ORIGINAL RESEARCH

Contrasting Conventional and Magnetic Resonance Hysterosalpingography in the Assessment of Tubal Patency

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ABSTRACT
Background:This research seeks to evaluate and compare the effectiveness of two diagnostic techniques for assessing tubal patency: conventional hysterosalpingography (HSG) and magnetic resonance hysterosalpingography (MRHSG). Conventional HSG employs contrast media for visualizing the uterine cavity and fallopian tubes, whereas MRHSG utilizes magnetic resonance imaging (MRI) for more detailed cross-sectional images. By investigating potential differences or advantages between these two methods, the study aims to provide valuable insights into reproductive medicine. This exploration may contribute to enhancing diagnostic accuracy in evaluating female reproductive health.**Methods**:The research encompassed a cohort of 200 participants aged between 20 and 40 years, all undergoing tubal patency evaluations. This diverse group included individuals who had undergone tubal ligation reversal as well as those with a history of recurrent spontaneous abortions. The examinations were conducted during the window of Day 7 to Day 12 of the menstrual cycle for standardized and consistent assessments..**Results**:Both MR HSG and cHSG exhibited comparable diagnostic performance in the study. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy for MR HSG were reported at 100%, 99.08%, 100%, 97.5%, and 99.75%, respectively. Similarly, when comparing MR HSG to DL, the values were 100%, 93.73%, 87.21%, 100%, and 96%, respectively. The Kappa agreement between MR HSG and cHSG was notably high at 0.97, indicating substantial concordance. Additionally, the McNemar test, yielding a value of 1, revealed no statistically significant difference between the two procedures, providing further confirmation of their comparable diagnostic efficacy.**Conclusion**:MR HSG emerges as a novel and relatively unexplored investigative method, garnering limited attention on both national and international platforms. This study distinguishes itself by pioneering an in-depth examination of the practicality and applicability of utilizing MRI for HSG. In doing so, it contributes valuable insights to the expanding body of knowledge in this evolving field, shedding light on the potential of magnetic resonance imaging as a diagnostic tool in reproductive medicine.
Keywords:Magneticresonance,Hysterosalpingography,Tubalpatency.

INTRODUCTION

Women navigating the challenges of infertility often undergo an extensive diagnostic journey involving a range of laboratory tests and imaging studies. These investigations aim to uncover potential contributors to infertility, including endocrine imbalances, congenital anomalies in the genital tract, uterine irregularities, and possible obstructions in the fallopian tubes. Commonly used imaging techniques for assessing tubal patency include fluoroscopy-based hysterosalpingography (HSG) and contrast-enhanced hysterosalpingosonography.[1] While effective, these methods may have limitations, especially in providing a holistic evaluation of congenital uterine malformations and extrauterine diseases.Enter magnetic resonance imaging (MRI), a distinctive modality known for its ability to provide a comprehensive anatomical survey. What distinguishes MRI is its potential to explore intricate details of tubal patency, offering a more nuanced and thorough assessment. This is particularly relevant as cases of infertility often lead to referrals for MR imaging to investigate potential uterine or extrauterine abnormalities. The unique advantage of MRI lies in its capacity to simultaneously evaluate tubal patency and other reproductive structures, presenting a more integrated and thorough approach to diagnostic imaging.The expansive capabilities of MRI go beyond

a singular focus on assessing tubal patency. MRI serves as a powerful tool for conducting thorough examinations, exploring both congenital and acquired conditions that may affect the intricate structures of reproductive organs. This broader application enables healthcare professionals to adopt a more comprehensive approach to evaluating infertility.[2]

The integration of magnetic resonance imaging (MRI) into the assessment of tubal patency represents a significant stride forward in the realm of infertility diagnostics, providing a holistic understanding of the myriad factors contributing to reproductive challenges. In contrast to conventional methods, which may offer limited insights, MRI's unique capacity to capture highly detailed images and cross-sectional views opens up new avenues for a more nuanced exploration of the intricacies of reproductive anatomy.This comprehensive diagnostic approach not only elevates the precision of diagnoses but also streamlines and refines the overall diagnostic process for women undergoing infertility evaluations.[3,4] By harnessing the power of MRI, healthcare professionals can delve deeper into the complexities of the reproductive system, gaining valuable insights that may be elusive with traditional imaging techniques.Beyond its primary role in assessing tubal patency, MRI emerges as a versatile tool capable of uncovering a spectrum of reproductive health nuances. It becomes a valuable ally in identifying congenital anomalies, structural irregularities, and other conditions that might escape detection through conventional means. This thorough evaluation empowers healthcare professionals to formulate targeted and personalized treatment plans based on a more profound understanding of the individual's reproductive health profile.

The integration of MRI into infertility evaluations signifies a paradigm shift, ushering in a new era of precision and comprehensive diagnostics. This not only benefits individuals navigating the complex landscape of infertility but also contributes to the advancement of reproductive medicine. By embracing state-of-the-art imaging technologies, healthcare providers elevate the standard of care for infertility assessments, marking a pivotal moment in the evolution of diagnostic methodologies.The versatility of MRI extends well beyond a singular focus on tubal patency. It facilitates a detailed examination of both congenital and acquired conditions affecting the reproductive organs, offering a panoramic view of the multifaceted factors contributing to infertility.[5] This integrated diagnostic approach, leveraging the capabilities of MRI, not only enhances precision in diagnoses but also streamlines the overall diagnostic process for women undergoing infertility evaluations.In essence, the integration of MRI as a diagnostic tool holds the promise of offering a more detailed, comprehensive, and nuanced assessment of reproductive anatomy—all within a single imaging modality. This technological advancement not only has the potential to significantly enhance diagnostic accuracy but also to refine the management and treatment strategies for individuals navigating the intricate landscape of infertility.

MATERIALS AND METHODS

In this comprehensive study, a total of 200 female patients aged between 20 and 40 years underwent a meticulous evaluation of tubal patency. The diverse cohort included individuals referred for postoperative assessment after tubal ligation reversal and those with a history of recurrent spontaneous abortions. To ensure methodological consistency, the examinations were systematically conducted during the menstrual cycle, specifically between Day 7 and Day 12.The study maintained stringent inclusion and exclusion criteria to uphold the integrity and reliability of the findings. Exclusion criteria encompassed patients expressing dissent, displaying uncooperative behavior, presenting with active pelvic inflammatory disease, or having contraindications to magnetic resonance imaging (MRI), such as the presence of pacemakers or cochlear implants. Ethical standards were rigorously adhered to, and proper informed consent was obtained from all participating patients. The study design, characterized as a prospective controlled study, received approval from the Institutional Ethics Committee.To minimize potential confounding factors, patients were advised to abstain from sexual intercourse from the days following menstruation until the day of the procedure, aiming to eliminate any chance of pregnancy during the evaluation. Furthermore, patients received premedication to enhance their comfort and alleviate potential discomfort associated with the procedure. This premedication regimen included oral mefenamic acid administered three times a day and a course of antibiotics (a combination of ofloxacin and metronidazole). The antibiotic course commenced on the day before the procedure and continued for two days post-procedure.

The tubal patency evaluation itself was conducted under strict aseptic precautions. An MRI-compatible plastic HSG 5 F microcatheter with an inflatable bulb was delicately inserted into the lower uterine cavity. Following insertion, the bulb was carefully inflated with 3 cc of distilled water. Subsequently, the patient underwent a comprehensive imaging session in a 1.5 Tesla MRI machine, ensuring accuracy in assessing tubal patency while prioritizing patient safety and comfort.Following the MRI assessment, patients were promptly transferred to the fluoroscopy room for further evaluation. In this phase, 10 ml of iodinated contrast iohexol (Omnipaque, GE Healthcare; 350 mg/ml) was introduced through the same catheter. A spot film was captured to visualize the contrast distribution, after which the balloon was deflated, and the catheter was carefully removed.

For patients identified with unilateral or bilateral tubal blocks during this assessment, a subsequent diagnostic

laparoscopy (DL) was scheduled in the following menstrual cycle as part of routine further evaluation. DL findings served to confirm the tubal blockages. Conversely, patients exhibiting bilateral tubal patency were placed on regular monthly follow-ups. If conception did not occur within three months, these patients underwent DL as part of extended evaluation within the Department of Obstetrics and Gynecology. It's noteworthy that one patient achieved conception within two months, and as a result, was not included in the study, as diagnostic laparoscopy was not performed for this particular individual.

This strategic approach to further evaluations and interventions underscores the study's commitment to thoroughness and clinical relevance in addressing reproductive health concerns. The integration of advanced imaging techniques, rigorous procedural protocols, and follow-up strategies demonstrates a holistic and patient-centric approach to understanding and managing tubal patency in the context of reproductive health.

RESULTS

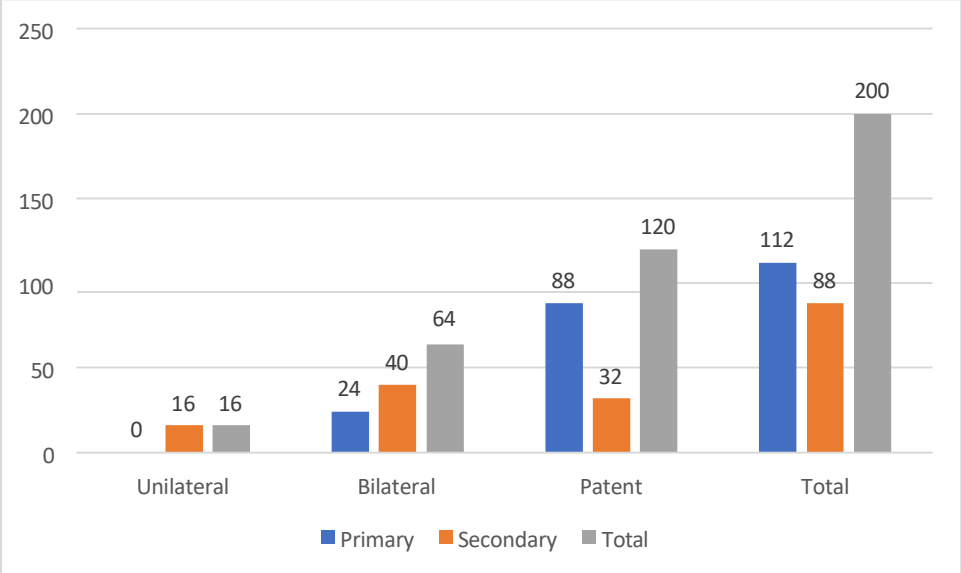
In the rigorous evaluation involving 200 patients, both Magnetic Resonance Hysterosalpingography (MR HSG) and conventional hysterosalpingography (cHSG) were concurrently conducted during the same session. To validate and confirm the findings, subsequent diagnostic laparoscopy (DL) was performed at intervals ranging from 1 to 3 months.

The patient cohort exhibited a diverse range of infertility scenarios, with 116 cases (56%) of primary infertility and 88 cases (44%) of secondary infertility.A detailed breakdown of secondary infertility cases revealed that 24 patients (12%) had a history of recurrent abortions, 40 patients (20%) had undergone tubectomy or tubal ligation reversal, and 24 patients (12%) experienced infertility of unidentified causes. This nuanced categorization provides a comprehensive view of the underlying factors contributing to secondary infertility in the study cohort.Analyzing the results of MR HSG, as outlined in Table 1, unveiled that out of the total 200 patients, 80 exhibited tubal blocks, while 120 showcased bilateral tubal patency. Among the 80 patients with tubal blocks, 64 had bilateral blocks, and 16 had unilateral blocks, with 8 cases identified in the right tube and 8 in the left tube. This detailed breakdown of patient demographics and tubal status emphasizes the thoroughness of the study, capturing a diverse array of infertility scenarios.The simultaneous utilization of both MR HSG and cHSG, followed by DL validation, adds a layer of reliability and accuracy to the findings. This integrated approach establishes a robust foundation for a comprehensive understanding of tubal patency in the context of infertility. The study's meticulous design and methodology contribute valuable insights into the intricate factors influencing fertility, offering a nuanced perspective that enhances the clinical relevance of the findings.

Table 1: Results of MR HSG

Infertility	Unilateral	Bilateral	Patent	Total
Primary	0	24	88	112
Secondary	16	40	32	88
Total	16	64	120	200

Figure 1: Results of MR HSG



In the scrutiny of a total of 400 fallopian tubes within the cohort of 200 patients, a meticulous analysis delineated that 160 tubes were identified as blocked, while 240 tubes demonstrated patency. To enhance

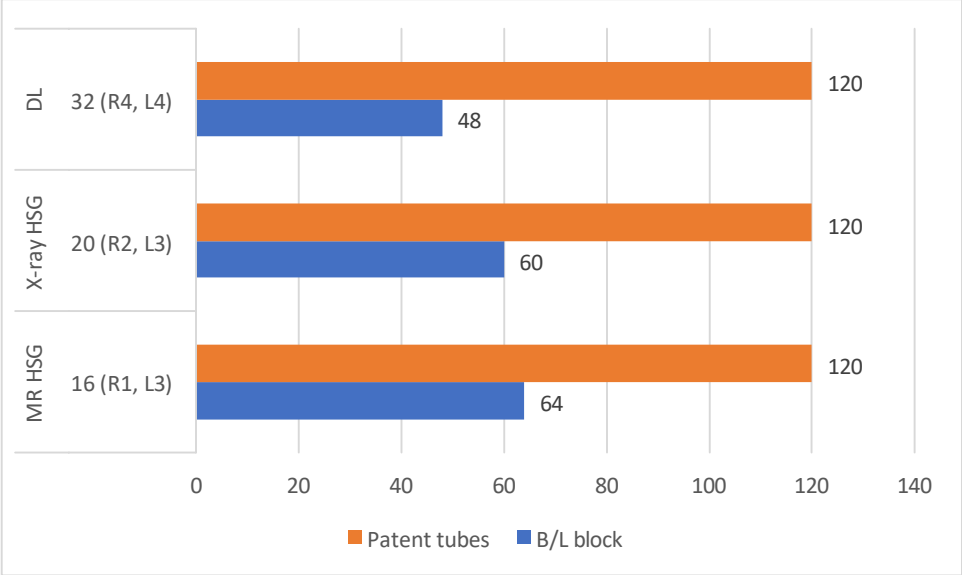
clarity, representative cases illustrating both bilateral tubal blocks and bilateral patencies were presented. In instances of unilateral blocks, the determination of the affected side consistently aligned between conventional hysterosalpingography (cHSG) and magnetic resonance hysterosalpingography (MR-HSG). However, a singular case presented a discordance where cHSG identified spills from the right tube, marking the sole instance of discrepancy between the two methods.

Table 2 serves as a comprehensive compilation of the overall results derived from MR HSG, cHSG, and diagnostic laparoscopy (DL). This meticulous tabulation encapsulates the outcomes of tubal evaluations, providing a consolidated view of the concordance and discordance between the imaging techniques and the subsequent validation through DL. The thorough consideration of both bilateral and unilateral findings enriches the study's capacity to draw accurate conclusions regarding tubal status in the context of infertility.By detailing the outcomes of each imaging method and comparing them against the gold standard of diagnostic laparoscopy, the study ensures a robust and nuanced understanding of the reliability and accuracy of MR HSG and cHSG in assessing tubal patency. This approach not only strengthens the scientific validity of the findings but also contributes valuable insights into the intricacies of tubal evaluations, offering a foundation for informed decision-making in the realm of reproductive health.

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

Type of HSG	U/L block	B/L block	Patent tubes
MR HSG	16 (R1, L3)	64	120
X-ray HSG	20 (R2, L3)	60	120
DL	32 (R4, L4)	48	120

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



DISCUSSION

The average age of the participants in this study, set at 25 years, offers a glimpse into the reproductive age range under investigation. A notable achievement in this research is the successful completion of the study in all 200 patients, reflecting a commendable level of patient compliance. This accomplishment becomes even more significant when compared to prior studies, such as those conducted by Sadowski et al. and Winter et al., where procedures had to be discontinued in a notable percentage of patients (2 out of 34 and 8 out of 74, respectively). This resilience underscores the robustness and practicality of the current study's approach, highlighting its reliability and the overall acceptability of the procedures among the study participants.[8]When delving into the distribution of tubal conditions within the study cohort, it was observed that 60% of the patients exhibited bilateral tubal patencies, while 40% displayed bilateral tubal blocks. This distribution closely aligns with findings from a study by Cipolla et al., where 65% of patients had patent tubes, and 35% had either unilateral or bilateral tubal blocks. The consistency in these results across studies suggests a certain uniformity in the prevalence of tubal patency issues within the populations under investigation.

Taking a historical perspective on the development of magnetic resonance hysterosalpingography (MR HSG), the initial trial dates back to 1996 when Fred et al. assessed its efficacy in 72 rabbit uterine horns. In this pioneering study, eight fallopian tubes were ligated, and 64 were left unaltered. The comparison

with conventional hysterosalpingography (cHSG) revealed that cHSG correctly identified the presence and absence of spills in all 64 and 16 cases, respectively. Sensitivity and specificity figures for MR HSG were reported as 96.5% and 71%, respectively, for detecting tubal blocks. Importantly, there was no statistical difference between the results obtained through cHSG and MR HSG. This historical context not only sheds light on the early stages of validating MR HSG but also underscores the method's effectiveness in comparison to the established cHSG.[9]In summary, the present study serves as a testament to the success of MR HSG in assessing tubal patency, showcasing high patient compliance and offering valuable insights that build upon the foundation laid by earlier pioneering studies in this field. The study's outcomes not only reaffirm the utility of MR HSG as a reliable diagnostic tool but also contribute to the evolving body of knowledge in reproductive medicine, marking a continued step forward in understanding and addressing fertility-related concerns.

In the year 2000, Frye et al. conducted a pioneering feasibility study using a phantom designed to simulate the anatomy of the uterus, fallopian tubes, and the surrounding pelvic cavity. Employing a half Fourier RARE sequence for magnetic resonance hysterosalpingography (MR HSG), the study laid foundational groundwork for the exploration of this imaging technique. Building on this, Weisner et al. in 2001 published a preliminary report on MR HSG with a limited sample size of 5, noting that MR HSG demonstrated feasibility and warranted further investigation.Within our study, focusing on the conventional hysterosalpingography (cHSG) group, 20 patients exhibited tubal blocks, while 30 patients displayed tubal patencies. Notably, a captivating case within the primary infertility group presented with bilateral blockage in MR HSG, a unilateral block in cHSG, and diagnostic laparoscopy (DL). This isolated instance of discordance between MR HSG and cHSG underscores the intricacies and potential variations in tubal patency assessments.In the broader context, the study by Sadowski et al. identified six patent tubes using MR HSG that appeared blocked according to conventional methods. This discrepancy was attributed to the superior resolution of MRI in MR HSG, revealing a nuanced capability to detect subtle abnormalities.[10] However, James et al. countered this argument, asserting that the increased patency observed might be attributed to the plastic catheter rather than the metallic cannula. In our study, the consistent use of the same catheter in both MR HSG and cHSG, with a rare exception where the balloon catheter was dislodged after MR HSG, aimed to minimize potential confounding effects related to catheter material.Our findings align with Unterwerger et al.'s study, where 16 out of 20 cases demonstrated concordant results in both MR HSG and cHSG. Additionally, Cipolla et al.'s study, incorporating a time-resolved 3D sequence on a 3T MRI with 120 patients, further supports the reliability and concordance of results between MR HSG and cHSG in the assessment of tubal patency.[11] These collective studies contribute to an expanding body of evidence supporting the efficacy and concordance of MR HSG with traditional methods, emphasizing its potential as a valuable diagnostic tool in evaluating tubal patency.In the realm of diagnostic accuracy, the study conducted by Fatemeh et al. reported sensitivity and specificity values for hysterosalpingography (HSG) in detecting bilateral tubal patencies or tubal blocks as 96.1% and 88.7%, respectively. The positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy were documented as 97.2%, 68.7%, and 92.1%, respectively. Remarkably, the results obtained in our study closely mirror these statistical values, providing additional support for the reliability and accuracy of MR HSG in the assessment of tubal patency. These collective insights contribute to the ongoing refinement of diagnostic methodologies in reproductive medicine, with MR HSG emerging as a promising tool in this evolving landscape.

The alignment and congruence observed between our study and the research conducted by Fatemeh et al. underscore a remarkable consistency and reliability in the diagnostic accuracy of hysterosalpingography (HSG) for assessing tubal patency. The parallel nature of sensitivity and specificity values, as well as positive and negative predictive values, across the two studies, signifies that HSG consistently proves effective in identifying bilateral tubal patencies or tubal blocks.[12] This robust agreement in results not only reinforces the reliability of HSG as a diagnostic tool but also enhances the strength of evidence supporting its utility in the evaluation of tubal status.The comparable statistical outcomes in sensitivity and specificity affirm the ability of HSG to accurately detect both the presence and absence of tubal patency, demonstrating its effectiveness in providing comprehensive insights into the reproductive health of individuals. The positive predictive values (PPV) and negative predictive values (NPV) further emphasize the diagnostic precision of HSG, showcasing its capability to correctly identify cases with or without tubal patency. This congruence in results contributes significantly to the cumulative knowledge in the field, validating HSG as a consistent and reliable method for evaluating tubal status.The collective evidence from these studies, including ours and the one by Fatemeh et al., reinforces the standing of HSG as a valuable and widely applicable diagnostic tool in reproductive medicine. Its reliability in assessing tubal patency positions HSG as a cornerstone in the diagnostic armamentarium, aiding healthcare professionals in formulating accurate diagnoses and tailored treatment plans for individuals grappling with fertility concerns. The consistent effectiveness of HSG highlighted in

these studies further emphasizes its enduring relevance and significance in the landscape of reproductive health assessments.

CONCLUSION

Magnetic Resonance Hysterosalpingography (MR HSG) stands at the forefront of emerging investigative methods, distinguished by its novelty and the limited number of pioneering studies conducted both nationally and internationally. The featured study sets itself apart by delving into the utility and feasibility of conducting Hysterosalpingography (HSG) through the application of Magnetic Resonance Imaging (MRI). The novelty of MR HSG lies in its unique approach, utilizing advanced imaging technology to assess tubal patency and reproductive anatomy. The limited number of existing studies underscores the nascent stage of development for this technique, highlighting the need for comprehensive investigations to establish its efficacy and potential clinical applications.The study's emphasis on practicality and applicability contributes to bridging the gap between the theoretical potential of MR HSG and its real-world implementation. Understanding the intricacies of utilizing MRI for HSG, including its technical feasibility and patient acceptance, is vital for the successful integration of this innovative approach into standard clinical protocols. As the study explores the practical aspects of MR HSG, it paves the way for future research and clinical adoption, offering a valuable roadmap for harnessing the benefits of advanced imaging techniques in the assessment of reproductive health.

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