# Predictive value of sonohysterography in the assessment of uterine cavity in patients with uterine defects: a comparative study

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## ABSTRACT

***Objective:*** To compare between hysterosalpingorame, transvaginal Ultrasound, sonohysterography and hysteroscopy for assessment of uterine factor in sub fertile women.
Patients and methods: in a prospective comparative study a hundred of age-matched women with a history of sub fertility (primary or secondary) were recruited. For all women hysterosalpingorame, transvaginal ultrasound, sonohysterograghy and hysteroscopy were done.
***Results:*** Of the study group hysteroscopy diagnosed 70% as normal findings and 30% had uterine abnormalities that include endometrial polyps (9%), uterine anomaly (11%) and submucous myoma (10%) . while sonohysterograghy revealed 27 uterine abnormalities with an overall sensitivity, specificity and negative predictive value of 90%, 100%, and 95.8% respectively. Hysterosalpingography diagnosed 21 uterine abnormalities with an overall sensitivity, specificity and negative predictive value of 70%, 100% & 88.6% respectively. While transvaginal ultrasound examination revealed 89 cases of normal findings, and diagnosed 11 uterine abnormalities with an overall sensitivity, specificity and negative predictive value of 36.6%,100%,95.8% respectively.
***Conclusion:*** Sonohysterograghy is an easier, less expensive, safer and better tolerated alternative to diagnostic hysteroscopy for patients with uterine filling defects noted on HSG. It is highly sensitive and specific as high as the hysteroscopy. It can be used as a preliminary test for screening the patients who are candidate for operative hysteroscopy as normal sonohysterographic examination will not need further evaluation by office hysteroscopy.
***Key words:*** Sub fertility, uterine factor, sonohysterography, hysteroscopy.

## INTRODUCTION

Subfertility, defined as the inability to conceive despite regular unprotected sexual intercourse over 1–2 years, varies significantly in prevalence in different parts of the world. Causes including male factor, female (e.g. ovulatory disorder, tubal factor, adhesion or endometriosis, abnormalities in cervical mucus sperm interaction (cervical factor), Uterine abnormalities (uterine factor) or even unexplained factors 1.

Special investigative techniques for evaluating the uterus, tubes and pelvis have become increasingly popular among gynecologists. Initial evaluation of the infertile couples involves at first evaluation of the male factor which can be excluded by normal semen analysis while evaluation of the female factors involving assessment of ovulatory function ,evaluation of the normal pelvic structural anatomy and detection of tubal patency with finding out any structural abnormalities of the reproductive tract either congenital abnormalities as unicornuate uterus, bicornuate uterus , uterus didelphyse or septate uterus or acquired abnormalities as intra uterine adhesion or uterine fibroids 2.

There are various methods for evaluating the uterine cavity. Hysterosalpingography (HSG) is a widely used diagnostic tool. The overall risk of infection with HSG was reported to be <1%, but in a high-risk population infection can occur in 3% of cases. At present, ultrasonography is a basic diagnostic tool in the field of sub fertility. Sonohysterography (SHG), in which the uterine cavity is scanned while it is infused with sterile saline, is a new diagnostic tool for the detection of intracavitary abnormalities 3. Hysteroscopy is the 'gold standard' in the diagnosis of intrauterine pathologies 4. In unexplained sub fertility, hysteroscopy may be performed simultaneously with laparoscopy to evaluate the uterine cavity and cervix 5.

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## PATIENTS AND METHODS

This is a prospective comparative study performed at Suzan Mubarak Neonatal & Maternity Hospital, Department of Obstetrics and Gynecology, Menia University, Faculty of Medicine after approval of the ethical committee of the department from December 2006 up to December 2007 in which 100 women with primary or secondary sub fertility were recruited. Written consent was taken from all women after full explanation of the study procedure. This study was pre-approved by the ethics research committee at Suzan Mubarak neonatal & maternity University Hospital.

The inclusion criteria included all women in the reproductive period with primary or secondary subfertility and regular marital life ,normal semen analysis, normal ovulatory cycles evidenced by follicular monitoring or normal level of mid luteal serum progesterone. All women with Irregular marital life, husband with abnormal semen analysis, ovulatory dysfunction, or PID were excluded from the study. All women were subjected to detailed history taking; thorough general examination was done involving, abdominal and pelvic examination. For all women HSG, transvaginal sonohysterograghy (TVS) and Hysteroscopy were done.

HSG was done immediately in the first half of menstrual cycle In the Radiology Department of Menia University Hospital .All abnormalities were fully reported. TVS was performed by a single operator using a transvaginal probe with a 7.5 MHz transducer (MEDISON BW-128) after complete emptying of the urinary bladder. The uterus was imaged in three major scanning planes with transvaginal sonography. These include views in its long axis, an oblique semicoronal or semiaxial plane, and a short axis view. After taking measurements of endometrial thickness and length of the uterus and cervical canal, specific observations were made to ascertain the normality of the endometrium, myometrium and endometrial-myometrial interface. Any deviation in the uterine cavity shape, outline and echogenicity of the endometrium was imaged and recorded. Similar observations were made for the cervix and endocervical canal. Afterwards, SHG was performed with the patient in the dorsal lithotomy position. Under general anesthesia a forward oblique 30c, 4 mm hysteroscopy (Karle Storz Hysteroscopy) was performed.

## RESULTS

Table 1 shows patient's characteristic. The age of the studied group, one hundred patients ranged between 21 and 40 years old, with mean of 29.1±6.4 years. The parity ranged from 0 to 4, with mean of 2.2±1.4. The study included 55 women (55%) with primary subfertility, and 45 women (45%) with secondary subfertility. Table 2 shows the hysteroscopic findings of the studied patients. 70% had normal findings, and 30% had uterine abnormalities that include endometrial polyps (9%), uterine anomaly (11%) and submucous myoma (10%).They are distributed according to the type of subfertility. There was a significant increase in uterine abnormalities with secondary infertility when compared to primary infertility (53.4% vs. 11%). Table 3 shows distribution of the intrauterine pathologies according to the diagnostic methods and their comparison with hysteroscopic findings. Transvaginal ultrasonography alone was able to detect eleven intrauterine lesions (36.6%). HSG was able to detect more of these lesions (70%). On the other hand, except for three endometrial polyps, all intrauterine pathologies (90%) were detected by sonohysterography. Table 4 shows true and false positive and negative diagnostic values obtained by different methods for diagnosis of uterine abnormalities. There were no false positive results obtained by any method on diagnosis of any uterine abnormality. Table 5 shows shows statistical analysis of the methods with respect to their diagnostic capabilities of endometrial polyps (the gold standard is hysteroscopy). Sonohysterography had the highest sensitivity (66.7%) and had specificity of 100%, positive predictive value of 100% and negative predictive value of 91.3%. Table 6 shows statistical analysis of the methods with respect to their diagnostic capabilities of uterine anomaly (the gold standard is hysteroscopy). Sonohysterography had the highest sensitivity (100%) and had specificity of 100%, positive predictive value of 100% and negative predictive value of 100%. Table 7 shows statistical analysis of the methods with respect to their diagnostic capabilities of submucous myoma (the gold standard is hysteroscopy). Sonohysterography had the highest sensitivity (100%) and had specificity of 100%, positive predictive value of 100% and negative predictive value of 100%.

Table 1: Patient's characteristics & type of subfertility.

| Patient's characteristics | Range or No. (N=100) | Mean ±SD or % |
|---|---|---|
| Age | 21-40 | 29.1±6.4 |
| Parity | 0-4 | 2.2±1.4 |
| Type of subfertility | | |
| Primary | 55 | 55% |
| Secondary | 45 | 45% |

Table 2: Hysteroscopic findings according to the type of subfertility

| Hysteroscopic findings | Primary subfertility (N=55) | Secondary subfertility (N=45) | P-value |
|---|---|---|---|
| Normal | 49 (89%) | 21 (46.6%) | 0.0001** |
| Abnormal | 6 (11%) | 24 (53.4%) | 0.0001** |
| Endometrial polyp | 2 (3.6%) | 7 (15.5%) | 0.04* |
| Uterine anomaly | 2 (3.6%) | 9 (20%) | 0.01* |
| Submucous myoma | 2 (3.6%) | 8 (17.7%) | 0.02* |

Table 3 Distribution of the intrauterine pathologies according to the diagnostic methods and their comparison with Hysteroscopic findings.

| Method | Endometrial polyp | Uterine anomaly | Submucous myoma | Total (%) |
|---|---|---|---|---|
| TVS | 3 | 5 | 3 | 11 (36.6%) |
| HSG | 3 | 10 | 8 | 21 (70%) |
| SHG | 6 | 11 | 10 | 27 (90%) |
| Hysteroscopy | 9 | 11 | 10 | 30 (100%) |

Table 4 True and false positive and negative diagnostic values obtained by different methods for diagnosis of uterine abnormalities (the gold standard is hysteroscopy.

| Uterine abnormality | No. | Method | True positive | False positive | True negative | False negative |
|---|---|---|---|---|---|---|
| All abnormalities | 30 | TVS | 11 | 0 | 70 | 19 |
| | | HSG | 21 | 0 | 70 | 9 |
| | | SHG | 27 | 0 | 70 | 3 |
| Endometrial polyp | 9 | TVS | 3 | 0 | 21 | 6 |
| | | HSG | 3 | 0 | 21 | 6 |
| | | SHG | 6 | 0 | 21 | 3 |
| Uterine anomaly | 11 | TVS | 5 | 0 | 19 | 6 |
| | | HSG | 10 | 0 | 19 | 1 |
| | | SHG | 11 | 0 | 19 | 0 |
| Submucous myoma | 10 | TVS | 3 | 0 | 20 | 7 |
| | | HSG | 8 | 0 | 20 | 2 |
| | | SHG | 10 | 0 | 20 | 0 |

Table 5 Statistical analysis of the methods with respect to their diagnostic capabilities of endometrial polyps (the gold standard is hysteroscopy).

| Method | Sensitivity | Specificity | Positive predictive value | Negative predictive value |
|---|---|---|---|---|
| TVS | 33.3% | 100% | 100% | 77.7% |
| HSG | 33.3% | 100% | 100% | 77.7% |
| SHG | 66.7% | 100% | 100% | 91.3% |

Table 6 Statistical analysis of the methods with respect to their diagnostic capabilities of uterine anomaly (the gold standard is hysteroscopy).

| Method | Sensitivity | Specificity | Positive predictive value | Negative predictive value |
|---|---|---|---|---|
| TVS | 45.4% | 100% | 100% | 76% |
| HSG | 90.9% | 100% | 100% | 95% |
| SHG | 100% | 100% | 100% | 100% |

Table 7 Statistical analysis of the methods with respect to their diagnostic capabilities of submucous myoma (the gold standard is hysteroscopy).

| Method | Sensitivity | Specificity | Positive predictive value | Negative predictive value |
|---|---|---|---|---|
| TVS | 30% | 100% | 100% | 74% |
| HSG | 80% | 100% | 100% | 90.9% |
| SHG | 100% | 100% | 100% | 100% |

## DISCUSSION

Uterine cavity abnormalities can be the cause of subfertility in 10-15% of women; abnormal uterine findings occur in approximately 50% of infertile women 1. This high prevalence of uterine abnormalities, make inspection of the uterine cavity is a routine work in the evaluation of infertile women 2.

Transvaginal ultrasonography (TVS) is safe, noninvasive, and readily available tool in the office setting. Findings on TVS that have been used to describe uterine findings e.g. myometrial involvement, endometrial thickness, heterogeneity, cavitary lesions, and determine which patients should undergo further investigation. Despite the increased use of high-resolution abdominal and TVS, they have limited usefulness in evaluating the exact location of endometrial cavity pathology 6. Moreover, the usefulness of endometrial thickness is predicated on visualization of a clear longitudinal stripe of endometrium. This may be challenging in cases of endometrial distortion resulting from uterine fibroids or abnormal uterine angulation 7.

Hysterosalpingography (HSG) is the most commonly used technique in the evaluation of subfertility. It is recommended for the study of the uterine cavity in the diagnosis of and treatment planning for other gynecologic problems such as intrauterine adhesions and congenital anomalies. Endometrial lesions are shown as filling defects or uterine wall irregularities. HSG also enables visualization of the general configuration of the cavity. Disadvantages of HSG include pelvic exposure to radiation, use of iodinated contrast medium, and patient discomfort 7.

It is associated with considerable false-positive findings for both tubal patency and uterine cavity abnormalities 8. Furthermore, HSG often cannot differentiate myomas from polyps or various mullerian anomalies 9. The sonohysterography (SHG) was provided to describe the instillation of saline into the uterine cavity during ultrasound. Saline infusion sonography (SIS) has also been used to describe this procedure. This procedure has some major advantages over HSG, including simplicity, cost, minimal invasiveness, absence of ionizing radiation, and a high level of diagnostic accuracy 3 in detection of possible intracavitary defects, including polyps, submucosal leiomyoma(s), and endometrial carcinoma 10.

Hysteroscopy has increasingly been gaining acceptance and is today a necessary tool in the investigation of female subfertility. It permits direct visualization of the cervical canal and the uterine cavity, enabling observation of the shape and vascular pattern of any abnormality. It also permits direct biopsy of lesions. Hysteroscopy is an office procedure performed without local or general anesthetic and causes minimal discomfort to the patient 7 .

Hysteroscopy has traditionally been performed as an adjunct tool to evaluate abnormalities suspected as a result of HSG evaluation. Recent studies have shown increased benefit from combining diagnostic hysteroscopy and HSG in the evaluation of female subfertility 11. The accuracy of hysteroscopy, SHG, HSG and transvaginal ultrasound in the diagnosis of uterine cavity abnormalities in infertile women has been compared in various studies 7, 9, 12, 14, 16, 17, 18, 19. In our study we evaluated the diagnostic accuracy of transvaginal ultrasound, HSG, SHG and hysteroscopy in uterine cavity diseases in infertile women, with hysteroscopy considered the gold standard.

In the present study, TVS alone was able to detect eleven intrauterine lesions (36.6%) while HSG was able to detect more of these lesions (70%). On the other hand, SHG was able to detect 90% of intrauterine pathologies. SHG had the highest sensitivity and negative predictive values for diagnosis of all uterine abnormalities 90% and 95.8%, respectively) than HSG (70% and 88.6%), and TVS (36.6% and 78.6%, respectively).

In agreements with our results ,a previous study by Alatas et al. ,in which TVS, SHG, HSG and finally hysteroscopy were performed in 37 patients with primary and 25 patients with secondary subfertility. Suspected uterine anomalies were also confirmed by laparoscopy. TVS was able to detect 36.3 % while HSG was able to detect 72.7% of uterine pathologies. SHG was able to detect all the anomalies except for a single endometrial polyp (90.3%). However, there was no significant difference between the diagnostic capabilities of these methods 12.

In another study in which the researchers assessed the value of SHG in evaluating both the uterine cavity and tubal patency in 84 infertile women and to compare its results with HSG, diagnostic hysteroscopy and laparoscopic chromo-pertubation. As regards the appearance of the endometrial cavity, the results of SHG agreed with hysteroscopy in 72.2% while HSG agreed with hysteroscopy in 75.6% of cases. They concluded that SHG is similar to HSG as regards the appearance of the endometrial cavity but it is inferior to it for evaluating tubal factor 13.

Gronlund et al assessed the diagnostic value of SHG in the evaluation of Sixty-six women (41 with metrorrhagia, 20 with subfertility and five with habitual abortion) .Hysteroscopy was taken as the standard. The overall sensitivity and specificity for SHG was 90.9% and 100%, respectively. The positive and negative predictive values were 100% and 90%, respectively. When examining the metrorrhagia and subfertility groups separately the sensitivity and specificity and predictive values were found to be 88.5%, 100%, 100% and 76.9% (metrorrhagia) and 100% for all parameters in cases of subfertility. No complications were recorded during the procedures. Therefore, those authors concluded that SHG is a simple, fast, well tolerated and accurate method to evaluate the uterine cavity in patients with metrorrhagia or subfertility 14 .

In a prospective study for the evaluation of uterine and tubal pathologies evaluating the diagnostic accuracy of HSG and sonohysterosalpingography in detecting tubal and uterine abnormalities. With surgical findings as the gold standard, sonohysterosalpingography had a sensitivity of 78.2%, a specificity of 93.1%, a positive predictive value of 82.7%, and a negative predictive value of 91%.

For total tubal and uterine pathologies, the findings for the same parameters using HSG were 76.3%, 81.8%, 90.9%, and 59.2%, respectively 15.

HSG versus hysteroscopy in the detection of intrauterine abnormality in Seventy-eight infertile women showed a sensitivity of 81.2% compared with that of hysteroscopy and a specificity of 80.4%, with a positive predictive value of 63.4% and a negative predictive value of 83.7% 7.

Ragni et al. evaluated the accuracy of TVS, SHG compared to hysteroscopy in the diagnosis of intrauterine pathology in a population of infertile patients. The TVS sensitivity and specificity compared with hysteroscopy were 91 and 83% respectively. Using TVS, a 9.2% false positive rate (9 cases) and a 5.1% false negative rate (5 cases) were detected compared to hysteroscopy. The TVS PPV and NPV were 85.4 and 90% respectively. SHG yielded better results: sensitivity and specificity when compared to hysteroscopy were 98 and 94% respectively. The SHG PPV and NPV were 95 and 98% respectively 17.

In the detection of intrauterine pathologies in infertile women Bartkowiak et al. evaluated the diagnostic accuracy of saline infusion SHG .The findings were compared to the results of two widely used procedures: TVS and hysteroscopy. Intrauterine pathologies were diagnosed in 25% of patients. TVS detected 6 (37.5%) and SHG revealed 11 (87.5%) of 13 intrauterine pathologies finally visualized at diagnostic hysteroscopy 18.

In the present study, SHG had sensitivity, specificity and predictive values of 100% in the evaluation of intrauterine anomalies and submucous myomas when compared to hysteroscopy. We observed endometrial polyps and submucous myoma as protrusions into the saline-filled intrauterine cavity under sonohysterographic imaging. An endometrial polyp was detected as a sessile, homogeneous echogenicity without distortion of the endometrial–myometrial junction.

Because a submucous myoma originates from the myometrium, the integrity of the uterine wall and the relationship of the lesion to the endometrial floor (sessile or pedunculate) were easily determined. These details were very useful during hysteroscopic surgical management of the lesions. In mullerian anomalies, SHG has the advantage of evaluating both the interior and exterior surfaces of the uterus at the same time. In this way, it is easier to distinguish between septate and bicornuate uteri. In cases of septate uteri, the thickness of the septum and its relationship to fundal myometrium can be measured. These details are useful while performing hysteroscopic metroplasty.

Regarding these findings concerning the diagnostic value of SHG over the other methods (TVS and HSG) in diagnosing of endometrial polyps, uterine anomalies and submucous myoma, similar results to the present study were obtained by 12, 17,18, 20, 21.

Kamel et al. compared the diagnostic accuracy of TVS and vaginal SHG in detecting endometrial polyps. TVS resulted in false positive and false negative rates of 25% and 36.2% respectively while For SHG were 5.4% and 8% respectively. Combining both techniques further improved such rates to 2.9% and 2.8% respectively but not significantly. The sensitivity and specificity were 64.5%, 75.5% for TVS, and 93.1%, 93.9% for SHG. In the present study, the sensitivity and specificity for endometrial polyps were 66.7% and 100% with SHG and 33.3% and 100% with HSG and TVS 21.

The advantage of SHG for the diagnosis and location of submucous myomas and focal endometrial lesions was confirmed by Becker et al. who assessed whether SHG provides added diagnostic value over TVS in patients with suspected or known myomas by comparing diagnostic confidence, interobserver agreement, accuracy, and change in diagnoses when 2 independent observers interpreted TVS alone and later interpreted TVS and SHG together. The added information provided by SHG resulted in improved diagnostic confidence for most parameters. Sensitivity values for submucous myomas and focal endometrial lesions were 100% and 90% for TVS and SHG together and 100% and 70% for transvaginal sonography alone 22.

Nass Duce et al. evaluated the diagnostic value of SHG in the evaluation of submucosal fibroids and endometrial polyps. The findings were then compared with histopathological results. The sonohysterographic diagnosis was fibroid in seven patients, endometrial polyp in 23 patients and simple hyperplasia in two patients. Histopathological findings confirmed diagnosis in all except three patients with endometrial polyps, who had normal secretory endometrium 23.

In the study by Bartkowiak et al., transvaginal ultrasound failed to visualize three submucous myomas, one endometrial polyp and two cases of septate uteri. One submucous myoma and one endometrial polyp were not identified with SHG [18]. Therefore, the most important advantage of SHG over HSG, TVS and hysteroscopy is the ability to visualize both the uterine cavity and the myometrium by a single technique. SHG can ameliorate the surgical approach to myomas defining the intramural and submucous extension of a myoma 17. Furthermore, Alatas et al. and Goldstein et al. confirmed that SHG could also better define a congenital abnormality, suggesting the diagnosis of the type of alteration (e.g., differentiating a septate uterus from a bicornuate uterus), and it also allows for the simultaneous detection of ovarian abnormalities 3, 12, 24, 25.

An expected complication of SHG is the possibility of intracavitary infection. To avoid such complications in the present study, patients with mucopurulant discharge were excluded from the study group. The patients who remained in the study group did not receive prophylactic antibiotics because al procedures were performed under totally aseptic conditions. None of the patients developed an infectious complication. The risk of a postprocedural infection should be accepted as similar to that involved in traditional intrauterine manipulations, i.e. HSG. In addition, the procedure was painless and well tolerated in every case.

Overall, the present study was in agreement with other studies in the literature which clarified that SHG was a test that could be easily learnt by expert transvaginal ultrasonographists. SHG was performed in a very short time and no adverse events were experienced. Moreover, patient's discomfort is practically absent, compared to hysteroscopy. We therefore propose that a patient showing a normal uterine cavity at SHG might not require any further evaluation, avoiding an unnecessary diagnostic hysteroscopy. Hysteroscopy could be performed in doubtful diagnosis cases or when a biopsy and a histological evaluation are needed.

Therefore, in experienced hands, SHG is an easy, safe, and well-tolerated alternative to diagnostic hysteroscopy in the initial evaluation of uterine cavity infertile women. We recommend the routine use of SHG in the diagnosis of uterine cavity of infertile patients, reserving hysteroscopy only in selected cases.

From this study the authors concluded that sonohysterograghy is an easier, less expensive, safer and better tolerated alternative to diagnostic hysteroscopy for patients with uterine filling defects. It is highly sensitive and specific as high as the hysteroscopy. It can be used as a preliminary test for screening the patients who are candidate for operative hysteroscopy as normal sonohysterographic examination will not need further evaluation by office hysteroscopy. However, SHG can't completely substitute HSG as HSG provide a good visualization of the tubes and its patency; it can suspect presence or absence of pelvic adhesions which may be taken as an important cause of sub fertility.

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## REFERENCES


1. Lee A, Ying YK, Novy MJ. 1997 Hysteroscopy, hysterosalpingography and tubal ostial polyps in subfertility patients. J Reprod Med 42(6):337-41.
2. Loverro G, Nappi L, Vicino M, Carriero C, Vimercati A, Selvaggi L. 2001 Uterine cavity assessment in infertile women: comparison of transvaginal sonography and hysteroscopy. Euro J Obstet Gynecol Reprod Biol 10; 100(1):67-71
3. Parsons AK, Lense JJ. 1993 Sonohysterography for endometrial abnormalities: preliminary results. J Clin Ultrasound. 21(2):87-95.
4. Gillespie A, Nichols A. 1994 The value of hysteroscopy. The Aust NZ J Obstet Gyn 34(1):85-7.
5. Balmaceda JP, Ciuffardi I. 1995 Hysteroscopy and assisted reproductive technology. Obstet Gynecol Clin North America 22(3):507-18.
6. Laifer-Narin SL, Ragavendra N, Lu DS, Sayre J, Perrella RR, Grant EG. 1999 Transvaginal saline hysterosonography: characteristics distinguishing malignant and various benign conditions. The Aust NZ J Obstet Gyn 172(6):1513-20.
7. Roma A, Ubeda B, Nin Garaizabal P. 2007 [Hysterosalpingography: how, when, what for?]. Radiologia 49(1):5-18.
8. Valle JA, Lifchez AS. 1983 Reproductive outcome following conservative surgery for tubal pregnancy in women with a single fallopian tube. Fertil Steril 39(3):316-20.
9. Soares SR, Barbosa dos Reis MM, Camargos AF. 2000 Diagnostic accuracy of sonohysterography, transvaginal sonography, and hysterosalpingography in patients with uterine cavity diseases. Fertil Steril 73(2):406-11.
10. Wegienka G, Baird DD, Hertz-Picciotto I, Harlow SD, Steege JF, Hill MC. 2003 Self-reported heavy bleeding associated with uterine leiomyomata. Obstet Gynecol 101(3):431-7.
11. Brown SE, Coddington CC, Schnorr J, Toner JP, Gibbons W, Oehninger S. 2000 Evaluation of outpatient hysteroscopy, saline infusion hysterosonography, and hysterosalpingography in infertile women: a prospective, randomized study. Fertil Steril 74(5):1029-34.
12. Gora RW, Bartkowiak W, Roszak S, Leszczynski J. 2004 Intermolecular interactions in solution: elucidating the influence of the solvent. J Chem Physics 120(6):2802-13.
13. Darwish AM, Youssef AA. 1999 Screening sonohysterography in subfertility. Gynecol Obstetric Invest 48(1):43-7.
14. Gronlund L, Hertz J, Helm P, Colov NP. 1999 Transvaginal sonohysterography and hysteroscopy in the evaluation of female subfertility, habitual abortion or metrorrhagia. A comparative study. Acta Obstet Gynecol Scand 78(5):415-8.
15. Alborzi S, Dehbashi S, Khodaee R. 2003 Sonohysterosalpingographic screening for infertile patients. Intern J Gynecol Obstet 82(1):57-62.
16. Lindheim SR, Adsuar N, Kushner DM, Pritts EA, Olive DL. 2003 Sonohysterography: a valuable tool in evaluating the female pelvis. Obstet Gynecol Survey 58(11):770-84.
17. Ragni G, Diaferia D, Vegetti W, Colombo M, Arnoldi M, Crosignani PG. 2005 Effectiveness of sonohysterography in infertile patient work-up: a comparison with transvaginal ultrasonography and hysteroscopy. Gynecol Obstet Invest 2005; 59(4):184-8.
18. Bartkowiak R, Kaminski P, Wielgos M, Bobrowska K. 2006 The evaluation of uterine cavity with saline infusion sonohysterography and hysteroscopy in infertile patients. Neuroendocrinol letters 27(4):523-8.
19. Valenzano MM, Mistrangelo E, Lijoi D, Fortunato T, Lantieri PB, Risso D. 2006 Transvaginal sonohysterographic evaluation of uterine malformations. Euro J Obstet Gynecol Reprod Biol 124(2):246-9.
20. Cicinelli E, Romano F, Anastasio PS, Blasi N, Parisi C, Galantino P. 1995 Transabdominal sonohysterography, transvaginal sonography, and hysteroscopy in the evaluation of submucous myomas. Obstet Gynecol 85(1):42-7.
21. Kamel HS, Darwish AM, Mohamed SA. 2000 Comparison of transvaginal ultrasonography and vaginal sonohysterography in the detection of endometrial polyps. Acta Obstet Gynecol Scand 79(1):60-4.
22. Becker E, Lev-Toaff AS, Kaufman EP, Halpern EJ, Edelweiss MI, Kurtz AB. 2002 The added value of transvaginal sonohysterography over transvaginal sonography alone in women with known or suspected leiomyoma. J Ultrasound Med 21(3):237-47.
23. Nass Duce M, Oz U, Ozer C, Yildiz A, Apaydin FD, Cil F. 2003 Diagnostic value of sonohysterography in the evaluation of submucosal fibroids and endometrial polyps. The The Aust NZ J Obstet Gyn 43(6):448-52.
24. Alatas C, Aksoy E, Akarsu C, Yakin K, Aksoy S, Hayran M. Evaluation of intrauterine abnormalities in infertile patients by sonohysterography. Hum Reprod 12(3):487-90.
25. Goldstein SR. The routine use of ultrasound in the gynecological visit. Ultrasound Obstet Gynecol 8(6):369-70.