



## การเปรียบเทียบความแม่นยำในการวินิจฉัยภาวะมีบุตรยากในผู้หญิง ระหว่างการตรวจ Hysterosalpingography กับ การทำ Hysteroscopy ร่วมกับ Laparoscopy

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## Diagnostic Accuracy of Hysterosalpingography Compared with Hysteroscopy and Laparoscopy for Female Infertility

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### บทคัดย่อ

**หลักการและวัตถุประสงค์:** ความผิดปกติทางกายวิภาค เป็นสาเหตุหลักของการเกิดภาวะมีบุตรยากในเพศหญิง ซึ่งอาจเป็นตั้งแต่กำเนิดหรือเกิดขึ้นในภายหลัง การตรวจ Hysterosalpingography (HSG) มักถูกใช้เป็นการตรวจเบื้องต้นในการตรวจกายวิภาคของปีกมดลูกและโพรงมดลูก การศึกษานี้มีวัตถุประสงค์เพื่อประเมินความแม่นยำของการตรวจ HSG ในเพศหญิงที่เกิดภาวะมีบุตรยาก โดยเปรียบเทียบกับความผิดปกติในโพรงมดลูกที่เห็นได้จาก hysteroscopy ร่วมกับปีกมดลูกที่เห็นได้จาก laparoscopy

**วิธีการศึกษา:** เป็นการศึกษาย้อนหลัง ในผู้ป่วยที่ได้รับการตรวจ HSG เพื่อหาสาเหตุของภาวะมีบุตรยาก จำนวน 515 ราย ระหว่างเดือน มกราคม 2561 ถึงเดือนธันวาคม 2563 ในจำนวนนี้มีผู้ได้รับการทำ hysteroscopy จำนวน 26 ราย และ laparoscopy จำนวน 19 ราย

**ผลการศึกษา:** การตรวจ HSG มีความไวและความจำเพาะในการตรวจหาการตีบภายในปีกมดลูกเท่ากับร้อยละ 89 และ 70 น้ำคั่งในปีกมดลูกเท่ากับร้อยละ 100 และ 70 และความผิดปกติภายในโพรงมดลูกเท่ากับร้อยละ 74 และ 43 ความแม่นยำในการตรวจความผิดปกติที่ปากมดลูกอยู่ในระดับต่ำมาก โดยมีค่าความไวเพียงร้อยละ 0

**สรุป:** การตรวจหาความผิดปกติภายในมดลูกและปากมดลูกของผู้ป่วยที่เกิดภาวะมีบุตรยาก หลังจากตรวจด้วย HSG แล้ว ควรทำ laparoscopy หรือ hysteroscopy ในผู้ป่วยทุกราย

**คำสำคัญ:** ภาวะมีบุตรยาก, เพศหญิง, ส่องกล้อง

### Abstract

**Background and Objective:** The main anatomical cause of female infertility is congenital or acquired abnormalities. Hysterosalpingography (HSG) is a non-invasive procedure commonly used for the initial evaluation of the fallopian tubes and uterine cavity, especially for female infertility. This study aimed to evaluate the diagnostic accuracy of HSG in infertile women by comparing the findings of intrauterine abnormality with hysteroscopy and patency of fallopian tubes with diagnostic laparoscopy.

**Methods:** A retrospective study from January 2018 to December 2020, among 515 women who underwent HSG, 26 patients had performed hysteroscopy and 19 patients had undergone laparoscopy for infertility.

**Results:** The sensitivity and specificity of HSG to detect abnormal tubal patency were 89% and 70%, hydrosalpinx were 100% and 70%, intrauterine abnormality were 74% and 43%. However, the diagnostic accuracy of HSG to detect cervical abnormality was rather poor with the sensitivity of 0%.

**Conclusion:** In addition to HSG, laparoscopy, hysteroscopy, should be performed for every female infertility case.

**Keywords:** infertility, female, hysterosalpingography, hysteroscopy, laparoscopy

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## Introduction

World Health Organization (WHO) defines infertility as the failure to achieve a clinical pregnancy after 12 months or more of regular unprotected sexual intercourse<sup>1</sup>. According to global estimates of the prevalence of and trends in infertility of 190 countries, the absolute number of couples affected by infertility increased from 42.0 million in 1990 to 48.5 million in 2010<sup>2</sup>. The possible causes of female infertility are numerous and fallopian tube abnormalities are the most common cause<sup>3</sup>. Hysterosalpingography (HSG) is a noninvasive radiographic procedure to evaluate fallopian tubes and uterine cavity<sup>4</sup>. It also remains as the best modality to image fallopian tubes. Many abnormalities can be seen by HSG such as Mullerian duct anomalies, tubal occlusion, hydrosalpinx, peritubal abnormalities and intrauterine filling defects. Thus, HSG is an important measure for primary diagnostic assessment to determine the next step of management for female infertility<sup>5</sup>.

The purpose of this study is to evaluate the diagnostic accuracy of HSG in comparison with hysteroscopy and laparoscopy to detect tubal, intrauterine, and cervical abnormalities of infertile women.

## Methods

The Ethics Committee for Human Research of our institute approved this study. From January 2018 to December 2020, 515 women underwent HSG, 45 were eligible for this study; 26 underwent hysteroscopy due to suspicion of intrauterine abnormalities and 19 had pelvic laparoscopy due to bilateral tubal obstruction.

The HSG performed with fluoroscopic technique in supine position for at least four images including preliminary frontal view, early contrast filling, maximal opacification of the uterine cavity, and full opacification of fallopian tubes. A visible intraperitoneal contrast spillage proved the tubal patency. The hydrosalpinx showed visual inspection of abnormal tubal dilatation. The intrauterine and cervical abnormalities were defined as filling defect or abnormal contour. We excluded cases that failed to insert catheter through cervix resulting in lack of contrast opacification within the reproductive tract or inadequate study that has less than four images as mentioned above. Two radiologists evaluated the HSG films without any clinical data. Any discrepancy was concluded by consensus. The laparoscopy and hysteroscopy were performed by gynecologists in the infertility clinic of the Department of Obstetrics and Gynecology. The intraoperative findings of laparoscopy with methylene blue injection for tubal status and findings of hysteroscopy

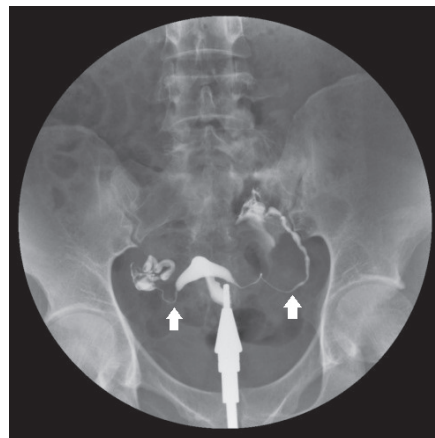
for intrauterine and cervical abnormalities were respectively reviewed.

The performance of the diagnostic test was summarized by accuracy, sensitivity, specificity, positive predictive and negative predictive values with 95% confidence interval. All statistical analyses were performed using STATA statistical software version 10 (StataCorp, College Station, TX).

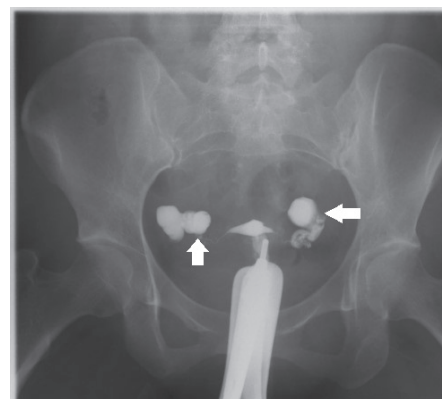
## Results

Forty-five cases with the problem of infertility were included in this study; 26 cases compared HSG with hysteroscopy, and 19 cases compared with laparoscopy. The mean age was 35.6 years (range 24-43).

Primary infertility was more frequent than secondary infertility (31 VS 14 cases). The mean BMI was 22.3 (SD 3.39). The mean interval between HSG and endoscopy (laparoscopy or hysteroscopy) was 7.2 months (SD 4.58). The HSG showed bilateral tubal patency in Figure 1, and bilateral hydrosalpinx in Figure 2.



**Figure 1** HSG showed bilateral tubal patency (arrows), the result was confirmed by laparoscopy.



**Figure 2** HSG demonstrated bilateral hydrosalpinx (arrows), the result was confirmed by laparoscopy.

**Comparison of HSG and laparoscopy**

Among 19 cases underwent HSG followed by laparoscopy, the results of HSG for tubal patency were; 8 (42.1%) bilateral tubal patency, 5 (26.3%) unilateral tubal patency, and 6 (31.6 %) no patency. By laparoscopy, 10 out of 19 cases were diagnosed as bilateral tubal patency. For those 10 cases, HSG diagnosis were 7 cases of bilateral tubal patency, 1 case of unilateral tubal patency and 2 cases of bilateral tubal occlusion. The sensitivity and specificity of HSG on bilateral tubal patency or no patency were 88.9% (95%CI; 51.75-99.72) and 70.0% (95%CI; 34.8-93.3). The positive predictive value and negative value were 72.7% (95%CI; 50.16-87.60)

and 87.5% (95%CI; 51.35-97.89) (Table 1). The results of hydrosalpinx detected by HSG showed 6 cases each of bilateral and unilateral hydrosalpinx and 7 cases of no hydrosalpinx. In contrast, the gold standard laparoscopy revealed 8 cases of bilateral hydrosalpinx, 1 case of unilateral hydrosalpinx and 10 cases of no hydrosalpinx. The sensitivity and specificity of HSG on hydrosalpinx detection (either unilateral or bilateral hydrosalpinx) were 100% (95%CI; 66.4-100.0) and 70.0% (95%CI; 34.8-93.3). The positive predictive value and negative value were 75.0% (95%CI; 53.8-88.6) and 100.0% (95%CI; 59.0-100.0) (Table 2).

**Table 1.1** Diagnostic performance of HSG compared with laparoscopy in tubal patency and no patency.

	Bilateral or unilateral tubal occlusion	Bilateral tubal patency	Total, No.
Bilateral or unilateral tubal occlusion	8	3	11
Bilateral tubal patency	1	7	8
Total, No.	9	10	19

**Table 1.2** Diagnostic performance of HSG compared with laparoscopy in tubal patency and no patency.

	Unilateral or bilateral hydrosalpinx	No hydrosalpinx	Total, No.
Unilateral or bilateral hydrosalpinx	9	3	12
No hydrosalpinx	0	7	7
Total	9	10	19

**Table 2** Diagnostic performance of HSG compared with Laparoscopy in hydrosalpinx detection.

HSG Diagnostic for	Sensitivity (95%CI)	Specificity (95%CI)	PPV (95%CI)	NPV (95%CI)
Tubal occlusion	88.9 (51.8-99.7)	70.0 (34.8-93.3)	72.7 (50.2-87.6)	87.5 (51.4-97.9)
Hydrosalpinx	100.0 (66.4-100.0)	70.0 (34.8-93.3)	75.0 (53.8-88.6)	100.0 (59.0-100.0)

**Comparison of HSG and hysteroscopy.**

The results of HSG for cervical findings were; 11 cases of cervical stenosis and 15 cases of normal cervix. In contrast, hysteroscopy showed 1 case of cervical polyp and 25 cases of normal cervix (Table 3). Thus, the sensitivity and specificity of HSG on cervical findings are 0% (95%CI; 0-97.50) and 56% (95%CI; 34.9-75.6). The positive predictive value (PPV) and negative value (NPV)

were 0% (95%CI; 0-28.5) and 93.3% (95%CI; 68.1-99.8) (Table 4).

The comparative results of intrauterine findings detected by HSG and hysteroscopy were true positive and true negative in 14 cases (53.85%) and 3 cases (11.54%), and false positive and false negative in 4 cases (15.38%) and 5 cases (19.23%) (Table 5).

**Table 3.1** Cervical findings detected by HSG and hysteroscopy.

Hysterosalpingography (Cervical findings)	Normal	Hysteroscopy Abnormal	Total
Normal	14	1	15
Abnormal	11	0	11
Total	25	1	26

**Table 3.2** Intrauterine findings detected by HSG and hysteroscopy.

Hysterosalpingography (Intrauterine findings)	Abnormal	Hysteroscopy Normal	Total
Abnormal	14	4	8
Normal	5	3	18
Total, No.	7	19	26

**Table 4** Diagnostic performance of HSG compared with hysteroscopy to detect cervical and intrauterine abnormality.

	Sensitivity % (95% CI)	Specificity % (95% CI)	PPV % (95% CI)	NPV % (95% CI)
Cervical abnormality	0 (0-97.5)	56 (34.9-75.6)	0 (0-28.5)	93.3 (68.1-99.8)
Intrauterine abnormality	73.7 (48.8-90.9)	42.9 (9.9-81.6)	77.8 (52.4-93.6)	37.5 (8.52-75.5)

TPR: true positive rate, FPR: false positive rate, FNR: false negative rate, TNR: true negative rate

## Discussion

Female infertility is a common problem of reproductive-age women. For pregnancy, women need functioning ovaries, fallopian tubes and a uterus. Any problems with these organs may lead to female infertility. The clinician will perform a basic evaluation with a history, physical examination and then non-invasive investigations including tubal evaluation, seminal analysis, and ovarian reserve testing<sup>6</sup>. HSG is a radiographic procedure of reproductive tract commonly used for initial evaluation of the uterus and fallopian tubes. Under fluoroscopic examination, the radiologist inserts a catheter and pushes the contrast material into the uterus through cervix and observes the cervical canal, intrauterine morphology, contour, diameter, and the patency of fallopian tubes. This procedure is less invasive than laparoscopy or hysteroscopy<sup>7</sup>. Laparoscopy is the pelvic endoscopic procedure considered as the gold standard for tubal evaluation, and hysteroscopy is a good procedure for direct visualization of the uterine cavity<sup>8,9</sup>.

Both congenital and acquired uterine abnormalities

are significant causes the infertility. The congenital abnormalities are referred to Mullerian anomalies, such as septate uterus, bicornuate uterus, etc. The acquired abnormalities occurred after birth resulting the stenosis or distortion of the intrauterine structures, such as endometrial polyps, intrauterine adhesions, uterine fibroids, etc.

### Comparison of HSG and laparoscopy.

We found high sensitivity and high specificity of HSG to detect tubal occlusion. The false positive rate was 15.8% and the false negative rate was pretty low. Our results were comparable with the study of Rizvi et al. with the sensitivity of 90.9% (95%CI; 76.43-96.86) and specificity of 77.8% (95%CI; 59.24-89.39)<sup>10</sup>. We also found very high sensitivity and high specificity of HSG to detect hydrosalpinx (either unilateral or bilateral). There was no false negative rate for hydrosalpinx in our study. The results of this study were comparable with the study of Gharekhanloo and Rastegar in that the sensitivity and specificity of HSG in detecting uterine anomalies and hydrosalpinx were 93.3% and 93.9%<sup>11</sup>.

### Comparison of HSG and hysteroscopy.

When cervical abnormality detection by HSG was compared with the gold standard hysteroscopy, we found discordant results (Table 4) and no statistical significance compared to the previous study of Zafarani et al.<sup>12</sup>. This probably is explained by some limitations due to inadequate assessment of the cervical region, which might be obscured by the introducer placement during performing HSG.

We also found low diagnostic accuracy of HSG for the detection of intrauterine abnormality (Table 5) which corresponded to the study of Soares et al. in that the sensitivity of HSG to detect uterine lesions was about 50%<sup>13</sup>.

Finally, this study had limitations due to the small sample size. We recommended further research with more population to obtain more solid research outcome.

### Conclusion

HSG is a useful procedure for initial evaluation of female infertility especially in Thailand due to cost-effective, simple procedure with few radiation exposures under fluoroscopy without admission. We recommended HSG as an initial evaluation of female infertility especially in point of tubal abnormalities such as tubal obstruction and hydrosalpinx. However, HSG still cannot be replaced or alternative to the diagnostic laparoscopy for detecting tubal occlusion.

Finally, the HSG was probably not suitable for detecting the cervical abnormalities due to possible overestimation of abnormality.

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### References

1. Zegers-hochschild F, Adamson GD, de Mouzon J, Ishihara O, Mansour R, Nygren K, et al. International Committee for Monitoring Assisted Reproductive Technology (ICMART) and the World Health Organization (WHO) revised glossary of ART terminology, 2009. *Fertil Steril* 2009;92:1520-4.

2. Mascarenhas MN, Flaxman SR, Boerma T, Vanderpoel S, Stevens GA. National, regional, and global trends in infertility prevalence since 1990: A systematic analysis of 277 health surveys. *PLoS Med* 2019;9:e1001356. <https://doi.org/10.1371/journal.pmed.1001356>
3. Mauricio SA, Ludovico M, Riccardo M. Anatomical causes of female infertility and their management. *Int J Gynecol Obstet* 2013;12352:518-24.
4. Chalazonitis A, Tzovara I, Laspas F, Porfyridis P, Ptohis N, Tsimitselis G. Hysterosalpingography: technique and applications. *Curr Probl Diagn Radiol* 2009;38:199-205.
5. Eng CW, Tang PH, Ong CL. Hysterosalpingography: current applications. *Singapore Med J* 2007;48:368-73.
6. CDC.gov [Internet]. USA: U.S. Department of Health and Human Services; c2021 [cited 2021 Jan 27]. <https://www.cdc.gov/reproductivehealth/infertility/index.htm>
7. Simpson WL Jr, Beitia LG, Mester J. Hysterosalpingography: a reemerging study. *Radiographics* 2006;26:419-31.
8. Bassil A, Rubod C, Borghesi Y, Kerbage Y, Schreiber ES, Azais H, et al. Operative and diagnostic hysteroscopy: A novel learning model combining new animal models and virtual reality simulation. *Eur J Obstet Gynecol Reprod Biol* 2017;211:42-7.
9. Watrelot A, Nisolle M, Chelli H, Hocke C, Rongières C, Racinet C, International Group for Fertiloscopy Evaluation. Is laparoscopy still the gold standard in infertility assessment? A comparison of fertiloscopy versus laparoscopy in infertility. Results of an international multicentre prospective trial: the 'FLY' (Fertiloscopy-Laparoscopy) study. *Hum Reprod* 2003;18:834-9.
10. Rizvi SM, Ajaz S, Gulshan, Nikita, Anjum S, Inara. Comparison of hysterosalpingography and laparoscopy in diagnosis of tubal occlusion. *Annal Int Med Dental Res* 2016;2:165-8.
11. Gharekhanloo F, Rastegar F. Comparison of hysterosalpingography and laparoscopy in evaluation of female infertility. *Med Res Arch* 2017;5:1-12.
12. Zafarani F, Ahmadi F, Shahrzad G. Hysterosalpingographic features of cervical abnormalities: acquired structural anomalies. *British J Radiol* 2015;88:20150045.
13. Soares SR, Barbosa dos Reis MM, Camargos AF. Diagnostic accuracy of sonohysterography, transvaginal sonography, and hysterosalpingography in patients with uterine cavity diseases. *Fertil Steril* 2000;73:406-11.