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Conventional and magnetic resonance hysterosalpingography in assessing tubal patency—A comparative study

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Abstract

Context: Tubal factors, one of the leading causes of female infertility, have been conventionally evaluated by hysterosalpingography (HSG). The role of magnetic resonance imaging (MRI) in assessing female infertility is gaining importance because of its inherent efficiency in detecting structural abnormalities. Magnetic resonance hysterosalpingography (MR HSG) is less invasive and avoids exposure of ovaries to ionizing radiation. Its utility is extrapolated to visualize fallopian tubes. **Aims:** To assess the diagnostic accuracies of dynamic MR HSG and conventional HSG (cHSG) in identifying tubal patency in women with infertility using diagnostic laparoscopy (DL) as gold standard. **Materials and Methods:** A prospective study of 40 patients was conducted over a period of 6 months. The patients were subjected to MR HSG followed by cHSG during the preovulatory period. If tubes were blocked, the patients were subjected to DL in the next menstrual cycle. If the tubes were patent and there was failure of conception, they were subjected to DL in the interval of 3 months. **Results:** Twenty-four patients had bilateral tubal spill which was confirmed using cHSG and DL. One patient had discordant MR HSG and cHSG results and six patients had discordant MR HSG and DL results. No statistical difference was observed between MR HSG and cHSG. **Conclusion:** Pelvic MRI is an inevitable tool in infertility evaluation. MR HSG can be used in addition as it avoids exposure of the reproductive organs to radiation and has the same efficacy as cHSG.

Key words: Conventional hysterosalpingography; diagnostic laparoscopy; female infertility; magnetic resonance hysterosalpingography; tubal patency

Introduction

Infertility is defined by the World Health Organization as the "inability to achieve pregnancy after one year or more of unprotected regular sexual intercourse".[1] The global prevalence of primary infertility is about 2% and secondary infertility is 3%.[2] Tubal factors are the common factors contributing to 30%–40% of female infertility.[3] HSG, the radiographic technique used in the evaluation of uterus and fallopian tubes, is the first line of investigation in the evaluation of tubal factors in infertility.[4] However, it carries an unavoidable risk of exposing the reproductive organs of young and potentially fertile women to radiation. Moreover, most of the women undergoing cHSG further require transabdominal and transvaginal ultrasound for further anatomical details and identification of pathologies. Although sonosalpingogram can detect fluid spill, the

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indirect evidence of tubal patency, it cannot detect the tubes. MR HSG[5] is a novel technique used in evaluating tubal patency. Having the inherent advantage of MR in imaging the pelvis, MR HSG is an innovative tool for female infertility evaluation. MR HSG may be used as a one-stop investigation tool in detecting uterine, ovarian, and tubal pathologies.[6]

Very few pioneer studies have been conducted on MR HSG, both at national and international levels. This distinctive study in India considers the introduction of this novel technique, designing its operational methodology, and evaluating its diagnostic accuracy, thereby incorporating it in the infertility evaluation protocol in the near future. The chief objective of the study is to assess the feasibility and accuracy of MR HSG in identifying tubal patency in female infertility.

Materials and Methods

Forty patients, age 20–40 years, who had primary or secondary infertility and were referred by the department of Obstetrics and Gynecology for evaluation of tubal patency were included in the study. It includes patients referred for postoperative evaluation, following reversal of tubal ligation and recurrent spontaneous abortions. The examination was done on Day 7–Day 12 of the menstrual cycle.[4] Patients who were dissent, uncooperative, and have active pelvic inflammatory disease and contraindications to MRI [pacemaker and cochlear implants] were excluded from the study.

Proper informed consent was obtained from all the patients. The prospective controlled study was approved by the Institutional Ethics Committee.

All the patients were advised to abstain from sexual intercourse during the days after menstruation till the day of procedure so as to avoid any chance of pregnancy during the procedure. The patient was given oral mefanamic acid three times a day and a course of antibiotics [combination of ofloxacin and metronidazole] as premedication starting on the day before and continued two days post procedure.

Under strict aseptic precautions, MRI-compatible plastic HSG 5 - F microcatheter with inflatable bulb was inserted into the lower uterine cavity. The bulb was inflated with 3 cc of distilled water and shifted to MRI scan 1.5 Tesla [GE] machine.

T2 W (TR: 7120 ms, TE: 90 ms, flip angle 900, slice thickness 5 mm, matrix 256 × 256) axial, sagittal, and coronal sequences were done.

Dynamic T1 Cube Coronal 5 phases were taken. (TR: 3.8 ms, TE: 1.8 ms, TI: 7 ms, flip angle 120, slice thickness 3.4 mm, matrix 256 × 256). The first phase was imaged prior to saline infusion. Then, 10 ml of gadodiamide [1:100 dilution with 0.9% saline; Omniscan, GE Healthcare; 0.5 mmol/ml] was instilled and four successive phases were obtained. It demonstrates the endometrial cavity, tubal patency/block, and peritoneal spill, if any. Corresponding subtracted images were generated automatically.

The patients were immediately mobilized to the fluoroscopy room and 10 ml of iodinated contrast iohexol [Omnipaque, GE Healthcare; 350 mg/ml] was instilled through the same catheter. The spot film was taken after which the balloon was deflated and the catheter was removed.

Patients with unilateral or bilateral tubal blocks were subjected to DL in their next menstrual cycle as a part of routine subsequent evaluation and the findings were confirmed simultaneously. Patients with bilateral tubal patency were followed up in regular monthly intervals. If they failed to conceive after 3 months, they were subjected to DL as a part of further evaluation at the department of Obstetrics and Gynecology. The findings were confirmed during the procedure. Only one patient conceived in 2 months and was not included in this study as diagnostic laparoscopy was not performed for the patient.

Statistical analysis

Sensitivity, specificity, positive and negative predictive values, and diagnostic accuracy were calculated for both MR HSG and cHSG. The results were compared using McNemar test and Kappa analysis using DL as the gold standard.

Results

A total of 40 patients were evaluated by MR HSG and by cHSG in the same sitting, followed by DL at intervals of 1–3 months. There were 22 cases of primary infertility (56%) and 18 cases of secondary infertility (44%). Among the patients with secondary infertility, 4 patients [10%] had previous history of recurrent abortions, 9 patients [22%] had history of tubectomy or tubal ligation reversal, and 5 patients [10%] had infertility due to unidentified causes.

MR HSG: The results of MR HSG are tabulated in Table 1. Of the 40 patients, 16 patients had tubal blocks and 24 patients had bilateral patencies. Of the 16 patients, 13 patients had bilateral blocks and 3 patients had unilateral blocks, one in the right and 2 patients in the left tube. Considering

Table 1: Reslts of MR HSG

Infertility	MR HSG tubal block		Patent	Total
	Unilateral	Bilateral		
Primary	0	5	17	22
Secondary	3	8	7	18
Total	3	13	24	40

MR HSG: Magnetic resonance hysterosalpingography

the total number of tubes as 80 studied in 40 patients, 29 tubes were found to be blocked and 51 tubes were patent. Representative cases of bilateral tubal blocks and bilateral patencies are provided in [Figures 1 and 2], respectively. Determination of the sides was corresponding between the cHSG and MR-HSG in case of unilateral blocks. In one case, cHSG could identify spills from the right tube which was the only discordant case [Figure 3]. A case of bilateral fimbrial block is shown in Figure 4 which was initially diagnosed as hydrosalphinx in MRI. A case of unilateral right tubal block is shown in Figure 5.

The overall results of MR HSG, cHSG, and DL are tabulated in Table 2. The comparative results of MR HSG and cHSG and that of MR HSG and DL are shown in Tables 3 and 4, respectively.

The comparative sensitivity, specificity, positive predictive value [PPV], negative predictive value [NPV], and diagnostic accuracy of MR HSG and cHSG were 100%, 98.08%, 100%, 96.5%, and 98.75%, respectively, and those of MR HSG and DL were 100%, 92.73%, 86.21%, 100%, and 95%, respectively.

The Kappa agreement between MR HSG and cHSG was excellent [0.94] and a McNemar test value of 1 showed no statistical difference between the two procedures. The extra tubal factors identified in our study were four cases of congenital uterine anomalies [1 bicornuate, 3 septate], two cases of myoma, three cases of complex ovarian cysts, six cases of polycystic ovaries, and one case of endocervical polyp.

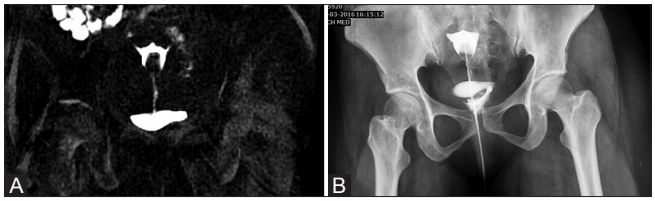

Figure 1 (A and B): 30 yrs old, P2L1, tubectomy done 5 years back, post tubal reanastamosis status, (A) MR HSG Subtracted images reformatted showing contrast within endometrial cavity and absence of peritoneal spill, reflux of contrast in the vagina, (B) Conventional HSG showing uterine cavity and bilateral tubal block

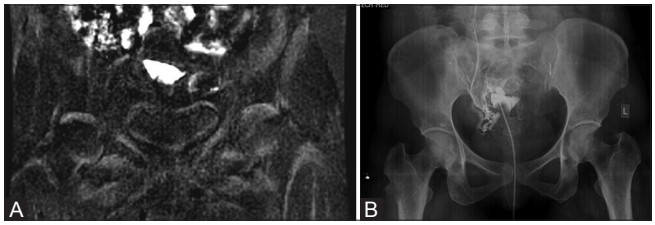

Figure 3 (A and B): 25 years old nullipara, the only case with discordant result between MR HSG and Conventional HSG, (A) MR HSG Subtracted reformatted image showing bilateral tubal block and (B) Conventional HSG shows right tubal spill and Type III intravasation of contrast

Discussion

The mean age of the patients was 24.8 years. The study was completed in all 40 patients with good patient compliance

Table 2: Results of MR HSG, conventional HSG, and D L

Type of HSG	U/L block	B/L block	Patent tubes	Total
MR HSG	3 (R1, L2)	13	24	40
X-ray HSG	4 (R2, L2)	12	24	40
DL	7 (R3, L4)	9	24	40

MR HSG: Magnetic resonance hysterosalpingography, X-ray HSG: X-ray hysterosalpingography, DL: Diagnostic laparoscopy, U/L: Unilateral, B/L: Bilateral, R: Right tubal block, L: Left tubal block

Table 3: Bilateral tubes: MR HSG vs X-ray HSG

MR HSG	X ray HSG		
	Positive	Negative	Total
Positive	28	1	29
Negative	0	51	51
Total	28	52	80

MR HSG: Magnetic resonance hysterosalpingography, X-ray HSG: X-ray hysterosalpingography

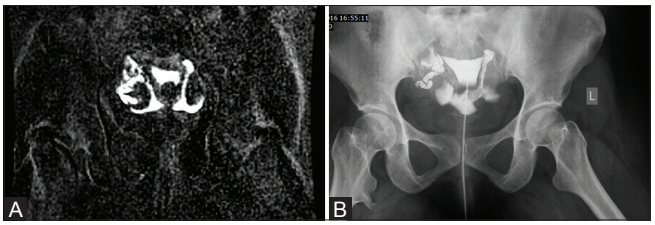

Figure 2 (A and B): 31 years old nullipara, (A) MR HSG Subtracted images reformatted showing contrast within endometrial cavity and bilateral peritoneal spill, (B) Conventional HSG showing uterine cavity and bilateral peritoneal spill

Figure 4 (A-C): 35 years old, P1L1, last child birth 10 years back, (A) MR T2W – hyperintense oblong cystic lesion in right adnexa with few internal septations mimicking right hydrosalphinx, (B) MR HSG Subtracted reformatted image showing bilateral tubes and distal block and no peritoneal spill, refluxed contrast in the vagina, (C) Conventional HSG showing bilateral fimbrial block and no peritoneal spill

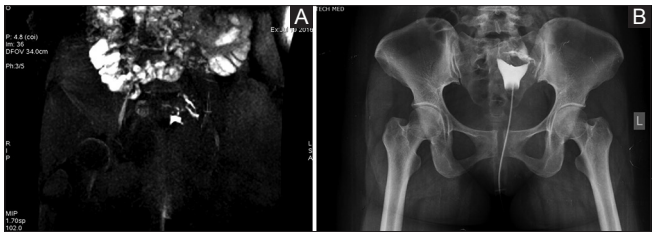

Figure 5 (A and B): 25 years old, nullipara, (A) MR HSG Subtracted images showing contrast within endometrial cavity and left peritoneal spill and right tubal block, (B) Conventional HSG showing uterine cavity, left peritoneal spill, and right tubal block

Table 4: Bilateral tubes: MR HSG vs DL

MR HSG	DL		
	Positive	Negative	Total
Positive	25	4	29
Negative	0	51	51
Total	25	55	80

MR HSG: Magnetic resonance hysterosalpingography, DL: Diagnostic laparoscopy

as against the previous studies conducted by Sadowski *et al*. and Winter *et al*. in which it was abandoned in 1/17 and 4/37 patients, respectively.[5,7] In our study, 60% of the patients had bilateral patencies and 40% had bilateral blocks which is similar to the study by Cipolla *et al*.[8] in which 65% patients had patent tubes and 35% patients had either unilateral or bilateral blocks.

The first MR HSG trial dates back to 1996 when Fred *et al*.[9] evaluated its efficacy in 18 rabbit uterine horns. Five of the fallopian tubes were ligated and 11 were left unaltered. cHSG correctly identified the presence and absence of spills in all 11 and 5 cases, respectively. MR HSG showed concurrent results in 14 of the 16 cases. Sensitivity and specificity of MRHSG were 95.5% and 70%, respectively, for tubal blocks. There was no statistical difference between the cHSG and MR HSG results.

Frye *et al*.[10] in 2000 did a feasiblity study with a phantom simulating uterus, fallopian tubes, and surronding pelvic cavity using half Fourier RARE sequence. Weisner *et al*.[11] in 2001 published a preliminary report on MR HSG with a small sample size of 5 and concluded that MR HSG is a feasible technique that requires further studies.

Among the cHSG group patients of our study, 16 patients had tubal blocks and 24 patients had tubal patencies. But a case of primary infertility which showed bilateral block in MR HSG was found to have a unilateral block in the cHSG and DL. This was the only case with discordance between MR and the cHSG [Figure 3]. In all the other cases, the results were concordant between MR and cHSG.

Sadowski *et al*.[5] in their study identified six patent tubes using MR HSG which appeared to be blocked as per the conventional methods, owing to the better resolution of MRI in MR HSG. However, James *et al*.[12] disagreed with the fact stating that the increased patency was only due to the plastic catheter and not because of the metallic cannula. It was not a confounding factor in our study as the same catheter was used in both MR HSG and cHSG except in one case where the balloon catheter was dislodged after MR HSG and thus proceeded with cHSG using a metallic cannula.

Our results are also supported by the study conducted by Unterwerger *et al*.[6] in which 8 out of the 10 cases showed concordant results in both MR HSG and cHSG. Cipolla *et al*.[8] in 2016 did a study with 116 patients on 3T using time-resolved 3D sequence. The results showed patencies in 65%, unilateral blocks in 25%, and bilateral blocks in 9.8% patients and suggested MR with HSG as a one-stop investigation tool for infertility imaging.

In DL, all patients with bilateral patency in MR HSG and cHSG were found to be patent. Among the patients with tubal blocks, 7 had unilateral blocks and 9 had bilateral blocks. Six patients with bilateral blocks in MR HSG were found to have unilateral blocks in DL. Five patients with bilateral blocks in cHSG were found to have unilateral blocks in DL.

We attribute the increased patency in DL to the fact that the tubes were opened during the previous two procedures as stated by Sadowski *et al*.[5]

He also identified associated findings of three cases of myomas, two cases of uterine anomalies [1 arcuate, 1 partial septate], one hydrosalphinx, one endometrioma, and one atrophic ovary similar to our study.

Our results are comparable with the study done by Winter *et al*.[7] in which 27 out of 33 patients had bilateral tubal patencies and 1 out of 6 patients had bilateral block which were confirmed using laparoscopy. In the same study, tubal catheterization was done in two patients and in three of the remaining six patients with bilateral tubal blocks, neither cHSG nor laparoscopy could be done.

Fatemeh *et al*.[13] in their study stated that the sensitivity and specificity of HSG in detecting bilateral tubal patencies or tubal blocks were 92.1% and 85.7%, respectively. The PPV, NPV, and diagnostic accuracy were 97.2%, 66.7%, and 91.1%, respectively. Our results were comparable with the statistical values obtained in our study.

Conclusion

MR HSG is a novel upcoming investigation method with very few pioneering studies at both national and international levels. This study is distinctive in the sense that it explores the utility and feasibility of HSG being done using MRI.

MR HSG gives promising results as good as the age old investigation of X-ray HSG. In addition, it picks up uterine and extrauterine pathologies determining the management protocol in infertility. It also has the added advantage of avoidance of radiation exposure to the potential reproductive organs and use of highly diluted contrast.

The use of MR HSG in pelvic MRI in cases of infertility protocols has a great way in the future. It can replace cHSG and can be the one-stop investigation method for identifying uterine lesions, structural abnormalities, tubal status, and ovaries in female infertility workup.

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Conflicts of interest

There are no conflicts of interest.

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