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**Original Research Article**

# Gynecologic radiology in fertility treatment: assessing tubal patency and ovarian reserve

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## ABSTRACT

**Background:** A tubal patency test is a medical procedure that can help determine if a woman is having trouble conceiving due to blocked fallopian tubes. Fallopian tubal pathology is a primary risk factor for female infertility. Ovarian reserve is the number of healthy eggs in a woman's ovaries, and it's a measure of the ability to have children. This study aimed to assess tubal patency and ovarian reserve in fertility treatment.
**Methods:** In a retrospective cohort study, 75 women aged 18-40, treated from January to December 2023, were included. Fallopian tube patency was tested using hysterosalpingography, hysterosalpingo-contrast sonography, or laparoscopic chromopertubation.
**Results:** Of 75 women, 19 (25.5%) were found to have at least one blocked fallopian tube. Unilateral blockage was more common than bilateral blockage, occurring in 12 out of the 19 cases (63.2%) compared to 7 out of 19 cases (36.8%). Mainly, blockages occurred near the opening of the fallopian tubes 86.2%. After adjusting for other factors, the presence of hydrosalpinx (odds ratio, OR, 13.323, 95% confidence interval, CI: 2.679-66.253, p=0.002) and myomas (OR 2.108, 95%CI: 1.008-4.409; p=0.048) were statistically significant factors associated with fallopian tube blockage.
**Conclusions:** Gynecologic radiology is still of major relevance in fertility evaluation. The presence of uterine myomas and hydrosalpinges significantly increases the risk.

**Keywords:** Infertility, Fallopian tubes, Fallopian tube diseases, Fertility, Patency testing, Uterine leiomyomas

## INTRODUCTION

Infertility is the inability to achieve a clinical pregnancy after 12 months of regular unprotected intercourse with the same partner and affects up to 12% of couples of reproductive age.[1] Around 15-30% of infertile couples do not have a clear cause, but the most common reasons for infertility are ovulatory dysfunction, male factor infertility, endometriosis, diminished ovarian reserve, uterine and cervical factors, and tubal disease.[2,3] According to the American College of Obstetricians and Gynecologists' Committee on Gynecologic Practice and the American Society for Reproductive Medicine, the basic infertility evaluation includes patient history, physical examination, hormonal status, semen analysis, and uterine and tubal evaluation, such as transvaginal ultrasound and hysterosalpingography. Additionally, further diagnostic steps and more invasive procedures should not be routinely performed for unexplained infertility, such as endometrial biopsy and laparoscopy.[4] The gold standard for tubal patency testing is laparoscopy with chromopertubation, combined with hysteroscopy to evaluate the uterine cavity for abnormalities. Diagnostic laparoscopy may be indicated for intra-abdominal adhesions, myomas, or hydrosalpinges. Hysterosalpingography (HSG) and hysterosalpingo-contrast sonography (HyCoSy) are less invasive options for low-risk cases, but they are operator-dependent and

have limitations. HyCoSy has become increasingly popular and has largely replaced HSG for tubal infertility evaluation. Both HSG and HyCoSy have comparable diagnostic accuracy to laparoscopic chromopertubation.[5-11] Tubal pathology can be responsible for up to 35% of infertility cases, with 10-25% of women experiencing blockages at the proximal end.[12] Recent theories suggest that proximal blockages may be due to tubal spasms, incorrect introduction of dye or distention medium during patency testing, or retained intraluminal debris. The most common cause of true distal blockage is pelvic inflammatory disease.[13,14] Some studies indicate that proximal tubal blockages are more common than distal ones, and one study showed a twenty-fold higher prevalence of proximal blockage in women with chronic endometritis.[8,9,15]

Current clinical observations also support the higher frequency of proximal tubal disease. One possible explanation for the difference between historical and current observations is that improved medical diagnostics and treatment of pelvic inflammatory disease may have changed the nature of upper genital infection, making it less likely for the disease to ascend beyond the uterus and into the peritoneal cavity.[16] This study aimed to prompt the role of gynecologic radiology in fertility treatment by assessing tubal patency and ovarian reserve. Patients' consent and ethical clearance were ensured prior to the study.

### *Objective*

*General objective*

The objective of this study was to study the role of gynecologic radiology in fertility treatment.

*Specific objective*

This study aimed to assess tubal patency and ovarian reserve as part of gynecologic radiology for the treatment of infertility.

## METHODS

This cross-sectional study included a total of 75 female patients, who were of productive age, 18 to 40 years old. These patients visited the department of radiology and imaging, at Rajshahi Medical College Hospital, Rajshahi, Bangladesh for the treatment of infertility, from January 2023 to December 2023.

### *Inclusion criteria*

Patients aged more than 18 years to 40, who underwent evaluation of tubal patency for primary or secondary infertility were included in this study.

### *Exclusion criteria*

Patients with a history of tubal reconstruction surgery were excluded. Also, the woman who had a unicornuate uterus was excluded from this study.

Age, body mass index (BMI), number of tubes, type of infertility (primary/secondary), gynecologic/obstetric history, and previous abdominal surgery were evaluated. Data acquisition was conducted using AKIM Software (version 7, SAP Software Solutions Austria, Vienna, Austria; SAP-based patient management system. The main outcome parameter was fallopian tube patency diagnosed using either HSG or HyCoSy. Tubal patency testing was performed within the three months after the first consultation. Distal tubal occlusion was diagnosed when the passage of distention medium/dye beyond the ampullary segment of the tube but not the fimbria was observed. Statistical analysis was performed using SPSS 29.0 for Windows (IBM Corp., Armonk, NY, USA, 1989-2023). This study was approved by the institutional review board of the RMCH.

## RESULTS

The median age of the patients was 33 years, with an interquartile range (IQR) of 29-36, and the median BMI was 23.9 kg/m$^2$, with an IQR of 21.1-28.0 at the time of evaluation of tubal patency. Out of the women evaluated, 55.2% suffered from primary infertility, and 44.8% suffered from secondary infertility. Additionally, 17.7%, 4.8%, and 6.7% of the women had experienced previous first-trimester miscarriage, extrauterine pregnancy, and termination of pregnancy, respectively (Table 1).

When comparing the method for tubal patency testing with the results, it was found that HyCoSy revealed the highest rates of unilateral and bilateral occlusion per patient ($p=0.019$) and was the most likely to identify a tube as occluded ($p<0.001$) (Table 2).

Polycystic ovary syndrome (PCOS), presence of myomas, and endometriosis occurred in 19.3%, 15.5%, and 14.5% of women, respectively. Excluding the results of tubal patency testing, the causes of infertility remained "otherwise unexplained" in 18.2% of women (Table 3).

All the factors that reached statistical significance in the univariate model also did so in the multivariate model, except for age (univariable model, OR 1.059, $p=0.020$; multivariable model, adjusted OR 1.055, $p=0.051$). Specifically, the following parameters were associated with an increased risk for the presence of unilateral or bilateral occlusion: presence of hydrosalpinx (OR 13.323, 95% CI: 2.679-66.253; $p=0.002$) and myomas (OR 2.108, 95% CI: 1.008-4.409; $p=0.048$) (Table 4).

**Table 1: Study patient characteristics.**

| Characteristics | | N (%) |
|---|---|---|
| **Demography** | Number of women | 75 |
| | Age (years) | 33 (29; 36) |
| | BMI (kg/m$^2$) | 23.9 (21.1; 28.0) |
| | Number of tubes | 245 |
| | Women with one tube | 4 (2.9) |
| | Secondary infertility | 34 (44.8) |
| **Gravidity** | 0 208 | 41 (55.8) |
| | 1 94 | 19 (25.2) |
| | ≥2 71 | 14 (19.0) |
| **Parity** | 0 | 54 (72.4) |
| | 1 | 15 (20) |
| | ≥2 | 6 (7.5) |
| **History** | Previous first-trimester miscarriage | 13(17.7) |
| | Previous extrauterine pregnancy | 4 (4.8) |
| | Previous termination of pregnancy | 5 (6.7) |
| | Previous intrauterine fetal death | 1 (1.3) |
| **Previous abdominal surgery** | Cesarean section | 8 (10) |
| | Curettage | 9 (13.1) |
| | Laparoscopy: unilateral salpingectomy | 2 (2.7) |
| | Laparoscopy: ovarian cyst removal | 5 (6.7) |
| | Laparoscopy: endometriosis | 3 (3.8) |
| | Laparoscopy or laparotomy: myoma enucleation | 2 (2.4) |
| | Laparoscopy: ovarian drilling | 2 (2.4) |
| | Diagnostic laparoscopy | 7 (9.7) |
| | Appendectomy | 7 (8.8) |
| | Other intraperitoneal procedures | 3 (3.8) |
| | Previous hysteroscopic myoma resection | 1 (1.1) |

**Table 2: Tubal patency test results according to the method used.**

| System | Number of evaluated women | Unilateral occlusion (%) | Bilateral occlusion (%) | P value | Number of evaluated tubes | Number of occluded tubes (%) | P value |
|---|---|---|---|---|---|---|---|
| **Hysterosalpingography** | 37 | 5 (12.4) | 2 (6.5) | 0.019 | 15 | 9 (12.8) | <0.001 |
| **HyCoSy** | 11 | 3 (25.0) | 2 (14.3) | | 4 | 6 (27.5) | |
| **Chromopertubation** | 27 | 5 (17.6) | 3 (11.5) | | 10 | 11 (20.5) | |

**Table 3: Factors for subfertility independent of tubal patency testing.**

| | Number of Women (n, %) | Unilateral occlusion | Bilateral occlusion | Total number of tubes | Occluded tubes |
|---|---|---|---|---|---|
| **Previously known or newly diagnosed endometriosis** | 11 (14.5) | 2 (16.7) | 6 (1.1) | 22 | 4 (19.4) |
| **PCOS** | 14 (19.3) | 2 (2.7) | 3 (1.2) | 29 | 3 (10.5) |
| **Hypogonadotropic hypogonadism** | 2 (2.7) | 1 (1.3) | 0 | 4 | 0 |
| **Premature ovarian insufficiency** | 1 (1.3) | 1 (7.0) | 0 | 2 | 0 |
| **Myoma** | 12 (15.5) | 14 (24.1) | 9 (15.5) | 23 | 6 (28.3) |
| **Endometrial polyp** | 5(6.7) | 3 (1.0) | 3 (12.0) | 10 | 2 (18.4) |
| **Male factor** | 7 (45.0) | 8 (22.6) | 4 (11.9) | 67 | 5 (23.3) |
| **One tube missing** | 2 (2.9) | 4 (36.4) | - | 2 | 1 (36.4) |
| **Otherwise unexplained infertility** | 14 (18.2) | 1 (1.5) | 2 (2.9) | 7 | 1 (3.7) |

**Table 4: Univariable followed by a multivariable binary regression model for the prediction of any kind of tubal occlusion (unilateral and/or bilateral).**

| | | Women with uni- or bilateral occlusion (n=95) | Women with bilateral patency (n=278) | OR (95%CI) | P value | Adj. OR (95% CI) | Adj. p value |
|---|---|---|---|---|---|---|---|
| **Age (years)** | | 34 (30; 38) | 32 (29; 36) | 1.059 (1.009; 1.112) | 0.020 | 1.065 (1.000; 1.113) | 0.051 |
| **BMI (kg/m$^2$)** | | 24.5 (21.3; 28.4) | 23.4 (21.0; 27.9) | 1.020 (0.976; 1.064) | 0.392 | - | - |
| **Secondary infertility** | | 9 (49.5%) | 23 (41.0%) | 1.387 (0.869; 2.215) | 0.170 | - | - |
| **Parity** | 0 | 13 (72.6%) | 41 (72.3%) | reference | | - | - |
| | 1) | 18 (18.9%) | 11 (20.5%) | 0.920 (0.507; 1.670 | 0.892 | - | - |
| | ≥2 | 8 (8.4%) | 4 (7.2%) | 1.165 (0.491; 2.766) | | - | - |
| **Previous extrauterine pregnancy without salpingectomy** | | 4 (4.2%) | 1 (2.2%) | 2.519 (0.751; 8.450) | 0.135 | - | - |
| **Previous salpingectomy** | | 5 (5.3%) | 1 (2.2%) | 1.983 (0.550; 7.219) | 0.294 | - | - |
| **Previous caesarean section** | | 3 (13.7%) | 6 (10.1%) | 1.415 (0.700; 2.860) | 0.333 | - | - |
| **Previous other intraperitoneal surgery** | | 7 (37.9%) | 15 (27.7%) | 1.587 (0.975; 2.602) | 0.063 | - | - |
| **Previously known or newly diagnosed endometriosis** | | 3 (15.8%) | 8 (14.0%) | 1.151 (0.602; 2.195) | 0.674 | - | - |
| **PCOS** | | 2 (12.6%) | 12 (21.6%) | 0.429 (0.269; 1.026) | 0.059 | - | - |
| **Hypogonadotropic hypogonadism#** | | 1 (1.1%) | 2 (3.2%) | 0.317 (0.040; 2.543) | 0.280 | - | - |
| **Premature ovarian insufficiency** | | 1 (1.1%) | 1 (1.4%) | 0.639 (0.080; 6.602) | 0.778 | - | - |
| **Myoma** | | 5 (24.2%) | 7 (12.6%) | 2.208 (1.232; 3.994) | 0.008 | - | 0.048 |
| **Endometrial polyp** | | 1 (6.3%) | 4 (6.8%) | 0.819 (0.356; 2-374) | 0.861 | - | - |
| **Other reasons of infertility** | | 1 (3.2%) | 25 (23.4%) | 0.116 (0.033; 0.349) | <0.001 | 0.213 (0.057; 0.733) | 0.015 |
| **Presence of any hydrosalpinx** | | 2 (9.5%) | 1 (0.7%) | 14.432 (3.062; 68.122) | <0.001 | 204 (0.057; 0.733) | 0.002 |

## DISCUSSION

In this study, 25% of the women in a cohort of 75 consecutive unselected couples referred for infertility were found to have unilateral or bilateral tubal occlusion, with 18% of all fallopian tubes being occluded. It is widely known that women in developed countries often postpone having children and that infertility becomes more common as women get older.[25,26] In this study, the typical age at the initial examination was 33 years, with a range from 29 to 36, which may seem somewhat high, but is consistent with other recent research on fallopian tube health in women experiencing infertility.[10,17,27] Interestingly, unexplained infertility was diagnosed in 65 women (17.4%) after a comprehensive evaluation of tubal health. This rate falls within the reported range of 10-30%.[28]

The overall rate of women affected by tubal occlusion in the study was about 25%. Unilateral occlusion can still raise concerns for bilateral tubal disease and lower conception rates. In the case of bilateral tubal occlusion, in vitro fertilization (IVF) is inevitable. A recent meta-

analysis showed that cumulative pregnancy rates (CPRs) after intrauterine insemination (IUI) were similar between women with proximal unilateral tubal occlusion and women with unexplained infertility. However, patients with distal unilateral occlusion had significantly lower CPR. For women with distal unilateral tubal occlusion, referral to specialists for assisted reproduction might be warranted earlier than expected. Multiple pathophysiological mechanisms for proximal tubal blockage have been described, including tubal spasms, past pelvic inflammatory diseases, hormonal and anatomical factors, impaired cilial activity, endometrial lesions/polyps, and the presence of amorphous material inside the tubes causing obstruction.[12,29-32]

The high number of proximal tubal occlusions should be considered in fertility counselling. Depending on the patient's financial and social situation, less invasive procedures like IUI can be recommended before IVF. There is a lack of recent studies on the prevalence of tubal occlusion in infertile women in the Western world. It is important to conduct more studies on tubal patency epidemiology. Additionally, the majority of non-patent tubes showed proximal occlusion, indicating a potential decrease in pelvic inflammatory disease prevalence. Early detection and treatment of various conditions could result in less peritubal disease and fimbrial agglutination. This increases the relevance of pathology from more cryptic sources, such as endometritis.[6,7,12,33]

Ultimately, these findings clearly demonstrate the need for fallopian tube patency evaluation in women of infertile couples due to the high prevalence of abnormal findings, even in a population with high access to care. It was surprising that several factors were not associated with fallopian tube occlusion. For example, having a previous extrauterine pregnancy without salpingectomy was not statistically significant, likely due to a small sample size, affecting only 4.8% (18 out of 373) of women. The same was true for the association of endometriosis with tubal occlusion.[20,34] Unfortunately, the database did not provide details about the staging of endometriosis. It is likely that the majority of these women were identified with only minimal to mild endometriosis, which is far less associated with tubal disease than advanced endometriosis.[16,34]

The study has limitations due to its retrospective design, a relatively small study population, and missing demographic and socioeconomic information. There are concerns about potential biases in the assessment methods and patient selection. The findings are based on a single medical facility in Austria, so their applicability to other populations may be limited.[12,29]

## CONCLUSION

Women with subfertility should have their fallopian tubes checked early in the infertility evaluation process to avoid delaying further treatment. This is especially important for women with hydrosalpinges and myomas, as they have the highest risk of fallopian tube blockage. While our results offer more understanding of fallopian tube issues, we need prospective data focusing on demographics, history of pelvic inflammatory disease, the link between tubal blockage and the stage of endometriosis, and the underlying causes of proximal tubal blockage.

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