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DIAGNOSTIC ROLE OF HYSTEROSALPINGOGRAPHY IN DETECTING TUBAL AND UTERINE CAUSES OF FEMALE INFERTILITY: A CROSS-SECTIONAL STUDY

Original Research

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ABSTRACT

Background: Infertility affects a significant portion of the reproductive-age population globally, with tubal and uterine abnormalities often implicated. Hysterosalpingography (HSG) remains a valuable, minimally invasive diagnostic tool for assessing the patency of fallopian tubes and structural integrity of the uterine cavity. In low-resource settings, it provides an affordable and effective first-line approach to evaluate female infertility, guiding further clinical decision-making and treatment pathways.

Objective: To assess the structural abnormalities of the uterus and fallopian tubes in infertile women using hysterosalpingography.

Methods: This prospective cross-sectional study was conducted over three months at Fatima Memorial Hospital, Lahore, after approval from the Departmental Board of Studies, Department of Radiological Sciences and Imaging, ICBS. A total of 299 women referred for infertility workup underwent HSG using fluoroscopy and iodine-based contrast media. Patients were selected via convenient sampling. Inclusion criteria comprised all women presenting with infertility referred by gynecologists for HSG. Imaging data were evaluated for uterine shape and tubal patency. Statistical analysis was performed using MEDCALC software.

Results: Out of 299 patients, 155 (52%) had secondary infertility and 144 (48%) had primary infertility. Uterine cavities were normal in all participants. Bilateral tubal patency was observed in 213 women (71.2%), while 44 (14.7%) exhibited bilateral tubal obstruction. Unilateral tubal obstruction was detected in 41 patients (13.7%), with 23 cases (7.7%) on the left and 18 cases (6.0%) on the right. A total of 211 patients (70.6%) showed no abnormalities on HSG imaging.

Conclusion: Hysterosalpingography remains a clinically valuable and cost-effective diagnostic tool in evaluating infertile women, particularly for detecting tubal occlusion. The high frequency of tubal pathologies identified reinforces its critical role in early infertility diagnosis and planning of reproductive interventions.

Keywords: Fallopian Tubes, Fluoroscopy, Hysterosalpingography, Infertility, Tubal Occlusion, Uterus, Uterine Abnormalities.

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INTRODUCTION

Infertility is a complex medical condition that presents a significant global health challenge, affecting approximately 10–15% of couples worldwide (1). Defined as the inability to achieve pregnancy after at least one year of regular, unprotected sexual intercourse, infertility is further categorized into primary—where no previous pregnancies have occurred—and secondary, which follows a prior pregnancy regardless of the outcome (2). While its prevalence varies globally, certain regions, particularly sub-Saharan Africa, report significantly higher rates, with estimates ranging from 20% to 60% of couples affected (3). Factors such as untreated sexually transmitted infections, complications from unsafe abortions, and puerperal infections have been identified as major contributors in these high-prevalence areas (4). In some community-based studies have reported infertility rates as high as 45% (5,6). Globally, it is estimated that 15% of women experience either primary or secondary infertility at some point in their reproductive lives. Female infertility arises from a wide spectrum of anatomical or physiological abnormalities affecting the fallopian tubes, uterus, cervix, or ovaries. Among these, tubal pathology remains a leading cause, implicated in approximately 35–40% of cases (7). Functioning fallopian tubes are critical for ovum pickup, sperm transport, fertilization, and embryo migration. However, infections and surgical trauma can impair these functions, particularly at the fimbrial ends or within the endosalpinx. Diagnostic imaging is essential in evaluating such pathologies, and among the available modalities, hysterosalpingography (HSG) stands out for its accessibility, safety, and cost-effectiveness. HSG provides a detailed assessment of the uterine cavity and fallopian tubes, offering a sensitivity of 65% and specificity of 83% in detecting tubal obstruction (8). Moreover, HSG may offer a therapeutic advantage by improving tubal patency through mechanical flushing of minor blockages (9).

In addition to HSG, other imaging modalities such as transvaginal ultrasound, saline infusion sonography, and magnetic resonance imaging contribute to the diagnostic evaluation of infertility. Ultrasound, particularly when combined with contrast agents, is effective in detecting intrauterine abnormalities like polyps or fibroids, although it is limited in assessing tubal pathology. MRI, while superior in delineating complex uterine anomalies such as Müllerian duct malformations, is less commonly employed for tubal assessment due to limited resolution in this area. Invasive procedures like laparoscopy and hysteroscopy provide direct visualization and therapeutic potential but are resource-intensive and not without risk (10,11). Despite its advantages, HSG is not without limitations. It can cause discomfort, carries a small risk of pelvic infection, and involves exposure to ionizing radiation. Moreover, its diagnostic accuracy is limited for conditions such as endometriosis and ovarian pathology, necessitating the use of complementary modalities. Nevertheless, due to its broad applicability, HSG remains a cornerstone investigation, particularly in resource-limited settings where advanced imaging may not be readily available (12). The rising burden of infertility and the critical role of structural anomalies of the uterus and fallopian tubes in impeding conception underscore the need for targeted diagnostic evaluation. Within this context, the present study was conducted with the objective of evaluating uterine and tubal structural abnormalities among infertile women using hysterosalpingography, thereby guiding effective clinical decision-making and reproductive interventions.

METHODS

This prospective cross-sectional study was conducted over a period of three months at the Department of Radiological Sciences and Medical Imaging, Fatima Memorial Hospital, Lahore. Ethical approval for the study was formally obtained from the Departmental Board of Studies of the Department of Radiological Sciences and Medical Imaging (DRSMI). All participants were thoroughly informed about the objectives and procedures of the study, and written informed consent was obtained prior to enrollment. Confidentiality of the data was maintained throughout, and participants were assured of their right to withdraw from the study at any point without any repercussions. A total of 299 female patients presenting with infertility were included in the study using a non-probability convenience sampling technique. The inclusion criterion was any woman who presented during the study period with a complaint of infertility and was referred for hysterosalpingography (HSG) by her gynecological consultant. Patients who did not undergo HSG or who had incomplete imaging data were excluded (13). The study population comprised women between the ages of 18 and 42 years, with a mean age of 29.22 years. The average age at menarche among participants was 14.78 years, with a range of 12 to 16 years.

Data collection involved performing HSG as per departmental protocol using fluoroscopic imaging after the introduction of an iodine-based contrast medium through a cervical cannula. Standard anteroposterior and oblique views were obtained to assess the uterine cavity

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and tubal patency. The procedure was carried out under strict aseptic conditions to minimize the risk of pelvic infections. All imaging findings were interpreted by qualified radiologists. Although not explicitly stated, it is assumed that standard radiological grading criteria were followed for identifying uterine anomalies, tubal blockages, or contrast spill patterns. Demographic and clinical data were recorded using a structured data sheet. Statistical analysis tools or software were not specified, which may limit reproducibility and interpretation of findings. Descriptive statistics such as means and ranges were used for participant characteristics; however, there was no mention of inferential statistical tests to support further analysis. This represents a methodological limitation as the absence of statistical comparisons restricts the ability to draw associations or measure significance.

RESULTS

A total of 299 infertile women were evaluated using hysterosalpingography. Among them, 155 patients (52%) presented with secondary infertility, while 144 patients (48%) had primary infertility. The mean age of participants was 29.22 years, ranging from 18 to 42 years, with a mean age of menarche recorded as 14.78 years (range: 12–16 years). Assessment of the uterine cavity revealed that all patients exhibited a normal uterine shape, with no detectable abnormalities. This finding suggests that uterine structural anomalies were not a predominant factor contributing to infertility in the studied cohort. Tubal assessment revealed that 213 patients (71.2%) demonstrated bilateral tubal patency, while 44 patients (14.7%) exhibited bilateral tubal obstruction. Unilateral tubal obstruction was observed in 41 patients (13.7%), of which 23 cases (7.7%) were on the left side and 18 cases (6.0%) on the right. A total of 211 patients (70.6%) showed no abnormalities on HSG, further highlighting the role of tubal pathology in the remaining subfertile cases. Further analysis was conducted to examine the association between clinical history and tubal or uterine abnormalities observed on HSG. Among patients with a history of abortion, 12% (35 patients) had bilateral tubal obstruction, 6% (18 patients) had unilateral left obstruction, and 5% (15 patients) had unilateral right obstruction, while 65% (191 patients) showed normal findings. Similarly, in patients with prior caesarean sections, 10% (30 patients) had bilateral obstruction, 5% (15 patients) had left-sided obstruction, 7% (21 patients) had right-sided obstruction, and 60% (178 patients) had no abnormalities.

Patients with a history of pelvic disease showed a higher prevalence of bilateral tubal obstruction (18%, 53 patients), with unilateral left and right obstruction occurring in 8% (24 patients) and 7% (21 patients), respectively, and normal findings in 50% (149 patients). In those with a history of dilatation and curettage (D&C), 14% (42 patients) showed bilateral obstruction, 6% (18 patients) left-sided, and 5% (15 patients) right-sided, while 55% (164 patients) showed no abnormalities. When evaluating fallopian tube lumen findings in relation to caesarean section history, patients without such history had 5 (1.7%) dilated right tubes and 4 (1.3%) dilated left tubes. In contrast, those with caesarean sections had no dilated tubes reported. A majority of patients had normal lumens on both sides: 284 (95.6%) on the right and 285 (95.3%) on the left. Peritoneal spill was found to be present in 236 right tubes (79.2%) and 230 left tubes (77.2%) among patients without any prior pelvic surgery, while 62 right (20.8%) and 68 left (22.8%) tubes demonstrated absent spill. Among those with prior pelvic surgery, absent spill was seen in 4 right and 3 left tubes, while present spill was found in 10 right and 11 left tubes. Uterine shape remained normal in all clinical subgroups analyzed. Among those with a history of abortion, 21 patients (7.0%) had a normal uterus. Similarly, patients with a history of caesarean section (15 patients, 5.0%), pelvic disease (22 patients, 7.4%), D&C (24 patients, 8.1%), and prior surgery (14 patients, 4.7%) also demonstrated normal uterine morphology on HSG.

Table 1: Association Between Tubal Abnormalities and Clinical History (n = 299)

Clinical History	Bilateral Tubal Obstruction	Unilateral Left Tubal Obstruction	Unilateral Right Tubal Obstruction	Normal Findings
Abortion	12% (35 patients)	6% (18 patients)	5% (15 patients)	65% (191 patients)
Caesarean Section	10% (30 patients)	5% (15 patients)	7% (21 patients)	60% (178 patients)
Pelvic Diseases	18% (53 patients)	8% (24 patients)	7% (21 patients)	50% (149 patients)
Dilatation & Curettage	14% (42 patients)	6% (18 patients)	5% (15 patients)	55% (164 patients)

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Table 2: The Fallopian/Uterine Tube Lumen H/o Caesarean Section

	Dilated		**Normal**		**Not outlined**	
	Right	Left	Right	Left	Right	Left
No	5	4	270	269	8	10
Yes	0	0	15	15	0	0
	5(1.7%)	4(1.3%)	285(95.6%)	284 (95.3%)	8(2.7%)	10(3.4%)

Table 3: The association of uterine tube findings with history of D&C among the included patients

	Dilated		**Normal**		**Not outlined**	
	Right	Left	Right	Left	Right	Left
No	5	3	263	265	6	8
Yes	0	1	22	19	2	2
	5(1.7%)	4(1.3%)	285(95.6%)	284 (95.3%)	8(2.7%)	10(3.4%)

Table 4: The association of peritoneal spill by uterine tubes with history of pelvic surgery among the included patients

	Absent		**Present**	
	Right	Left	Right	Left
No	58	65	226	219
Yes	3	3	10	11
	62(20.8%)	68(22.8%)	236(79.2%)	230 (77.2%)

Table 5: The association of abortion with uterine shape found on hysterosalpingography among the included patients

	Uterus shape	
H/o abortion	Normal	
No	277	277 (93.0%)
Yes	21	21 (7.0%)
	298(100.0%)	298

Table 6: The association of C- Section with uterine shape found on C-section patients

	Uterus shape	
H/o C- Section	Normal	
No	283	283 (95.0%)
Yes	15	15 (5.0%)
	298(100.0%)	298

Table 7: Association of Uterine Shape with History of Pelvic Disease, Dilatation and Curettage (D&C), and Surgery in Infertile Women Assessed by Hysterosalpingography

Clinical History	**Normal Uterus (n)**	**Normal Uterus (%)**	**Total Patients (n)**
No Pelvic Disease	276	92.6%	298
History of Pelvic Disease	22	7.4%	
No D&C	274	91.9%	298
History of D&C	24	8.1%	
No Surgery	284	95.3%	298
History of Surgery	14	4.7%	

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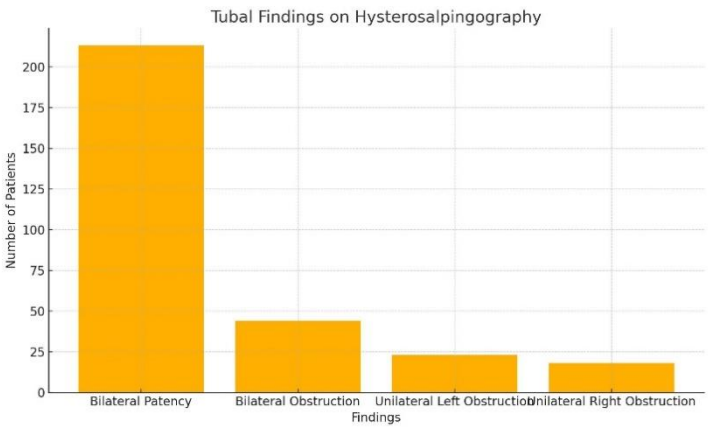

Figure 1 Tubal Findings on Hysterosalpingography

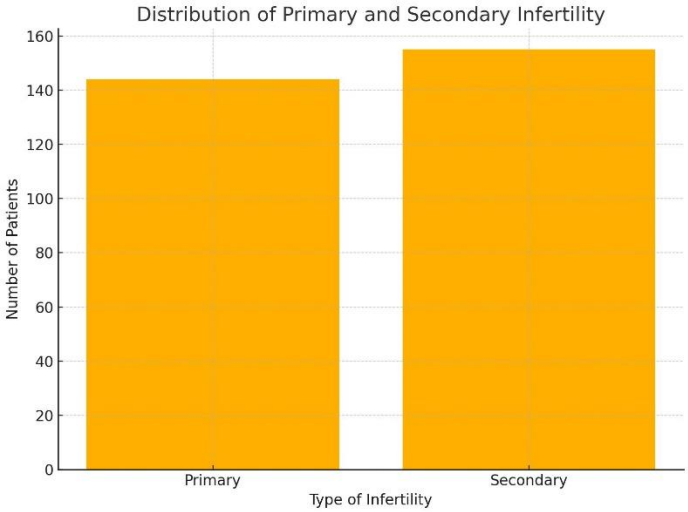

Figure 2 Distribution of Primary and Secondary Infertility

DISCUSSION

The findings of this study reaffirm the prevailing global understanding that uterine abnormalities are not the predominant cause of female infertility, while tubal factors continue to play a significant role in reproductive failure (12). The observed rate of bilateral tubal obstruction in this cohort, alongside the overall 29.4% detection of any tubal abnormality, aligns closely with existing data estimating that tubal factors contribute to 35–40% of infertility cases worldwide (13,14). This underscores the critical role that fallopian tube integrity plays in natural conception and the necessity for timely diagnostic evaluation in women experiencing infertility. The higher proportion of secondary infertility observed in this population, comprising 52% of the total sample, is also consistent with data from regions with elevated risks of pelvic infections, surgical interventions, and unsafe abortions (15,16). This suggests that post-pregnancy complications, often preventable with improved maternal care and infection control, continue to compromise fertility. In areas where sexually transmitted infections, postpartum sepsis, and iatrogenic trauma remain inadequately addressed, the burden of secondary infertility remains particularly pronounced (17). A noteworthy finding in this study was the absence of structural uterine abnormalities on hysterosalpingography in all participants. While this may reflect true anatomical normalcy, it also highlights one of the known limitations of HSG—its limited sensitivity for detecting certain intrauterine conditions such as subtle adhesions, polyps, or endometrial abnormalities. In comparison, advanced imaging modalities or direct visualization techniques like hysteroscopy offer higher diagnostic accuracy for intrauterine pathology (18). The complete lack of uterine findings, despite a relatively large sample size, may therefore indicate an underestimation or limitation in the diagnostic reach of the chosen modality.

The study demonstrated the practical utility of hysterosalpingography as a first-line diagnostic tool. It remains a widely accepted, non-invasive, and cost-effective imaging technique for initial fertility assessments, particularly in low-resource settings (18,19). In addition to its diagnostic capacity, HSG provides a therapeutic benefit through contrast-induced flushing of fallopian tubes, which may enhance fertility in selected cases by resolving minor blockages (20). These dual advantages reinforce its clinical value, especially where access to more advanced diagnostic methods is limited. Nevertheless, certain limitations of the study must be acknowledged. The use of a convenience sampling technique may have introduced selection bias, potentially affecting the generalizability of findings. Additionally, the absence of adjunctive imaging or confirmatory procedures such as laparoscopy or hysteroscopy limits the ability to cross-validate findings and fully exclude conditions beyond the resolution of HSG. The lack of statistical correlation tests further restricts inferential conclusions regarding the associations between clinical history and imaging abnormalities. The study's reliance on descriptive outcomes alone is a limitation that future investigations could address through the inclusion of statistical modeling or comparative subgroup analyses.

Despite these constraints, the study offers important insights into the structural assessment of infertility, particularly in highlighting the prevalence of tubal obstruction and its associations with reproductive history. Future research could benefit from a more robust

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methodological framework, incorporating multiple diagnostic modalities, comparative population groups, and long-term fertility outcomes post-HSG. Expanding diagnostic parameters to include functional assessments of tubal motility or endometrial receptivity may also enhance the clinical applicability of such investigations. Overall, this study contributes meaningful data to the understanding of infertility diagnostics and reinforces the continued relevance of HSG in routine gynecological practice, while simultaneously calling attention to areas in need of deeper evaluation and integration with broader diagnostic strategies.

CONCLUSION

Hysterosalpingography proved to be a valuable and practical diagnostic tool in the evaluation of female infertility, particularly in identifying tubal abnormalities that often hinder conception. This study highlighted the consistent relevance of HSG in detecting both normal and pathological findings of the uterus and fallopian tubes, supporting its role as a primary investigative step in infertility workups. The prominence of tubal factors among the abnormalities observed underscores the importance of early and accurate imaging in guiding timely clinical decisions. While HSG remains indispensable, integrating it with complementary diagnostic approaches ensures a more comprehensive understanding and management of infertility.

AUTHOR CONTRIBUTION

Author	Contribution
Saba Waleed*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Syed Zaigham Ali Shah	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published

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