosonography.
The recovery time from the procedure and anesthe-
sia is also at least 1 to 2 days, during which the
patient is unable to work.

In some cases, transvaginal salpingosonography
can be both a diagnostic and a therapeutic pro-
dure. In our study, two spontaneous pregnancies oc-
curred after the procedure. In one of these, unilat-
eral patency was found in both transvaginal salpin-
gosonography and chromoperturbation. Theo-
retically, there may have been some debris blocking
the tube, which was washed out of the salpinx after
rinsing with the saline solution. A fertility rate of
7.5% was reported in Volpi et al.'s previous studies (6/76 patients) (3).

In conclusion, transvaginal salpingosonography is a new, promising, low-cost, reliable, safe, and relatively painless method that can be used for the primary investigation of infertility on an outpatient basis. Complications are almost nonexistent and benign. A drawback is that the method requires some degree of experience in using transvaginal US and patients therefore must be referred to an experienced specialist. In the future, transvaginal salpingosonography may replace HSG but will not supplant totally the use of laparoscopic chromopertubation, which still seems to be the "gold standard" method in the assessment of tubal patency.

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