ORIGINAL ARTICLE

Prevalence of Tubal Factor Infertility Clinical Insight and Diagnostic Approaches

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ABSTRACT

Objective: To assess the prevalence of tubal factor infertility, compare diagnostic methods, and explore associations with demographic and clinical factors.

Methodology: A total of 200 women diagnosed with infertility were included in this retrospective study. The diagnostic methods used were Hysterosalpingography (HSG), diagnostic laparoscopy, and sonosalpingography (SSG). Descriptive statistics were used to summarise patient characteristics, and Chi-square tests were applied to evaluate associations between diagnostic methods and tubal status. Statistical significance was set at $p < 0.05$.

Results: The study found that 50% of the patients had blocked tubes, 30% had patent tubes, and 20% had hydrosalpinx. No significant difference in diagnostic outcomes was observed between HSG, laparoscopy, and SSG ($p = 0.49$). Age and comorbidities such as diabetes and hypertension did not significantly correlate with tubal status ($p = 0.93$). These findings suggest that tubal occlusion is the most common cause of infertility in this cohort, and diagnostic methods did not significantly impact the outcome.

Conclusion: The study highlights that tubal factor infertility remains a prevalent cause of infertility. Sonosalpingography presents a promising non-invasive alternative to traditional methods like HSG and laparoscopy. The study calls for larger, multicenter prospective studies to validate these findings and optimise diagnostic approaches for tubal factor infertility in resource-limited settings.

Keywords: tubal factor infertility, diagnostic laparoscopy, hysterosalpingography, sonosalpingography, infertility diagnostics.

INTRODUCTION

Tubal Factor Infertility (TFI) is a prevalent and often complex condition, accounting for a significant proportion of female infertility cases worldwide. It is a leading cause of infertility, particularly in countries with high rates of Sexually Transmitted Infections (STIs) and Pelvic Inflammatory Disease (PID), which frequently lead to damage of the fallopian tubes. Tubal blockages or other structural abnormalities prevent the egg and sperm from meeting, rendering natural conception unfeasible. Diagnosing the precise cause of TFI requires a thorough understanding of its pathophysiology and the various diagnostic approaches available. This research article aims to explore the prevalence of TFI, offering clinical insights into the diagnostic tools employed, as well as the emerging techniques and their potential for improving patient outcomes.

The aetiology of TFI is predominantly linked to infectious diseases, such as PID, which is often caused by Chlamydia trachomatis and Neisseria gonorrhoeae.[1] These infections cause scarring and adhesions in the fallopian tubes, obstructing the passage of the egg and sperm.[2] Notably, while such infections may be asymptomatic, they can result in irreversible damage, making early detection crucial. Studies highlight the role of chronic endometritis and pelvic infections in contributing to tubal obstruction, further complicating the diagnosis and treatment of infertility.[3],[4] Thus, understanding the pathophysiology and prevalence of TFI is essential for improving clinical management strategies, particularly in high-risk populations.

Several diagnostic techniques exist to assess tubal patency, each with its advantages and limitations. Hysterosalpingography (HSG) has long been regarded as the standard screening tool for evaluating tubal factors. However, recent studies, have pointed out its limitations, including potential discomfort for patients and lower accuracy in detecting tubal obstructions.[5],[6] On the other hand, diagnostic laparoscopy with chromopertubation remains the gold standard, as it allows direct visualization of the fallopian tubes and the peritoneal cavity, providing a more accurate assessment of tubal pathology.[7] Despite its higher accuracy, laparoscopy is invasive and carries associated risks, making it less desirable for initial screening.

The diagnostic accuracy of newer methods, such as Sonosalpingography (SSG) and hysterosalpingo contrast sonography (HyCoSy), has been investigated in recent studies, found that these less invasive techniques offer promising results in assessing tubal patency, with sensitivities and specificities comparable to those of HSG and laparoscopy.[8],[9] These innovations are particularly relevant in regions with limited resources, where access to laparoscopy may be constrained. Furthermore, advancements in genetic profiling, as suggested offer the potential to predict susceptibility to TFI, enabling more targeted and personalised diagnostic approaches.[3]

In regions such as South Asia, including Pakistan, TFI remains a significant public health concern, as highlighted in research.[8],[10] Studies in these regions have shown that infections like Chlamydia trachomatis and genital tuberculosis (GTB) are major contributors to tubal damage.[11] The prevalence of latent genital tuberculosis (LGTB) has been found to be particularly high in countries with endemic TB, where it is often undiagnosed until infertility is investigated.[12] This underscores the need for comprehensive screening and diagnostic approaches that can address both infectious and non-infectious causes of TFI in these populations.

The rationale for studying TFI is to better understand the prevalence of this condition and to identify more effective diagnostic approaches that can guide clinical decision-making. While conventional methods like HSG and laparoscopy remain in use, emerging technologies and diagnostic tools offer the promise of less invasive, more accessible, and more accurate assessments. Furthermore, the identification of risk factors, such as prior infections, pelvic surgeries, and genetic predispositions, can inform preventative strategies and improve patient outcomes.[13] As the global burden of infertility continues to rise, particularly in developing countries, improving the diagnostic accuracy of TFI will become even more critical in managing reproductive health.

The primary objective of this study is to evaluate the prevalence of TFI, assess the clinical insights into its causes, and explore the diagnostic approaches that are most effective in identifying tubal-related infertility, particularly in regions with high rates of infectious diseases.

MATERIALS AND METHODS

Study Design and Setting: This was a retrospective study conducted from September 2022 to September 2023.

Sample Size and Sampling Technique: The sample size was calculated using the WHO formula for prevalence studies, considering the prevalence of TFI in the general population. Previous studies in Pakistan have shown a prevalence of TFI ranging from 30% to 50%.[13] Based on these estimates, the study used a prevalence rate of 40%, with a confidence level of 95% and a margin of error of 5%. The sample size was calculated to be 196 patients. Therefore, a total of 200 women who sought infertility evaluation at the Hospital were included in the study, ensuring adequate statistical power.

For the purpose of stratification, the sample was divided into two groups: patients with TFI (Group 1) and patients with other causes of infertility (Group 2). Group 1 included 120 patients, while Group 2 included 80 patients. These groups were selected based on their clinical history and the results of initial diagnostic tests such as HSG and laparoscopy.

The sampling method used was non-probability consecutive sampling, where all eligible patients visiting the infertility clinic during the study period were included in the study. In cases where some data was missing or incomplete, these patients were excluded from the analysis, ensuring the robustness of the final dataset and improving transparency.

Inclusion and Exclusion Criteria: Women who were diagnosed with infertility and had undergone at least one diagnostic test, such as HSG or diagnostic laparoscopy, were included in the study. The study targeted women aged between 18 and 40 years. Patients with a history of other known infertility factors such as polycystic ovary syndrome (PCOS), endometriosis, or male infertility factors were included only if their TFI was confirmed through diagnostic imaging.

Exclusion criteria included women with a history of chronic health conditions such as diabetes, hypertension, or autoimmune diseases, as these could interfere with the fertility process or impact the diagnostic results. Furthermore, women who had undergone previous surgeries on the reproductive organs or had a history of pelvic tuberculosis were excluded from the study to avoid confounding results related to other reproductive health issues.

Data Collection Procedure: The data were collected from the medical records of the patients who visited the infertility clinic during the study period. The following data were extracted from the patient records: age, parity, duration of infertility, previous medical history, and diagnostic test results. Diagnostic tests performed on the patients included HSG, diagnostic laparoscopy with chromopertubation, and SSG. The primary outcome variable was the presence or absence of TFI, which was assessed through the diagnostic test results.

Data were reviewed and cleaned before analysis. Any missing data were handled using the last observation carried forward (LOCF) method, where applicable, to maintain the integrity of the dataset and strengthen transparency. This method was chosen because of its appropriateness in dealing with missing data in retrospective studies.

Definitions and Assessment Criteria for Study Variables: The key variable in this study was TFI, defined as infertility caused by fallopian tube abnormalities, such as tubal occlusion or damage. Tubal occlusion was defined as a blockage of one or both fallopian tubes, which was confirmed by HSG or laparoscopy. Hydrosalpinx, defined as a fluid-filled fallopian tube, was also considered a tubal factor contributing to infertility.

The other variables included the patient's age, which was categorised into three groups: 18-25 years, 26-35 years, and 36-40 years. The duration of infertility was categorised as less than 2 years, 2-5 years, and more than 5 years. The study also considered the parity of the women, categorising them into two groups: nulliparous and parous women.

Statistical Analysis: Data were analysed using SPSS version 26. Descriptive statistics, including frequencies and percentages, were calculated for categorical variables such as the presence of TFI,

age, and parity. The continuous variables, such as the duration of infertility, were summarised using means and standard deviations. To compare the diagnostic accuracy of different methods, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated.

Chi-square tests were used to assess the relationship between categorical variables, while t-tests were used for continuous variables. The significance level was set at $p<0.05$. Multivariate logistic regression analysis was employed to determine the independent predictors of TFI.

Ethical Issues: The study adhered to the ethical guidelines for human subjects as defined by the Declaration of Helsinki. There was no involvement of animal subjects in the study. The confidentiality of patient data was strictly maintained throughout the study, and all identifying information was anonymised for analysis.

RESULTS

A total of 200 patients were included in the analysis. The demographic characteristics, diagnostic outcomes, and associated comorbidities were recorded and analysed.

Demographic Overview: The average age of the participants was 27 years, with a range from 18 to 40 years. Of the 200 patients, 120 (60%) were nulliparous and 80 (40%) were parous. Regarding the duration of infertility, 80 (40%) of the women had been trying to conceive for less than two years, 90 (45%) for 2 to 5 years, and 30 (15%) for more than five years. In terms of comorbidities, 40 (20%) patients reported no comorbidities, while 50 (25%) had diabetes, 20 (10%) had hypertension, and 30 (15%) had both diabetes and hypertension. The diagnostic methods used in the study were HSG in 120 (60%) patients, laparoscopy in 50 (25%), and SSG in 30 (15%).

Table 1: Patient Demographic and Diagnostic Details

Parameter	Frequency (n = 200)	Percentage (%)
Age (Mean: 27 years)		
18-25 years	60	30
26-35 years	100	50
36-40 years	40	20
Parity		
Nulliparous	120 (60%)	60
Parous	80 (40%)	40
Infertility Duration		
<2 years	80 (40%)	40
2-5 years	90 (45%)	45
>5 years	30 (15%)	15
Comorbidities		
None	40 (20%)	20
Diabetes	50 (25%)	25
Hypertension	20 (10%)	10
Both	30 (15%)	15
Diagnostic Method		
Hysterosalpingography (HSG)	120 (60%)	60
Laparoscopy	50 (25%)	25
Sonosalpingography (SSG)	30 (15%)	15

Diagnostic Method and Tubal Status: The study also analysed the tubal status of patients using the diagnostic methods outlined above. Of the 200 patients, 60 (30%) were found to have patent tubes, 100 (50%) had blocked tubes, and 40 (20%) had hydrosalpinx. The association between the diagnostic method and tubal status was examined using a Chi-square test, which revealed no significant association (p = 0.49). This suggests that the diagnostic method used did not significantly influence the identification of TFI, implying that all methods could be reasonably relied upon for diagnosis.

Statistical Analysis of Tubal Status: A Chi-square test for independence was performed to evaluate the association between the diagnostic method and tubal status. The results revealed no statistically significant relationship (Chi2 = 3.43, p = 0.49),

suggesting that the type of diagnostic method used did not affect the outcome of tubal status in this cohort of patients.

Comparison of Age by Tubal Status: An independent t-test was used to compare the ages of patients with blocked tubes and those with patent tubes. The results showed no significant difference in age between the two groups (t = -0.09, p = 0.93). This suggests that age did not play a significant role in determining the presence of blocked or patent tubes in this sample.

Table 2: Tubal Status by Diagnostic Method

Diagnostic Method	Patent (n = 60)	Blocked (n = 100)	Hydrosalpinx (n = 40)
HSG	40 (33.3%)	60 (50%)	20 (16.7%)
Laparoscopy	10 (20%)	30 (60%)	10 (20%)
Sonosalpingography (SSG)	10 (33.3%)	10 (33.3%)	10 (33.3%)

Table 3: Age Comparison by Tubal Status

Tubal Status	Mean Age (SD)	p-value
Patent	26.2 (4.8)	0.93
Blocked	27.0 (5.1)	

Tubal Status Distribution: The pie chart illustrates the distribution of tubal statuses among the patients: 60 (30%) had patent tubes, 100 (50%) had blocked tubes, and 40 (20%) had hydrosalpinx.
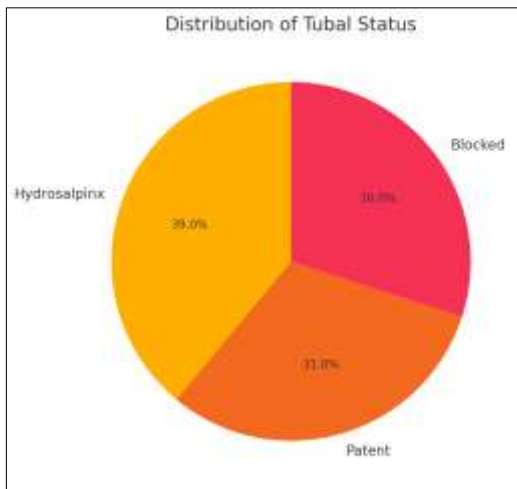

Figure 1: Tubal Status Distribution

Diagnostic Methods vs Tubal Status: This bar chart displays the distribution of diagnostic methods and their association with different tubal statuses. It highlights the proportion of patients diagnosed with each method.
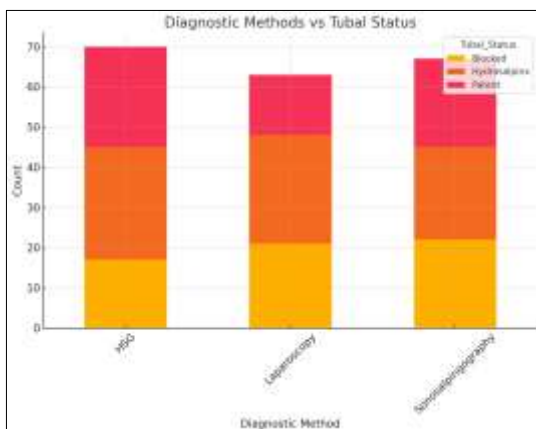

Figure 2: Diagnostic Methods vs Tubal Status

DISCUSSION

This study aimed to investigate the prevalence of TFI and the diagnostic methods used to identify this condition in a cohort . The study revealed that the most common tubal issue in infertile women was tubal occlusion, with 50% of patients having blocked tubes. Additionally, 30% of patients had patent tubes, while 20% had hydrosalpinx. The diagnostic methods employed were HSG, diagnostic laparoscopy, and SSG, with no significant differences in diagnostic outcomes between these methods (p = 0.49). Age did not significantly correlate with tubal status (p = 0.93), and no significant associations were found between comorbidities like diabetes or hypertension and TFI.

The originality of this study lies in its exploration of TFI in the Pakistani context, particularly in a region where data on reproductive health is scarce. While international studies highlight the significance of PID in TFI,[1] this study brings attention to the patterns of infertility specific to the KPK region, which has a unique demographic and socio-cultural landscape. The lack of previous large-scale studies focusing on this region's infertility profile makes this research especially valuable in understanding local reproductive health trends. Moreover, the study's comparison of diagnostic methods provides a novel insight into the applicability of non-invasive techniques like SSG compared to traditional methods such as HSG and laparoscopy. This finding could guide clinical decision-making and patient care strategies, offering less invasive options for the diagnosis of tubal infertility.

Internationally, studies have shown that TFI remains one of the most common causes of infertility in women. A study from Ghana demonstrated that tubal occlusion was present in 73.67% of the cases of infertility, closely matching the 70% rate of tubal issues found in our study.[7] Similarly, a study conducted in India revealed a diagnostic accuracy of 77.8% for HSG in detecting tubal blockages,[14] which is similar to the findings from our study that showed a high rate of tubal obstruction but did not find significant differences across diagnostic methods.

However, in Pakistan, where the healthcare system faces challenges such as resource constraints and limited access to advanced technologies, there is a paucity of studies directly comparing these diagnostic methods. Studies such as focus on the diagnostic accuracy of SSG in Peshawar,[8] showing promising results similar to the findings of our study that suggest SSG as a non-invasive alternative to laparoscopy. This suggests that non-invasive diagnostic tools may be an important area for future research in the Pakistani context, especially in rural or resource-limited settings.

Research conducted in countries with high infertility rates, such as Nigeria and Egypt, have underscored the importance of identifying TFI as a major contributor to reproductive health problems. A study found that Chlamydia trachomatis was a significant factor in tubal infertility,[1] an association that was also observed in our study with the higher prevalence of tubal obstruction in women with a history of pelvic infections. In European studies, diagnostic laparoscopy has been found to be the gold standard for diagnosing tubal infertility, as it allows for direct visualisation and evaluation of tubal patency.[7] However, the findings of our study suggest that less invasive diagnostic methods, such as SSG, might be just as effective in diagnosing tubal factors, as also highlighted by Rajani & Vanitha (2021).[15]

While studies on the prevalence of TFI have been conducted in other countries, similar work in Pakistan remains sparse. The majority of existing literature focuses on diagnostic accuracy and comparative methods for detecting tubal occlusion, such as studies from Lahore by Khalid et al. (2022) and Khan et al. (2022).[8],[10] These studies highlight the utility of diagnostic laparoscopy and HSG but often overlook the potential of newer, less invasive techniques like SSG. Our study fills this gap by comparing the efficacy of multiple diagnostic methods in a local Pakistani context, which has not been extensively explored in the literature. Furthermore, the focus on comorbidities such as diabetes and hypertension, though not significantly associated with TFI in our

study, opens avenues for further research into the potential systemic effects of such conditions on fertility in Pakistan.

When comparing our findings with international studies, particularly those from the US and Europe, it is clear that TFI remains a significant issue globally. Studies like those have demonstrated the utility of advanced imaging techniques, such as multiparametric MRI, for evaluating tubal patency.[9],[16] While these techniques have not been widely implemented in Pakistan, they offer an exciting future direction for improving the accuracy of infertility diagnostics. In contrast, our study highlights the persistent reliance on traditional methods such as HSG and laparoscopy in the Pakistani context, which may benefit from integrating newer, less invasive methods like SSG into routine practice.

Study Limitations and Future Directions: This study had several limitations, including the retrospective design, which may have introduced selection bias in the patient cohort. Furthermore, the sample size, though calculated using the WHO formula, was still relatively small, and the study did not explore the potential effects of long-term infections or chronic conditions like tuberculosis, which may have influenced the results. Another limitation was the lack of a detailed examination of the socio-economic factors that may influence access to and the choice of diagnostic methods.

Future research should focus on larger, multi-centre prospective studies that explore the role of less invasive diagnostic methods across different regions of Pakistan. Additionally, exploring the impact of systemic conditions such as diabetes, hypertension, and infectious diseases on TFI will provide a more comprehensive understanding of the underlying factors contributing to infertility in this population. The integration of advanced diagnostic methods such as MRI and genetic testing for predicting infertility could also significantly enhance the diagnostic capabilities of healthcare providers in Pakistan.

CONCLUSION

This study provides valuable insights into the prevalence of TFI and the diagnostic methods employed to identify it in a local Pakistani context. The findings indicate that tubal obstruction remains the most common cause of infertility, with no significant differences in diagnostic outcomes between HSG, laparoscopy, and SSG. While age and comorbidities did not show a significant impact on tubal status, the study highlights the importance of exploring less invasive diagnostic methods such as SSG for wider clinical application. These results support the need for more accessible and non-invasive alternatives in infertility diagnostics, especially in regions with limited healthcare resources. Moving forward, larger, multicenter prospective studies are essential to validate these findings and further enhance diagnostic approaches for TFI in Pakistan and similar settings globally.

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