Original Article

Diagnostic Approaches in Nuclear Medicine for Reproductive Health Assessment: Hysterosalpingography in Radiology versus hysterosalpingoscintigraphy

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Abstract

Background: Infertility is a significant aspect of reproductive health and evaluating degree of tubal pathology is essential for determining appropriate management plans. **Aims and Objectives:** To assess the role of hysterosalpingoscintigraphy (HSSG) as a tubal patency test in nuclear medicine and compare it with hysterosalpingography (HSG) in radiology in infertile women and study pain perception in both tests as well. **Materials and Methods:** A prospective study was conducted on 50 infertility patients undergoing infertility evaluation at a tertiary care hospital. Both HSG and HSSG procedures were performed during proliferative phase of menstrual cycle. **Results:** Our study demonstrated the potential of HSSG as a tool for evaluating tubal patency in infertility workup. It showed good accuracy in detecting tubal patency compared to HSG. **Conclusion:** HSG is a radiological procedure valued for its ability to provide detailed anatomical information of uterus and patency of fallopian tubes. In contrast, HSSG provides dynamic information on the functional aspects of the reproductive system using nuclear medicine techniques. Both HSG and HSSG are vital tools in the diagnostic armamentarium for assessing female reproductive health, offering complementary information that aids in comprehensive patient management.

Keywords: *Fallopian tubal blockage, gamma camera, hysterosalpingography, HSSG, infertility*

Introduction

Infertility is a significant aspect of reproductive health that affects both men and women, leading to anguish, depression, as well as discrimination and social isolation.[1,2] According to the World Health Organization (WHO), infertility is clinically defined as "a reproductive system disorder characterized by the inability to achieve a clinical pregnancy after 12 months or more of regular unprotected sexual intercourse."[3]

Determining the global prevalence rates of infertility is challenging due to the involvement of both male and female factors. A WHO report from 1991 stated that 8%–12% of couples (50–80 million) were affected by infertility in their reproductive lives.[4] Recent data suggest that one in every four couples in developing countries experiences infertility.[5]

In the Indian context, infertility is often wrongly attributed solely to women, unfairly making them the perpetrators.[6] However, infertility affects both sexes equally, with each contributing to 40% of cases. Approximately 10% of fertility problems are attributed to issues in both partners, while the remaining 10% remain unexplained despite extensive testing.

The causes of infertility vary across regions, populations, and localities, and they have diverse clinical, social, and demographic implications. Physiological dysfunctions, preventable factors, and unexplained issues are the primary sources of infertility. The common causes of female infertility include damage to the fallopian tubes, disruptions in ovarian function or hormonal imbalances, and uterine or cervical issues.[7]

Tubal factor infertility ranks among the most common causes of infertility, often resulting from pelvic inflammatory diseases, with 70% of cases attributed to sexually transmitted infections.[8]

Evaluating the degree of tubal pathology is essential for determining appropriate management plans and assessing fertility

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prospects. The most commonly used diagnostic tests for infertility include hysterosalpingography (HSG) and laparoscopy.[9,10]

Despite the availability of these tests, the diagnostic evaluation of fallopian tubes has been limited to assessing anatomical patency alone. Merely confirming tubal patency does not guarantee normal function.[11,12] Any defect in the coordinated movements of the fallopian tube function can hinder conception.[13]

Hysterosalpingoscintigraphy (HSSG) is a technique that involves the migration and imaging of radioactive tracer particles from the cervix to the peritoneal cavity and ovaries. This process mimics the movement of sperm through the fallopian tubes in a noninvasive manner.[14,15] HSSG is effortless, painless, less invasive, associated with fewer complications, and requires no premedication.[16]

There are limited studies related to HSSG evaluation for infertility in India. Keeping these factors in mind, we aim to assess the role of HSSG as a tubal patency test and compare it with HSG in infertile women, and study pain perception in both tests as well.

Materials and Methods

A prospective study was conducted on referred infertility patients at a tertiary care hospital.

Study duration

The study was conducted during May 2017–May 2019 (2 years).

Study population

Referred female patients undergoing evaluation for infertility at the department of gynecology of the tertiary care hospital.

Study site

Department of nuclear medicine of a tertiary care hospital.

Study design

Prospective study to assess the role of HSSG as a tubal patency test in infertility workup.

Sample size

Fifty (the sample size was calculated using the Fisher's formula).

Inclusion criteria

All female patients undergoing infertility workup.

Exclusion criteria

Previous history of pelvic inflammatory disease, patients unwilling to provide informed consent, patients unable to lie supine for imaging, and claustrophobic patients.

Study methodology

This prospective study was conducted in collaboration with the department of radiology and the department of gynecology for over 2 years. The patients included in the study were referred to the department of nuclear medicine for HSSG as part of infertility evaluation.

After approval of the Institutional Ethical Committee and Scientific Committee, the study was conducted on 50 patients. Each patient's detailed history was recorded, and informed written consent was obtained from each patient explaining how the procedures (both HSG and HSSG) would be performed with the administration of radioactive contrast or radionuclide.

Both HSG and HSSG procedures were performed during the proliferative phase of the menstrual cycle, between day 6 and day 12. HSG study was done first followed by conducting an HSSG study on successive days. The procedures were carried out only after excluding pregnancy.

HSG was performed in the department of radiology. The patient was administered a premedication of muscle relaxant to reduce uterine spasm and was positioned in the lithotomy position. After confirming patency with uterine sound, 15 ml of radio-opaque dye was injected under pressure into the uterine cavity using a Leech–Wilkinson cannula placed in the cervical canal. Serial X-ray images were captured delineating the uterine cavity, the outline of the fallopian tubes, and the presence or absence of dye in the abdominal cavity.

After the completion of the HSG study, the results were analyzed. A normal study showed visualization of contrast in the uterus followed by free spillage of the contrast medium into the peritoneal cavity, confirming the patency of both tubes [Figure 1]. If no spillage of contrast from the fallopian tube into the peritoneal cavity was observed in the delayed X-ray images, a blocked fallopian tube was considered.

The level of pain experienced during the procedure was assessed through a visual analog scoring system. The pain scale ranged from 0 to 10, with 0 indicating a painless procedure and 10 indicating a highly painful procedure.

After the HSG was performed, the HSSG procedure was explained and an appointment was given. Informed written consent was obtained from the patients for the procedure on the day of appointment. Technetium-99m sulfur colloid was prepared, and the radioactivity was checked using a dose calibrator. The patients were instructed to lie down in a supine position on the gamma camera after evacuating the bladder. The perineal area was cleaned before administering the radioactivity.

One mCi of technetium-99 m sulfur colloid in a volume of 0.5 ml was instilled just inside the endocervical canal, taking

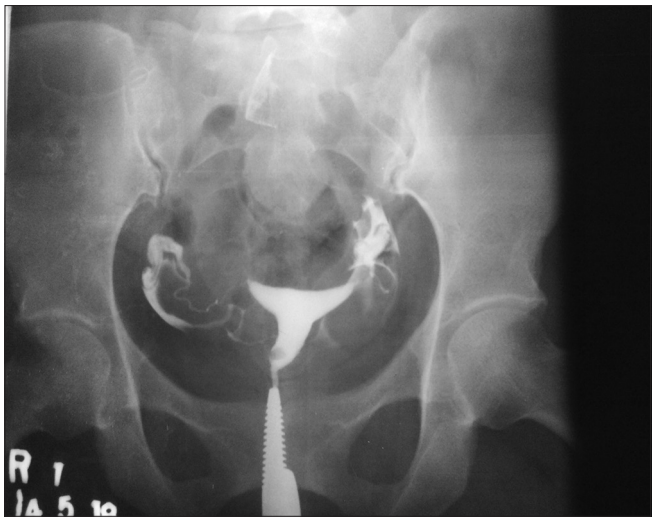

Figure 1: Normal hysterosalpingography study showing contrast medium in the uterus and bilateral spillage of contrast into the peritoneal cavity

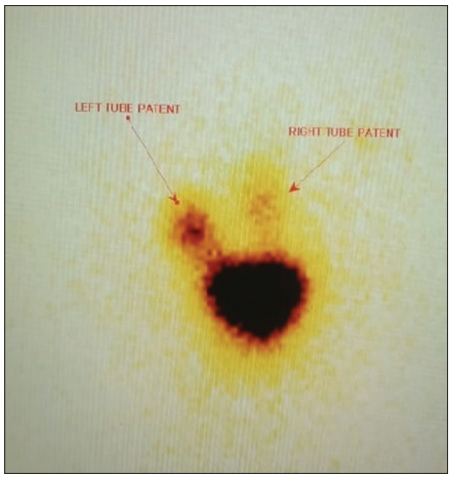

Figure 2: Normal HSSG study showing the flow of tracer from the uterine cavity into the bilateral fallopian tubes. HSSG: Hysterosalpingoscintigraphy

care not to push the colloid into the uterine cavity. Dynamic images were taken for 10 min followed by immediate static images acquired in anterior and posterior views for 5 min each. Additional static images were obtained at 15 min, 30 min, and 1 h. All images were acquired using a dual-head gamma camera with a low-energy parallel hole collimator and a 256 × 256 matrix.

The ascent of 99mTc sulfur colloid up the endocervical canal into the uterine cavity and through the fallopian tubes to the fimbrial end was observed [Figure 2]. Additional scans were conducted in cases where unilateral spillage or no spillage was observed to look for delayed ascent. Patients were instructed not to move during the scan.

Statistical analysis

The data were analyzed using IBM Corp. Released 2013. (IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp). The categorical data were represented in the form of frequency and percentage. The Chi-square/ Fisher's exact test was used to test the significance for qualitative data. Continuous data were represented as mean and standard deviation. $P < 0.05$ was considered significant. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy were also calculated for HSSG comparing it to HSG.

Fifteen (30%) study subjects were identified as having blocked left fallopian tube by HSG; among them, 12 (24%) were identified correctly by HSSG. Thirty-five (70%) study subjects were detected as having patent left fallopian tube by HSG; among them, 32 (64%) were identified as truly negative by HSSG. Chi-square test results showed the association between the two tests to be statistically significant ($P = 0.001$) [Figure 3].

Sixteen (32%) study subjects were identified as having blocked right fallopian tube by HSG; among them, 11 (22%) were identified correctly by HSSG. Thirty-four (68%) study subjects were detected as having patent right fallopian tube by HSG; among them, 28 (56%) were identified as truly negative by HSSG [Figure 4]. Chi-square test results showed the association between the two tests to be statistically significant ($P = 0.001$).

Sensitivity, specificity, PPV, and NPV of HSSG are better in detecting left-side tubal patency with an accuracy of 82% and 78%, respectively, on the left- and right-side tubal patency [Table 1].

Results

This prospective study included patients from various parts of the country. A total of 50 patients undergoing infertility evaluation were assessed using HSG and HSSG, both kinds of imaging techniques in collaboration with the radiologist and nuclear medicine physician. The data obtained from both procedures were compiled in a tabulated format and subjected to analysis.

The age range of the patients included in the study was 21–40 years. The majority of patients (56%) fell within the age group of 26–30 years. Forty-five patients (90%) were of primary infertility and only 5 (10%) patients were of secondary infertility.

Out of 50 study patients, only 10 patients had a history of diabetes, hypothyroidism, tuberculosis, and laparoscopy and intrauterine insemination cycles [Figure 5].

Postprocedure visual analog pain scoring was done for both HSG and HSSG. Higher scores were given in HSG than in HSSG [Table 2].

Discussion

This prospective study was conducted at the department of nuclear medicine with the primary aim to evaluate HSSG as a tool for assessing tubal patency in infertility workup.

Table 1: Accuracy of hysterosalpingoscintigraphy compared with hysterosalpingography

Fallopian tube	Sensitivity	Specificity	PPV	NPV	Accuracy
Left	80	82.86	66.67	90.63	82
Right	68.75	82.35	64.71	84.85	78

PPV: Positive predictive value, NPV: Negative predictive value

Table 2: Pain scale given by patients after hysterosalpingography and hysterosalpingoscintigraphy studies

Pain scale	1	2	3	4	5	6	7	8	9	10
HSG	0	0	0	0	0	2	11	15	17	5
HSSG	9	30	10	1	0	0	0	0	0	0

HSSG: Hysterosalpingoscintigraphy, HSG: Hysterosalpingography

The study objectives were to determine tubal patency using HSSG and compare the results with conventional HSG. In addition, the study aimed to compare the pain scale between the two procedures.

Fallopian tube patency is crucial in both primary and secondary infertility evaluations. HSG, a contrast-based imaging technique, is commonly used as the initial diagnostic tool to determine fallopian tube patency that requires the administration of contrast medium under pressure.[16]

Tubal patency was confirmed when the dye freely flowed into the abdominal cavity. The appearance of contrast in the uterine cavity depended on uterine alignment, the degree of uterine flexion, patient position, and the amount of traction applied to the cervix during the procedure.

In contrast, HSSG relies on the transport of radioactive particles through the genital tract without the need for a contrast medium under pressure.[17] While it does not provide anatomical information like HSG, it assesses the physiological function of the fallopian tubes.[18] HSSG allows the evaluation of transport and reveals functional capacity. A fallopian tube obstruction detected on HSSG, despite being patent on HSG, may suggest a functional rather than an anatomical defect.

The mean age of the study subjects was 28.46 ± 3.259 years, with the majority falling within the age group of 26–30 years (56%). Primary infertility was present in 90% of the study subjects, with a small percentage having a history of previous intrauterine insemination, hypothyroidism, or laparoscopy.

In terms of accuracy, HSSG identified blocked fallopian tubes in a significant proportion of cases where HSG also detected blockages. The association between the two tests was statistically significant.[15] HSSG showed a sensitivity of 80% and 68.75% in detecting patency of the left and right fallopian tubes, respectively. The specificity for both tubes was around 82%, and the overall accuracy of HSSG in detecting tubal patency was approximately 82%.

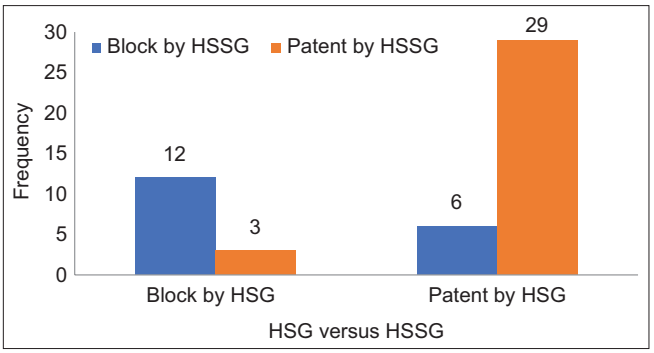

Figure 3: Comparative results of left fallopian tube patency by HSG and HSSG. . HSG: Hysterosalpingography, HSSG: Hysterosalpingoscintigraphy.

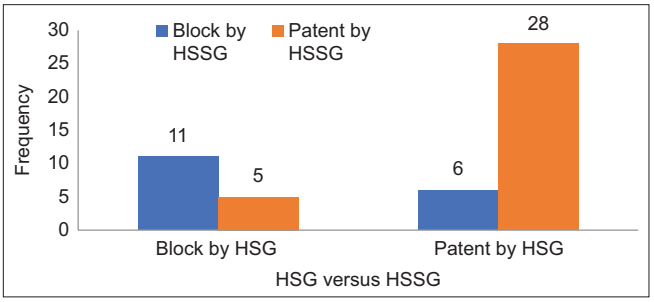

Figure 4: Comparative results of right fallopian tube patency by HSG and HSSG. HSG: Hysterosalpingography, HSSG: Hysterosalpingoscintigraphy.

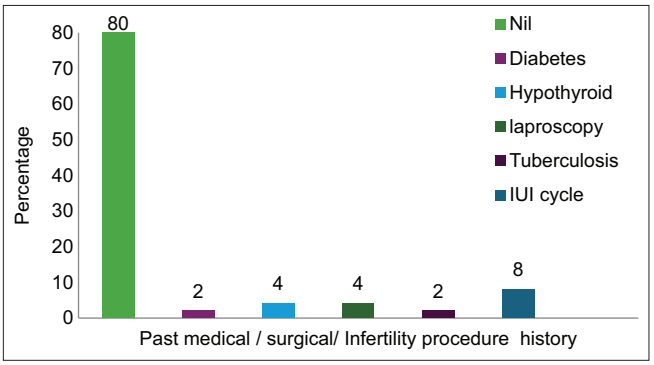

Figure 5: Distribution of subjects according to medical/surgical history. IUI: Intrauterine insemination

Lundberg *et al*. reported varying results regarding the accuracy of HSSG compared to HSG.[19] Some studies have shown HSSG to be a useful complementary test for assessing tubal patency, while others have found it less reliable or inconclusive HSG.[22] Factors such as sensitivity, specificity, and predictive values have been reported differently across studies.[16,20]

Sinha *et al*. reported that HSSG is an easy procedure with no need for premedication and less pain perception. The study showed that the rapid ascent of spermatozoa within the female genital tract to the site of fertilization is not dependent on the motility of spermatozoa and is determined by directed uterine peristalsis and the myometrial contractions toward the ovary bearing the dominant follicle. The unilateral patency demonstrated on HSSG is actually

a physiological phenomenon as only one ovary ovulates during each cycle, it is possible that the ipsilateral tube shall show physiological motility in that cycle.[16]

It is worth noting that HSSG was associated with lower radiation exposure compared to HSG in some studies. The radiation dose in HSSG was found to be lower, making it a potentially safer option.[21] The inclusion of more cases would have given more precise and accurate findings, and the result would have been more valid.

Conclusion

The findings of this study demonstrated the potential of HSSG as a tool for evaluating tubal patency in infertility workup. HSSG offers significant advantages, particularly in evaluating physiological fallopian tube patency, which is crucial in infertility evaluations showing good accuracy in detecting tubal patency compared to HSG.

HSSG eliminates complications associated with contrast media or uterine instrumentation and can be safely used as an alternative procedure for patients allergic to iodinated contrast media. It is associated with better patient acceptance due to its relatively painless nature compared to HSG, and the radiation dose is not greater than that of HSG.

The true potential of HSSG lies in its ability to assess the functional status of the fallopian tubes without the need for pharmacologic or physical intervention.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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