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Corresponding Author

Adeela Anwar Rana

Department of Obstetrics and
Gynecology, Sheikh Zayed Medical
College/Hospital, Rahim Yar Khan

Email: adeelaanwar1155@gmail.com

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Original Article

Comparative Evaluation of Hysterosalpingography—(HSG) and Diagnostic Hysterolaparoscopy in Female Subfertility and their Impact on Natural Conception Rates and Detection of Pelvic and Tubal Pathologies

Saima Zulfiqar¹, Sadia Zulfiqar², Adeela Anwar Rana³, Aisha Javed⁴, Tahira Afzal Durrani⁵

1. Department of Obstetrics and Gynecology, Sheikh Zayed Medical College/Hospital, Rahim Yar Khan
2. Department of Obstetrics and Gynecology, Sheikh Zayed Medical College/Hospital, Rahim Yar Khan
3. Department of Obstetrics and Gynecology, Sheikh Zayed Medical College/Hospital, Rahim Yar Khan
4. Department of Obstetrics and Gynecology, Sheikh Zayed Medical College/Hospital, Rahim Yar Khan
5. Department of Obstetrics and Gynecology, Sheikh Zayed Medical College/Hospital, Rahim Yar Khan

Abstract

Objective: To evaluate the diagnostic performance of hysterosalpingography (HSG) for detecting tubal pathology using diagnostic hystero-laparoscopy with chromopertubation as the reference standard, and to assess the association of tubal and pelvic findings with subsequent natural conception.

Methodology: This Comparative Cross-Sectional Study Was Conducted in The Department of Obstetrics and Gynecology, Sheikh Zayed Medical College/Hospital, Rahim Yar Khan, Punjab, Pakistan, From June 2025 To May 2026. We performed HSG in 180 women with primary or secondary subfertility during the early proliferative phase of the menstrual cycle using 10–15 mL of water-soluble iodinated contrast medium under fluoroscopic guidance. We then performed diagnostic hystero-laparoscopy during the follicular phase, generally within 2–4 weeks of HSG, under general anesthesia. We assessed tubal patency laparoscopically by chromopertubation using diluted methylene blue dye. HSG was the index test, and hystero-laparoscopy with chromopertubation was the reference standard. We recorded pelvic abnormalities identified during laparoscopy separately and did not consider them mutually exclusive. We followed participants for six months after completing the diagnostic evaluation to document natural conception.

Results: Most participants were aged 26–30 years (36.67%), and 56.67% had primary subfertility. HSG showed 70.91% sensitivity, 74.29% specificity, and 72.22% diagnostic accuracy for tubal pathology. Pelvic adhesions (32.22%) were most common. Natural conception occurred in 35.56% during six months, with higher rates among women with normal tubal findings.

Conclusion: Hystero-laparoscopy is more accurate for diagnosis and more useful for prognosis for natural conception than HSG in female subfertility.

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Introduction

Subfertility is a major clinical and public health problem and causes a significant amount of psychological distress, marital strain, and social consequences amongst affected couples [1,2]. The inability to conceive after a year of regular, unprotected sex is defined as such [3]. Almost half of all cases of infertility are due to female-related factors, and there is a broad range of underlying causes such as ovulatory dysfunction, tubal blockage, pelvic adhesions, endometriosis, uterine anomalies, and peritoneal disease [4]. These include tubal and pelvic diseases, which are believed to be the most important and potentially correctable subfertility causes and should therefore be accurately evaluated during an infertility workup [5]. Evaluation of tubal patency and pelvic anatomy is a key component in determining appropriate management in infertile women [6]. Because of its availability, low cost, and ability to evaluate uterine cavity morphology and fallopian tube patency, Hysterosalpingography (HSG) is the most frequently used initial diagnostic procedure [7]. It also provides indirect information about peritoneal spill, potentially indicating the tube's ability to function. In some cases, HSG is also thought to have a therapeutic effect due to flushing of the tubes and may enhance spontaneous conception rates [8]. However, HSG is not particularly useful for detecting peritubal adhesions, endometriosis, or subtle pathologies within the pelvis [9]. It can also provide an inaccurate diagnosis, either due to tubal spasm or technical reasons, which can impact clinical decisions [10]. Diagnostic hystero-laparoscopy, by contrast, is considered the standard technique for a full evaluation of infertility and allows direct visualization of the uterine cavity, fallopian tubes, ovary, and pelvic peritoneum [11,12]. Moreover, it can diagnose and treat correctable abnormalities such as adhesions, endometriotic lesions, and tubal distortions at the same time [13]. However, because of its superior diagnostic power, hystero-laparoscopy is invasive, costly, and requires anesthesia; therefore, it is not necessarily the best screening method in many scenarios. Therefore, a need exists to assess the comparative diagnostic accuracy of HSG and hystero-laparoscopy, especially when evaluating underlying pelvic and tubal pathology and its potential impact on future natural conception success.

Material and Methods

Study Design and Setting

This comparative cross-sectional study was conducted in the Department of Obstetrics and Gynecology, Sheikh Zayed Medical College/Hospital, Rahim Yar Khan, Punjab, Pakistan, from June 2025 to May 2026.

Sample Size and Sampling Technique

A total of 180 female patients with either primary or secondary subfertility were recruited for the study. We used a non-probability consecutive sampling technique to recruit patients who met the inclusion and exclusion criteria. We included all participants after obtaining informed written consent.

Inclusion and Exclusion Criteria

Women aged 20-40 years who presented for subfertility (primary or secondary) for a minimum of one year were included. We included patients willing to undergo both HSG and diagnostic hystero-laparoscopy who signed the informed consent form. Male factor infertility, active pelvic inflammatory disease, genital tuberculosis, pregnancy, contraindication to surgery or anesthesia, previous diagnosis of genital malignancy, and non-compliance were exclusion criteria.

Data Collection

We obtained demographic and clinical data using a structured proforma. We collected data on age, length and nature of infertility, menstrual and obstetric history, previous pelvic surgery, and relevant medical history. We clinically assessed all eligible patients, then performed HSG and diagnostic hystero-laparoscopy. We then assessed spontaneous conception outcomes.

Clinical Evaluation of Patients

We conducted comprehensive general, abdominal, and pelvic examinations on all patients. We performed complete blood count, hormonal profile, transvaginal ultrasonography, and semen analysis tests on the husbands and reviewed the results. Clinical data suggestive of endometriosis, PID, or adnexal disease were carefully documented.

Hysterosalpingography (HSG) Procedure

Hysterosalpingography was performed during the early proliferative phase of the menstrual cycle, usually between days 7 and 10, after cessation of menstrual bleeding and before expected ovulation. Pregnancy and active pelvic infection were excluded before the procedure. Under aseptic conditions, the patient was placed in the lithotomy position, the cervix was visualized using a sterile speculum, and the external cervical os was cleansed with an antiseptic solution. A cervical cannula or balloon catheter was introduced through the cervical canal. Approximately 10–15 mL of water-soluble iodinated contrast medium was injected slowly under fluoroscopic guidance. Images were obtained during filling of the uterine cavity, opacification of the fallopian tubes, and subsequent peritoneal spill. We obtained additional oblique images as needed to improve visualization. We classified a tube as patent when contrast passed through the entire fallopian tube with free intraperitoneal spill. We diagnosed tubal obstruction when contrast failed to progress beyond a defined portion of the tube with absent peritoneal spill. We defined unilateral obstruction as obstruction of one tube with demonstrated patency of the contralateral tube. In contrast, we defined bilateral obstruction as failure of contrast passage and spill from both tubes. We defined hydrosalpinx as abnormal dilatation of the fallopian tube, usually with distal dilatation and absent or restricted free peritoneal spill. HSG findings were recorded separately for each participant before hystero-laparoscopy.

Diagnostic Hystero-Laparoscopy and Chromoperturbation

Diagnostic hystero-laparoscopy was performed during the follicular phase of the menstrual cycle, generally within 2–4 weeks after HSG, under general anesthesia. Hysteroscopy was performed first to systematically evaluate the cervical canal, uterine cavity, endometrial surface, and tubal ostia, and to identify abnormalities such as polyps, intrauterine adhesions, septa, submucosal lesions, or congenital uterine anomalies. Diagnostic laparoscopy was subsequently performed using standard abdominal entry techniques. We systematically inspected the uterus, bilateral fallopian tubes, ovaries, pouch of Douglas, uterosacral ligaments, pelvic sidewalls, and pelvic peritoneum. We documented endometriosis, ovarian cysts, tubo-ovarian masses, hydrosalpinx, pelvic adhesions, peritubal adhesions, and distortion of tubo-ovarian anatomy. Tubal patency was assessed by chromoperturbation. Diluted methylene blue solution, approximately 20–30 mL, was slowly introduced through a cervical/uterine cannula while both fallopian tubes were directly visualized laparoscopically. A tube was considered patent when dye passed through the tube with visible free spill from the fimbrial end into the peritoneal cavity. We diagnosed tubal obstruction when no fimbrial spill was observed despite adequate dye instillation. We classified obstruction as unilateral or bilateral based on involvement of one or both tubes. We defined hydrosalpinx laparoscopically as visible dilatation/distension of the fallopian tube, particularly the ampullary portion, associated with distal tubal disease. We defined peritubal or pelvic adhesions as abnormal fibrous attachments involving the fallopian tube, ovary, uterus, or adjacent pelvic structures, with or without distortion of normal tubo-ovarian anatomy. For diagnostic-accuracy calculations, HSG served as the index test, and hystero-laparoscopy with chromoperturbation served as the reference standard for tubal pathology.

Assessment of Tubal Pathology

We identified and compared tubal abnormalities on HSG and diagnostic hystero-laparoscopy. The tubal pathologies evaluated were unilateral or bilateral tubal blockage, hydrosalpinx, distorted tubal, impaired dye spill, and peritubal adhesions. We assessed agreement between the two modalities.

Assessment of Pelvic Pathology

We recorded all pelvic pathologies detected during hystero-laparoscopy. These encompassed the presence of endometriosis, pelvic adhesions, ovarian cysts, tubo-ovarian masses, uterine anomalies, pelvic inflammatory changes, and other associated

abnormalities. All participants were followed for six months after completion of diagnostic hystero-laparoscopy to assess subsequent natural conception. We used the date of hystero-laparoscopy as the follow-up baseline because all participants had completed both HSG and hystero-laparoscopic evaluation before the observation period began. We followed participants monthly for six months through scheduled outpatient visits and, when a clinic visit was not feasible, by telephone contact. At each follow-up, participants were asked about menstrual history, regularity of unprotected intercourse, symptoms suggestive of pregnancy, use of contraception, and any medical, surgical, or assisted reproductive treatment received since the previous assessment. All 180 participants completed the six-month follow-up, with no loss to follow-up. Participants were not using contraception during the observation period and were advised to continue regular unprotected intercourse if attempting conception. No assisted reproductive techniques, including intrauterine insemination, in vitro fertilization, or intracytoplasmic sperm injection, were used during the follow-up period. For this study, natural conception was defined as pregnancy occurring through spontaneous intercourse without ovulation induction, assisted reproductive technology, or any subsequent medical or surgical fertility-enhancing intervention during the follow-up period. Participants reporting a missed menstrual period were initially assessed using a urinary pregnancy test. Pregnancy was subsequently confirmed by ultrasonography demonstrating an intrauterine gestational sac, with further assessment according to routine obstetric practice. We calculated time to conception from the date of hystero-laparoscopy to the estimated date of conception. Women who did not achieve pregnancy within six months were classified as not having conceived during the predefined follow-up period.

Outcome Measures

The primary outcome measures were the detection rates of tubal and pelvic pathologies with HSG and diagnostic hystero-laparoscopy, comparison of diagnostic findings between the two procedures, and evaluation of natural conception rates after diagnostic evaluation. Secondary outcomes included the frequency of uterine abnormalities and distribution of different infertility-related pathologies.

Data Recording and Variables

We recorded all collected data in a structured data collection form. Variables included patient age, type and duration of infertility, menstrual characteristics, HSG findings, hysteroscopic findings, laparoscopic findings, tubal patency status, pelvic pathology, and spontaneous conception outcomes.

Statistical Analysis

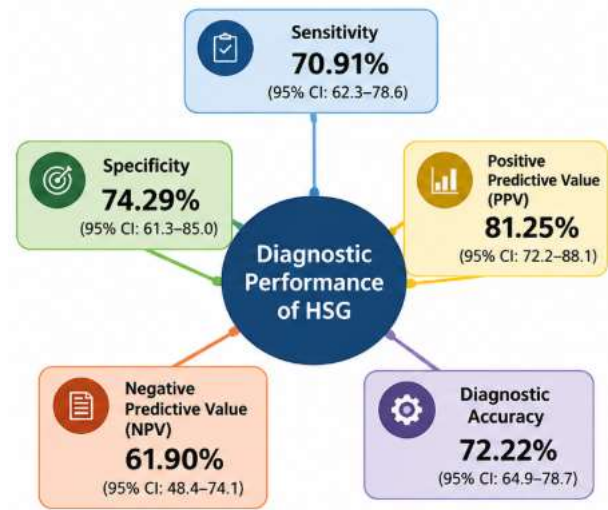
We analyzed data using the Statistical Package for the Social Sciences (SPSS), version 26. We summarized quantitative variables, including age and duration of subfertility, as mean and standard deviation, where appropriate. Categorical variables, including type of subfertility, tubal blockage, pelvic pathology, and conception outcome, were presented as frequencies and percentages. For diagnostic performance assessment, hysterosalpingography (HSG) was the index test, while diagnostic hystero-laparoscopy with chromopertubation was the reference standard for detecting tubal pathology. We constructed a 2 × 2 diagnostic table to classify HSG findings as true positive, false positive, false negative, or true negative based on hystero-laparoscopic findings. We then calculated HSG sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy. We assessed associations between categorical variables and natural conception outcomes using the chi-square test or Fisher's exact test, as appropriate. For comparisons involving paired diagnostic findings from HSG and hystero-laparoscopy in the same participants, an appropriate paired statistical test, including McNemar's test for paired binary outcomes, was used where applicable. We considered a two-sided p-value <0.05 statistically significant.

Results

A total of 180 women with primary or secondary subfertility were included. Most participants were aged 26–30 years (66/180, 36.67%), followed by 31–35 years (48/180, 26.67%), 20–25 years (42/180, 23.33%), and 36–40 years (24/180, 13.33%). Primary subfertility was present in 102 (56.67%) participants and secondary subfertility in 78 (43.33%). Subfertility lasted 1–3 years in 74 (41.11%), 4–6 years in 68 (37.78%), and more than 6 years in 38 (21.11%) participants (Table 1).

Using diagnostic hystero-laparoscopy with chromopertubation as the reference standard, tubal pathology was identified in 110 (61.11%) participants and was absent in 70 (38.89%). HSG identified tubal pathology in 96 (53.33%) participants and no tubal pathology in 84 (46.67%). There were 78 true positives, 18 false positives, 32 false negatives, and 52 true negatives. Accordingly, HSG had a sensitivity of 70.91%, specificity of 74.29%, positive predictive value (PPV) of 81.25%, negative predictive value (NPV) of 61.90%, and overall diagnostic accuracy of 72.22% (Table 2A; Figure 1). The Pearson chi-square test for the 2 × 2 classification table was 35.11 (df = 1, p < 0.001), indicating a significant association between HSG and hystero-laparoscopic classification. Because both tests were performed in the same participants, we also assessed paired disagreement using McNemar's test; discordant pairs included 18 HSG-positive/hystero-laparoscopy-negative and 32 HSG-negative/hystero-laparoscopy-positive cases, with no statistically significant difference on exact testing (p ≈ 0.065) (Table 2B). Hystero-laparoscopy identified pelvic adhesions in 58 (32.22%) participants, endometriosis in 46 (25.56%), ovarian cysts in 34 (18.89%), uterine anomalies in 22 (12.22%), and tubo-ovarian masses in 16 (8.89%). Overall, 140 (77.78%) participants had at least one pelvic abnormality, whereas 40 (22.22%) had no pelvic pathology. Because pelvic findings could coexist within the same participant, the individual pathology percentages are not mutually exclusive (Figure 2). Comparison of individual tubal findings showed that HSG classified 92 (51.11%) participants as having normal tubes compared with 70 (38.89%) on hystero-laparoscopy. HSG reported unilateral tubal block in 44 (24.44%) participants and 50 (27.78%) on hystero-laparoscopy; bilateral block in 26 (14.44%) and 38 (21.11%), respectively; and hydrosalpinx in 18 (10.00%) and 22 (12.22%), respectively. Peritubal adhesions were not identified by HSG but were detected in 42 (23.33%) participants by hystero-laparoscopy (Table 3). The reported marginal chi-square values should not be interpreted as paired tests because HSG and hystero-laparoscopy were performed in the same participants. For paired comparisons, the appropriate analysis is McNemar's test, which requires participant-level cross-tabulations for each finding; the source data did not include these paired cross-tabulations. Therefore, Table 3 is presented descriptively without p-values for the individual findings.

Figure 1. Diagnostic performance of HSG for detecting tubal pathology.



HSG was evaluated against diagnostic hystero-laparoscopy with chromopertubation as the reference standard. PPV, positive predictive value; NPV, negative predictive value.

Table 1. Baseline Characteristics of Study Participants (n = 180)

Variable	Category	n	%
Age (years)	20–25	42	23.33
	26–30	66	36.67
	31–35	48	26.67
	36–40	24	13.33
Type of subfertility	Primary	102	56.67
	Secondary	78	43.33

Duration of subfertility	1-3 years	74	41.11
	4-6 years	68	37.78
	>6 years	38	21.11

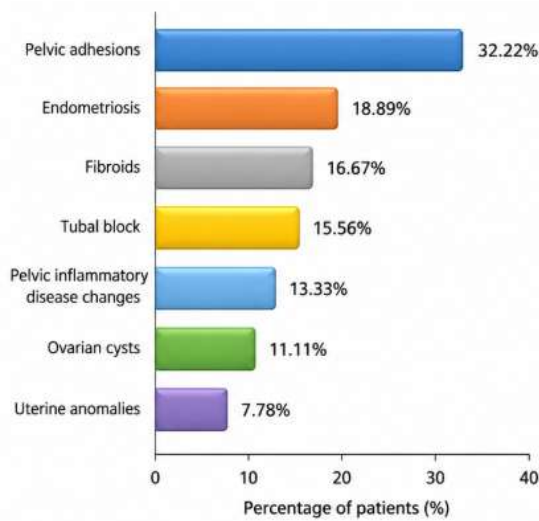
Values are presented as frequency (n) and percentage (%). Percentages are based on the total study population (n = 180).

Table 2A. Diagnostic Performance of HSG Using Hystero-Laparoscopy as the Reference Standard

Parameter	Value
Sensitivity	70.91%
Specificity	74.29%
Positive predictive value (PPV)	81.25%
Negative predictive value (NPV)	61.90%
Overall diagnostic accuracy	72.22%

HSG was the index test, and diagnostic hystero-laparoscopy with chromopertubation was the reference standard. PPV, positive predictive value; NPV, negative predictive value.

Figure 2. Pelvic pathologies detected by hystero-laparoscopy (n = 180).



Diagnostic hystero-laparoscopy identified pelvic pathologies. Individual findings were not mutually exclusive and could coexist in the same participant; therefore, percentages do not necessarily sum to 100%.

Table 2B. Association Between HSG and Hystero-Laparoscopic Classification

Comparison	χ^2	df	p-value
HSG vs hystero-laparoscopy (tubal pathology)	35.11	1	<0.001

We used Pearson’s chi-square test to assess the association between HSG and hystero-laparoscopic tubal pathology classification. We considered $p < 0.05$ statistically significant.

Table 3. Tubal Findings Detected by HSG and Hystero-Laparoscopy (n = 180)

Tubal finding	HSG present, n (%)	Hystero-laparoscopy present, n (%)
Normal tubes	92 (51.11)	70 (38.89)
Unilateral block	44 (24.44)	50 (27.78)
Bilateral block	26 (14.44)	38 (21.11)
Hydrosalpinx	18 (10.00)	22 (12.22)
Peritubal adhesions	0 (0.00)	42 (23.33)

Tubal findings are presented as frequency and percentage. We analyzed individual findings separately; they were not mutually exclusive. Because both diagnostic methods were performed in the same participants, paired comparisons require participant-level cross-tabulation.

Discussion

The present study found that hysterosalpingography (HSG) had a sensitivity of 70.91%, specificity of 74.29%, PPV of 81.25%, NPV of 61.90%, and overall accuracy of 72.22% compared with diagnostic hystero-laparoscopy. These results are consistent with previous studies showing HSG's moderate diagnostic accuracy, especially for evaluating tubal patency. Yildirim et al. reported similar HSG sensitivity of 85% and specificity of 65%, suggesting that although HSG is useful as a screening tool, it is less accurate than laparoscopy for definitive diagnosis of tubal disease [14]. In this study, HSG identified 78 true-positive cases, 18 false-positive cases, and 32 false-negative cases, demonstrating the test's limitations in distinguishing functional from true tubal disease. This pattern is also observed in the literature on infertility, with false-positive results often attributed to a tubal spasm or technical problems. In addition, previous studies showed that HSG diagnostic accuracy is reduced, especially in complex infertility cases; in our study, we had 32 false-negative cases among 180 patients [9,15,16]. Pathology identified in the left and right pelvis using hystero-laparoscopy was significantly higher than that identified using hystero-ovarian sonography. It included left- and right-sided pelvic adhesions (32.22%), endometriosis (25.56%), left- or right-sided ovarian cysts (18.89%), and tubo-ovarian masses (8.89%). Hystero-ovarian sonography failed to detect peritubal adhesions in 23.33% of cases. This superiority of laparoscopy is well supported by previous studies, where other pelvic abnormalities were found in as many as 40% of women with normal HSG. Research studies have also reported that laparoscopy revealed a significant amount of concealed pelvic disease in infertile women, thus establishing it as the gold standard for diagnostic laparoscopy [17]. Regarding tubal findings, results indicated differences between HSG and laparoscopy: normal tubal and bilateral tubal block frequencies were 51.11% and 14.44%, respectively, on HSG versus 38.89% and 21.11%, respectively, on laparoscopy. Gupta and Upreti claim similar differences in the rate of tubal patency determined by HSG and the failure to detect distal tubal disease in almost 25% of infertile women. [18] This re-emphasizes the need for caution in interpreting HSG in cases of suspected tubal infertility. Regarding reproductive outcomes, the present study found a 35.56% spontaneous conception rate after six months, highest among women with normal tubes (48.57%) and lowest among women with hydrosalpinx (18.18%). These observations are consistent with previous investigations that found significantly lower fertility when tubal pathology was present than when it was normal, highlighting the importance of evaluating the tubes in predicting fertility outcomes [19]. In addition, a small number of women with pelvic pathology (19.30%) had become pregnant. In comparison, the large number of women without pelvic pathology (60.00%) had become pregnant ($p < 0.001$), illustrating how significant undiagnosed pelvic disease is. Laparoscopy-based studies have yielded similar findings, in which rates of conception are significantly decreased in those with untreated endometriosis and normal HSG. Previous research also emphasized laparoscopy as a means of detecting clinically significant lesions that HSG would miss, and that could affect fertility prognosis [20,21]. Strengths of this study include its prospective comparative design, sample size, and head-to-head comparison of hysterosalpingography (HSG) with diagnostic hystero-laparoscopy (DH-LAP), considered the gold standard for evaluating tubal and pelvic disease. It offers a comprehensive assessment by linking diagnostic findings to clinically relevant reproductive outcomes, such as subsequent natural conception at follow-up, thereby improving its clinical utility in evaluating infertility. The introduction of both tubal and pelvic abnormalities provides a more comprehensive assessment of the infertility-related pathology than studies using only one diagnostic modality [22]. The study's limitations, however, include its single-center setting, which may limit generalizability to larger populations. The short follow-up period may also underestimate longer-term pregnancy outcomes. Furthermore, diagnostic bias may have occurred because observers interpreted imaging and laparoscopic findings differently and the study was not blinded. Cost-effectiveness analysis is not available, and long-term reproductive outcomes are not evaluated, limiting assessment of the overall clinical and economic impact of these diagnostic strategies.

Conclusion

Based on these results, hysterosalpingography has satisfactory diagnostic accuracy for assessing tubal pathology and lower accuracy for detecting associated pelvic abnormalities than diagnostic hystero-laparoscopy, a more comprehensive method for identifying clinically significant lesions of the reproductive tract. The study also shows differences in natural conception rates based on the underlying tubal and pelvic condition, with higher rates in patients with normal tubal and pelvic findings and lower rates in patients with

hydrosalpinx and/or pelvic pathology. Overall, these results emphasize the important role of hystero-laparoscopy in providing both accurate diagnostic information and valuable prognostic insight in the management of female subfertility.

Ethical Approval

The Institutional Review Board of Sheikh Zayed Medical College/Hospital, Rahim Yar Khan, Pakistan granted ethical approval through expedited review (Ref. No. 08/IRB/SZMC/SZH, dated 21/01/2026) before study commencement.

Authors' Contributions

Saima Zulfiqar: Conceptualization, study design, supervision, data interpretation, critical revision of the manuscript for important intellectual content, final approval of the version to be published, and accountability for all aspects of the work.

Sadia Zulfiqar: Conceptualization, study design, data collection, data curation, statistical analysis, data interpretation, manuscript drafting, critical revision of the manuscript, final approval of the version to be published, and accountability for all aspects of the work.

Adeela Anwar Rana: Data collection, data curation, literature review, data interpretation, manuscript revision, final approval of the version to be published, and accountability for all aspects of the work.

Aisha Javed: Data collection, laboratory assessment, data curation, literature review, manuscript revision, final approval of the version to be published, and accountability for all aspects of the work.

Tahira Afzal Durrani: Study supervision, interpretation of findings, critical review of the manuscript for important intellectual content, final approval of the version to be published, and accountability for all aspects of the work.

All authors approved the final version of the manuscript and agreed to be accountable for all aspects of the work in accordance with ICMJE authorship criteria.

Conflict of Interest

The authors declare no conflict of interest related to this study's conduct, authorship, or publication.

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This study received no external funding. The research used available institutional resources. No funding agency was involved in the study design, data collection, analysis, interpretation, or manuscript preparation.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request. The data are not publicly available due to privacy and confidentiality considerations for the study participants.

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