A COMPARATIVE ANALYSIS OF ULTRASOUND AND X-RAY HYSTEROSALPINGOGRAPHY FOR THE DIAGNOSIS OF ABNORMALITIES IN THE FEMALE REPRODUCTIVE TRACT IN INFERTILITY

Maida Hassan[1], Sana Javed[*2], Fiaz Hussain[3], Sadia Ismial[4], Umme Summaya[5], Mubashra Farooq[6], Marriam Asghar[7]

[1, *2, 3, 4, 5, 6, 7]*Riphah International University, Faisalabad, Pakistan*

Corresponding Author: *
Sana Javed

DOI: https:/doi.org/10.5281/zenodo.15853286

Received	Accepted	Published
02 April, 2025	23 June, 2025	10 July, 2025

ABSTRACT
Background: *Accurate identification of uterine abnormalities is essential in the diagnostic workup of Female infertility. Transvaginal sonography and hysterosalpingography are commonly used imaging modalities; however, their comparative diagnostic accuracy remains under evaluation.*
Objective: *This study aimed to compare the diagnostic accuracy of Transvaginal sonography and hysterosalpingography in detecting uterine abnormalities among women presenting with infertility.*
Methods: *A cross-sectional diagnostic accuracy study was conducted involving 78 infertile women Age between 22 and 40 years. All participants underwent both Transvaginal sonography and hysterosalpingography evaluations. Data were collected regarding the presence or absence of specific uterine abnormalities, including endometrial polyps, fibroids, endometrial hyperplasia, subseptated uterus, intrauterine adhesions, and congenital anomalies. Sensitivity, specificity, positive predictive value, and negative predictive value were calculated using standard formulas.*
Results: *TVS demonstrated high specificity (100%) and PPV (100%) across all uterine abnormalities. Sensitivity varied depending on the pathology, with higher sensitivity observed for fibroids (80%) and endometrial hyperplasia (66.67%), and lower values for endometrial polyps (63.64%), intrauterine adhesions (60%), and subseptated uterus (44.44%). HSG identified more cases across most abnormalities, particularly congenital anomalies and obliterate athologies, highlighting its higher sensitivity. No cases of septated or unicornuate uterus were detected in this study.*
Conclusion: *TVS is a highly specific and non-invasive tool for diagnosing uterine abnormalities, particularly effective in confirming fibroids and endometrial conditions. However, HSG offers superior sensitivity for detecting congenital anomalies and intrauterine adhesions. The combined use of TVS and HSG enhances diagnostic accuracy and supports comprehensive infertility evaluation and management.*
Keywords: *Transvaginal sonography, hysterosalpingography, infertility, diagnostic accuracy, uterine abnormalities, sensitivity, specificity.*

INTRODUCTION

Globally, infertility poses a significant public health challenge, with fallopian tube blockages caused by infections being the leading cause among females (Abebe et al., 2020). Compared to primary infertility, secondary infertility is more common and often points to post-abortion or postpartum infections as underlying causes (Egbe et al., 2020). Infertility is defined as the failure to achieve pregnancy after 12 months of consistent, unprotected sexual intercourse, or as the inability to conceive due to underlying reproductive issues affecting an individual's or couple's reproductive capacity (Duffy et al., 2020; Riaz et al., 2022). "Infertility is categorized as either primary or secondary. Primary infertility refers to the inability to achieve pregnancy after 12 months or more of regular, unprotected sexual intercourse in couples who have never used contraceptives and have never conceived. In contrast, secondary infertility is defined as the inability to have a live birth despite desiring a child, among women who have been in a relationship for at least five years since their last childbirth and have not used any form of contraception during that period" (Mubashar et al., 2022). Uterine abnormalities are among the leading causes of female infertility. The proper formation of uterus, fallopian tubes, cervix, and the upper vagina depends on the normal development of the müllerian ducts. Such abnormalities can interfere with embryo implantation or lead to pregnancy loss and the premature delivery. These conditions may be either congenital or can be acquired, affecting endometrium or myometrium and causing distortion of uterine cavity. They account for approximately 2% to 5% of infertility cases. Congenital müllerian anomalies range from complete absence of uterus and vagina, as seen in the Rokitansky Küster Hauser syndrome, to structural defects like bicornuate, septate, or arcuate uteri (Adekoya et al., 2024). Acquired conditions such as intramural fibroids and submucosal affecting the 25% to 50% of the women, particularly those of the African descent can distort uterine cavity and impair their blood supply. The intrauterine adhesions often result from the endometritis linked to traumatic deliveries, dilatation and curettage during pregnancy termination, intrauterine devices, or other procedures involving the endometrial cavity, leading to partial or complete cavity obliteration. Intracavitary lesions are recognized as contributors to infertility, and their surgical removal may enhance fertility. Following hysteroscopic polypectomy, pregnancy rates between 50% and 78% have been reported in previously infertile women (Huynh et al., 2021). Hysterosalpingography is a commonly used imaging technique in gynecological practice for evaluating female infertility. It involves injecting contrast material through the cervical canal, allowing visualization of uterine cavity, the fallopian tubes, and also the surrounding peritoneal structures (Bitrus et al., 2025). In our setting, hysterosalpingography remains the preferred method for the evaluation of the fallopian tube patency and is one of the most commonly performed uterine procedures in women with infertility. Tubal disease, often resulting from genital infections, is a major contributing factor to infertility in this population (Bitrus et al., 2025; Mubashar et al., 2022).Transvaginal sonography, commonly known as transvaginal ultrasound, is an imaging technique used to assess the female reproductive organs and pelvic region. It involves the use of a specialized instrument called a transvaginal probe, which is inserted into the vaginal canal. Unlike conventional abdominal ultrasound, where the transducer is placed on the skin surface, transvaginal sonography offers a clearer and more detailed visualization of the pelvic structures (Thaker et al., 2023).

Methodology

All patients with uterine abnormalities were admitted between March 2025 to June 2025 in the Faisal Hospital Faisalabad, Pakistan and their data gathered retrospectively. The sample of this study was 78 patients calculated by open epi software. All patients diagnosed with uterine abnormalities by Transvaginal sonography and hysterosalpingography will be included in the study. Ultrasound and x-ray machine was used, and procedure is performed by technologist and reporting have been done by radiologist. The data was collected on questionnaire that covered all aspects of patient with history of uterine abnormalities and TVS and HSG findings needed for research.

RESULTS AND DISCUSSION

A total of 78 participants meeting the eligibility criteria were enrolled in this cross-sectional diagnostic accuracy study. Each participant underwent both transvaginal sonography (TVS) and X-ray hysterosalpingography (HSG), allowing direct comparison of findings within the same individuals. The detailed findings are presented below, supported by clearly labeled tables and figures.

Descriptive Statistics of Age of Participants

Variable	N	Minimum	Maximum	Mean	SD
Age of Subjects	78	22	40	30.13	4.60

Note. SD = Standard Deviation

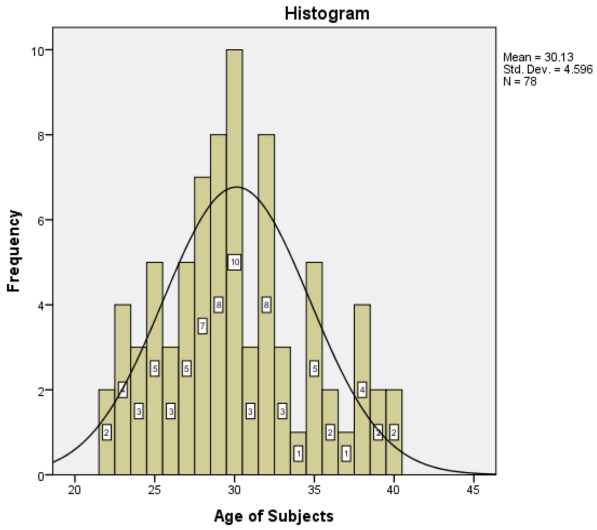

Figure 1: Histogram of age of subjects

The histogram demonstrates that the age distribution of participants is approximately normal, centered around the mean age of 30.13 years. Most subjects fall within the 25–35 age range, with frequencies peaking near the mean. The distribution indicates a moderately young study population, with ages spanning from 22 to 40 years.

Graphical Representation of Marital Status Distribution

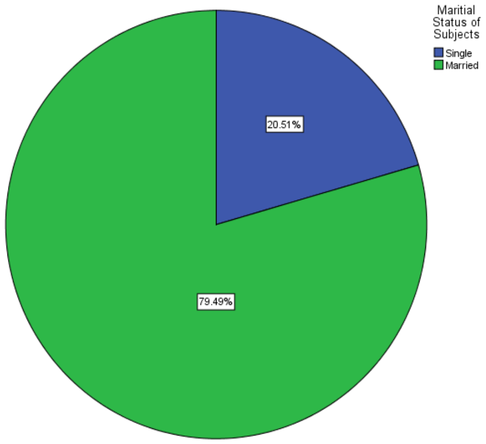

Figure 2: Pie chart of the marital status of the subjects

The pie chart reveals that the majority of participants are married (79.49%), while a smaller proportion are single (20.51%). This suggests that the study sample predominantly consists of married individuals, which may influence the generalizability of the findings regarding marital status

Descriptive Statistics of Endometrial Polyp on TVS & HSG

Table 1: Descriptive statistics of endometrial polyp on TVS & HSG

Variable	N	Mean	SD	Absent n (%)	Present n (%
Endometrial Polyp on TVS	78	0.09	0.29	71 (91.0%)	7 (9.0%)
Endometrial Polyp on HSG	78	0.14	0.35	67 (85.9%)	11 (14.1%)

Note. TVS = Transvaginal Sonography; HSG = Hysterosalpingography; SD = Standard

Deviation.

Among 78 subjects, TVS detected endometrial polyps in 9.0% of cases, with a mean detection rate of 0.09 ± 0.033, indicating low frequency and minimal variation. In contrast, HSG identified polyps in 14.1% of cases, with a mean of 0.14 ± 0.040, showing slightly higher detection and variability. While both modalities covered the full sample distribution, HSG demonstrated a marginally higher polyp detection rate than TVS, though further statistical testing is needed to confirm significance.

Diagnostic Accuracy of TVS compared with HSG for Endometrial Polyp

Table 2: Diagnostic accuracy of TVS compared with HSG for endometrial polyp

Condition	Sensitivity	Specificity	PPV	NPV
Endometrial Polyp	63.64%	100.00%	100.00%	94.37%

TVS demonstrated moderate sensitivity (63.64%) for endometrial polyp detection, correctly identifying approximately two-thirds of cases while missing one-third. However, it showed excellent specificity (100%) with no false positives, and perfect positive predictive value (100%), ensuring all positive results were accurate. The high negative predictive value (94.37%) indicates reliable exclusion of polyps when negative. While TVS excels at confirming polyp presence and absence, its moderate sensitivity suggests supplementary imaging may be beneficial for comprehensive detection.

Descriptive Statistics of Fibroma/Fibroids on TVS & HSG

Table 3: Descriptive statistics of fibroma/fibroids on TVS & HSG

Variable	N	Mean	SD	Absent n (%)	Present n (%)
Fibroma/Fibroids on TVS	78	0.15	0.36	66 (84.6%)	12 (15.4%)
Fibroma/Fibroids on HSG	78	0.19	0.40	63 (80.8%)	15 (19.2%)

Note. TVS = Transvaginal Sonography; HSG = Hysterosalpingography; SD = Standard

Deviation.

Transvaginal sonography (TVS) detected fibroids in 15.4% of participants, while hysterosalpingography (HSG) identified them in 19.2%. The majority of cases were negative for fibroids on both modalities (84.6% for TVS, 80.8% for HSG). HSG showed a slightly higher detection rate and greater variability, suggesting it may be more sensitive than TVS for identifying uterine fibroids, though further analysis is needed to confirm the clinical relevance of this difference.

Diagnostic Accuracy of TVS compared with HSG for Fibroma/Fibroids

Table 4: Diagnostic accuracy of TVS compared with HSG for fibroma/fibroids

Condition	Sensitivity	Specificity	PPV	NPV
Fibroma/Fibroids	80.00%	100.00%	100.00%	95.45%

TVS demonstrates high specificity (100%) and perfect positive predictive value (100%) for fibroid detection, ensuring no false positives and all positive results are true cases. However, sensitivity is 80%, indicating 20% of fibroid cases may be missed. The negative predictive value (95.45%) is robust but not absolute, suggesting TVS reliably excludes fibroids when negative, though supplemental imaging (e.g., MRI) could benefit high-risk cases given variable sensitivity in literature

Descriptive Statistics of Subseptated Uterus on TVS & HSG

Table 5: Descriptive statistics of subseptated uterus on TVS & HSG

Variable	N	Mean	SD	Absent n (%)	Present n (%)
Subseptated Uterus on TVS	78	0.05	0.22	74 (94.9%)	4 (5.1%)

Subseptated Uterus on HSG	78	0.12	0.32	69 (88.5%)	9 (11.5%)

Note. TVS = Transvaginal Sonography; HSG = Hysterosalpingography; SD = Standard

Deviation.
TVS detected subseptated uterus in 5.1% of participants (n=4), while HSG identified it in 11.5% (n=9). The majority of cases were negative for this anomaly (94.9% on TVS, 88.5% on HSG). HSG demonstrated a higher detection rate (mean 0.12 vs. TVS 0.05) and greater variability (SD 0.322 vs. 0.222), suggesting superior sensitivity for identifying uterine septations. This discrepancy may reflect HSG's enhanced capability in visualizing structural anomalies or differences in diagnostic thresholds. Further validation with gold-standard methods (e.g., hysteroscopy) is recommended to confirm accuracy.

Diagnostic Accuracy of TVS compared with HSG for Subseptated Uterus

Table 6: Diagnostic accuracy of TVS compared with HSG for subseptated uterus

Condition	Sensitivity	Specificity	PPV	NPV
Sub-septated Uterus	44.44%	100.00%	100.00%	93.24%

TVS demonstrates low sensitivity (44.44%) for subseptated uterus detection, missing over half of true cases. However, it shows perfect specificity (100%) and positive predictive value (100%), ensuring no false positives and all positive results are accurate. The high negative predictive value (93.24%) indicates reliable exclusion when negative. TVS alone is insufficient for screening; supplementary imaging is recommended for suspected cases

Descriptive Statistics of Septated Uterus on TVS & HSG

Table 7: Descriptive statistics of septated uterus on TVS & HSG

Variable	N	Mean	SD	Absent n (%)	Present n (%)
Septated Uterus on TVS	78	0.00	0.00	78 (100.0%)	0 (0.0%)
Septated Uterus on HSG	78	0.00	0.00	78 (100.0%)	0 (0.0%)

Note. TVS = Transvaginal Sonography; HSG = Hysterosalpingography; SD = Standard

Deviation.
In this study, neither transvaginal sonography (TVS) nor hysterosalpingography (HSG) identified any cases of septated uterus among the 78 participants, resulting in a 100% absence rate for both modalities. The mean detection rate, standard deviation, and standard error were all zero, indicating complete uniformity in the findings. This outcome may reflect a genuinely low prevalence of septated uterus within the study population or could be due to limitations in the sensitivity of the imaging techniques for this particular anomaly. Larger and more diverse samples are needed to better evaluate diagnostic utility for rare uterine conditions

Diagnostic Accuracy of TVS compared with HSG for Septated Uterus

Table 8: Diagnostic accuracy of TVS compared with HSG for septated uterus

Condition	Sensitivity	Specificity	PPV	NPV
Septated Uterus	infinity	100.00%	Infinity	100.00%

TVS demonstrated perfect specificity (100%) and negative predictive value (100%) for septated uterus detection, correctly identifying all participants without the condition. However, sensitivity and positive predictive value are mathematically undefined ("infinity") because no cases of septated uterus were identified in the study population. This absence of true positive cases prevents meaningful assessment of TVS diagnostic capability when the condition is present. Future studies with confirmed septated uterus cases are essential to properly evaluate sensitivity and overall diagnostic accuracy.

Descriptive Statistics of Intrauterine Adhesions on TVS & HSG

Table 9: Descriptive statistics of intrauterine adhesions on TVS & HSG

Variable	N	Mean	SD	Absent n (%)	Present n (%)
Intrauterine Adhesions on TVS	78	0.04	0.19	75 (96.2%)	3 (3.8%)
Intrauterine Adhesions on HSG	78	0.06	0.25	73(93.6%)	5 (6.4%)

Note. TVS = Transvaginal Sonography; HSG = Hysterosalpingography; SD = Standard

Deviation.

TVS detected intrauterine adhesions in 3.8% of participants (n=3), while HSG identified them in 6.4% (n=5). The majority of cases were negative for adhesions (96.2% on TVS, 93.6% on HSG). HSG demonstrated a higher detection rate (mean 0.06 vs. 0.04) and greater variability (SD 0.247 vs. 0.194), suggesting superior sensitivity for identifying intrauterine adhesions.

However, the overall low prevalence in both modalities indicates intrauterine adhesions were relatively uncommon in this study population.

Diagnostic Accuracy of TVS compared with HSG for Intrauterine Adhesions

Table 10: Diagnostic accuracy of TVS compared with HSG for intrauterine adhesions

Condition	Sensitivity	Specificity	PPV	NPV
Intrauterine Adhesion	60.00%	100.00%	100.00%	97.33%

TVS demonstrates moderate sensitivity (60%) for intrauterine adhesion detection, correctly identifying three-fifths of cases while missing 40% of true positives. However, it shows excellent specificity (100%) with no false positives, ensuring all negative cases are accurately identified. The perfect positive predictive value (100%) guarantees that all positive TVS findings represent true adhesions, providing high diagnostic confidence. The strong negative predictive value (97.33%) indicates reliable exclusion of adhesions when negative. While TVS excels at confirming presence and ruling out adhesions, its moderate sensitivity necessitates additional evaluation in high-suspicion cases with negative result

Descriptive Statistics of Endometrial Hyperplasia on TVS & HSG

Table 11: Descriptive statistics of endometrial hyperplasia on TVS & HSG

Variable	N	Mean	SD	Absent n (%)	Present n (%)
Endometrial Hyperplasia on TVS	78	0.10	0.31	70 (89.7%)	8 (10.3%)
Endometrial Hyperplasia on HSG	78	0.15	0.36	66 (84.6%)	12 (15.4%)

Note. TVS = Transvaginal Sonography; HSG = Hysterosalpingography; SD = Standard

Deviation.

TVS detected endometrial hyperplasia in 10.3% of participants (n=8), while HSG identified it in 15.4% (n=12). Most cases were negative for hyperplasia (89.7% TVS, 84.6% HSG). HSG showed a higher detection rate (mean 0.15 vs. TVS 0.10) and greater variability (SD 0.363 vs. 0.305), suggesting superior sensitivity for identifying endometrial hyperplasia.

This discrepancy may reflect HSG's enhanced ability to visualize endometrial abnormalities or differences in diagnostic criteria. Further analysis is needed to confirm clinical relevance.

Diagnostic Accuracy of TVS compared with HSG for Endometrial Hyperplasia

Table 12: Diagnostic accuracy of TVS compared with HSG for endometrial hyperplasia

Condition	Sensitivity	Specificity	PPV	NPV
Endometrial Hyperplasia	66.67%	100.00%	100.00%	94.29%

TVS demonstrates moderate sensitivity (66.67%), correctly identifying two-thirds of true hyperplasia cases but missing one-third. Its perfect specificity (100%) ensures no false positives, and the 100% PPV guarantees all positive results are true cases. The high NPV (94.29%) reliably excludes hyperplasia when negative, though false negatives remain possible. While TVS excels at confirming presence and ruling out false positives, its suboptimal sensitivity necessitates supplementary testing (e.g., biopsy) in high-risk patients with negative results.

Descriptive Statistics of Unicornuate Uterus on TVS & HSG

Table 13: Descriptive statistics of unicornuate uterus on TVS & HSG

Variable	N	Mean	SD	Absent n (%)	Present n (%)
Unicornuate Uterus on TVS	78	0.00	0.00	78 (100.0%)	0 (0.0%)
Unicornuate Uterus on HSG	78	0.00	0.00	78 (100.0%)	0 (0.0%)

Note. TVS = Transvaginal Sonography; HSG = Hysterosalpingography; SD = Standard

Deviation.

In this study, neither TVS nor HSG detected any cases of unicornuate uterus among the participants, resulting in a 100% absence rate and zero variability in findings. This likely reflects the rarity of unicornuate uterus, which accounts for only about 0.1% of the population. Larger or more targeted studies are needed to assess diagnostic performance for rare anomalies

Diagnostic Accuracy of TVS compared with HSG for Unicornuate Uterus

Table 4.15: Diagnostic accuracy of TVS compared with HSG for unicornuate uterus

Condition	Sensitivity	Specificity	PPV	NPV
Unicornuate Uterus	infinity	100.00%	infinity	100.00%

TVS achieved perfect specificity (100%) and negative predictive value (100%), correctly ruling out unicornuate uterus in all 78 participants. However, sensitivity and positive predictive value are mathematically undefined ("infinity") due to zero true positive cases in the study. This absence prevents meaningful evaluation of TVS's ability to detect the condition when present. The results only confirm TVS's reliability in confirming absence, not its diagnostic power for identifying unicornuate uterus. Larger studies with confirmed cases are essential for valid sensitivity assessment

DISCUSSION

This study aimed to compare the diagnostic accuracy of transvaginal sonography (TVS) and hysterosalpingography (HSG) in detecting uterine abnormalities among infertile women. The findings revealed that the diagnostic performance of TVS varied across pathologies but consistently showed high specificity and positive predictive value (PPV).For endometrial polyps, TVS had a sensitivity of 63.64% and perfect specificity and PPV, aligning with the results of Niknejadi et al. (2012). In detecting uterine fibroids, TVS showed 80% sensitivity and 100% specificity, comparable to findings from both Niknejadi et al. and Okonkwo et al. (2024).For congenital anomalies, such as a subseptated uterus, TVS demonstrated lower sensitivity (44.44%) despite high specificity, echoing previous literature that highlights the limitations of TVS in identifying subtle structural defects (Niknejadi et al., 2012; Okonkwo et al., 2024). No cases of septated or unicornuate uterus were observed in this sample, consistent with their low prevalence in other studies (Schramm et al., 2022).TVS identified intrauterine adhesions with 60% sensitivity and 100% specificity, a notable improvement over earlier findings by Niknejadi et al., though HSG detected more cases, supporting its superior sensitivity for obliterative pathologies (Okonkwo et al., 2024). For endometrial hyperplasia, TVS again showed high specificity (100%) with moderate sensitivity (66.67%), consistent with its known limitations for endometrial pathology (Niknejadi et al., 2012).These findings support previous research (Khanam & Ahmad, 2025; Asima et al., 2024; Wu et al., 2025), which recommends a multimodal imaging approach in infertility assessment. While TVS offers better patient comfort and accessibility, HSG remains valuable, particularly for tubal and cavity assessments, as emphasized by studies like those of Riaz et al. (2022) and Mubashar et al. (2022). Although newer techniques like MR-HSG and nuclear imaging are emerging, their availability remains limited.

REFERENCES

Abebe, M. S., Afework, M., Abaynew, Y. J. F. r., & Practice. (2020). Primary and secondary infertility in Africa: systematic review with eta-analysis. 6, 1-11.Duffy, J., Bhattacharya, S., Bhattacharya, S., Bofill, M., Collura, B.,Curtis, C., . . . Franik, S. J. H. R. (2020). Standardizing definitions and reporting guidelines for the infertility core outcome set: an international consensus development study. 35(12), 2735-2745.

Mubashar, B. A., Zulfiqar, T., Ali, A., & Rashid, A. J. M. S. J. f. A. R. (2022). Frequency Of Hysterosalpingography Findings In Females resenting With Infertility In Gujrat.3(3), 123-128.

Adekoya, A. O., Akiseku, A. K., Osisanwo, D. A., Egwuogu, A. C., Egbetayo, D. O., & latunji, A. A. J. E. J. o. H. S. (2024). Hysterosalpingography and Endocervical Microbial Assessment of Infertile Women in gun State, Nigeria. 34(4).

Huynh, M., Wang, A., Ho, J., Herndon, C. N., & Aghajanova, L. J. W. s. H. R. (2021).

Fertility preservation and infertility treatment in medical training: an assessment of residency and fellowship program directors' attitudes. 2(1), 576-585.

Bitrus, J., Lohnan, C. L., Oyeniran, O. F., dugbe, A. E., Odonye, C. E., Joshua, Z. N. J. I. J.

o. S. R., & Management. (2025). A 5-Year Retrospective Study of Microbial Isolates and Antibiogram from Endocervical Swabs of Infertile Women Attending

Gynaecological Clinic At Bingham University Teaching Hospital Jos, Nigeria. 13(04), 2173-2178.

Thaker, N., Dhande, R., Parihar, P., & DHANDE, R. J. C. (2023). Role of transvaginal sonography in the diagnosis of female infertility: A comprehensive review. 15(12).

Schramm, D., Kaltwasser, P., Seliger, G., Knörgen, M., Wohlgemuth, W. A., Wagner, S., & Böttcher, S.-I. (2022). Diagnostic value of hysterosalpingography: A retrospective data analysis.

Khanam, I., & Ahmad, H. A. J. T. R. o. M. S. R. (2025). COMPARISON OF HYSTEROSALPINGOGRAPHY AND ULTRASOUND IN EVALUATION OF UTERINE ABNORMALITIES IN PRIMARY AND SECONDARY INFERTILE PATIENTS. 3(1), 648-655

Asima, B., Jain, A., Biswas, J. K., Mahato, A., Vishnoi, M. G., & Tiwari, A. J. I. J. o. N. M.

(2024). Diagnostic Approaches in Nuclear edicine for Reproductive HealthAssessment: Hysterosalpingography in Radiology versus hysterosalpingoscintigraphy. 39(2), 115-119

Egbe, T. O., Ngombiga, M. D. N., Takang, W. A., Manka'a, E. W., Egbe, D. N., Fon, P. N., &

Tendongfor, N. J. A. i. R. S. (2020). Findings of Hysterosalpingography in Women Who Underwent Gynaecologic Imaging in a Tertiary Hospital in Douala, Cameroon. 8(2), 113-125