Panacea Journal of Medical Sciences 2022;12(3):615–621

Content available at: https://www.ipinnovative.com/open-access-journals

Panacea Journal of Medical Sciences

Journal homepage: http://www.pjms.in/

Original Research Article

Evaluation of culture, molecular assay (TB-PCR), GeneXpert system and histopathology for detection of genital tuberculosis

Ritu Mahata[1], Subrata Das[1,*], Amrita Gupta[1]

[1] *Dept. of Obstetrics and Gynaecology, ESI PGI MSR & ESIC Medical College and ESIC Hospital & ODC (EZ), Kolkata, West Bengal, India*

ARTICLE INFO

Article history:
Received 31-08-2021
Accepted 25-11-2021
Available online 28-11-2022

Keywords:
Genital tuberculosis
Histopathology
Polymerase chain reaction
Genexpert
AFB
Infertility

ABSTRACT

Background: Female genital tuberculosis (FGTB) has a crucial role in many gynaecological complaint and delay in diagnosis can cause irreversible damages. The new diagnostic technique GeneXpert system is accurate and rapid test can make paradigm shift in FGTB treatment.
Aim & Objectives: The aim of the study to estimate efficacy of different tests i.e. AFB BACTEC culture, molecular assay (TB-PCR) and histopathology in comparison to GeneXpert system to detect FGTB.
Materials and Methods: The prospective observational study was conducted in between January, 2018 and June, 2019. Randomly selected total 62 patients were put under all four diagnostic tests from endometrial sampling. The positivity of genital TB and efficacy of the tests were compared with test result of GeneXpert assay.
Results: In our study, out of 62 patients, most commonly 33.9% were each from age group of 21-30 and 31-40 years i.e. reproductive ages, 45.2% were overweight, primary infertility of 48.4% patients were predominant symptomatology. Overall positivity by GeneXpert test was 21% (3/62), histopathology 8.1% (5/62), AFB BACTEC culture 12.9% (8/62) and 24.2% (15/62%) by molecular assay (TB-PCR). On evaluating against our diagnostic tests, specificity of histopathology, AFB BACTEC Culture and TB-PCR was 97.96%, 95.92% and 75.51%. The diagnostic tests were analysed by Kappa measure agreement in comparison to GeneXpert assay. The histopathology and AFB BACTEC Culture showed fair and moderate agreement respectively, but on the contrary TB-PCR have not showed any agreement with GeneXpert assay.
Conclusion: High degree of suspicion and battery of tests needed for diagnosis of genital TB. Rapid diagnosis by GeneXpert assay may play a crucial role in TB control programme.
Key Messages: Female genital tuberculosis (FGTB) has a crucial role in many gynaecological complaint and delay in diagnosis can cause irreversible damages. The new diagnostic technique GeneXpert system is accurate and rapid test can make paradigm shift in FGTB treatment.

1. Introduction

Tuberculosis (TB) remains a major public health concern even in the twenty-first century. Almost 10 million people are developing active disease globally each year with an average of 1.33 million deaths.[1] The World Health Organization (WHO) declared TB, as a global emergency in 1993 and recommended Directly Observed Treatment Short-course (DOTS) strategy to tackle the disease, especially in developing countries.[2] The Revised National TB Control Programme (RNTCP) of India had incorporated the DOTS strategy in 2005 and diagnosed 71% cases and cured over 87% diagnosed cases with a seven-fold reduction in mortality.[3] Female genital TB (FGTB) was first reported by Morgagni in 1744 on the autopsy of

* *Corresponding author*.
E-mail address: drsubrata02@gmail.com (S. Das).

https://doi.org/10.18231/j.pjms.2022.115

a young woman who died from TB peritonitis. The FGTB causes infertility, dyspareunia, menstrual irregularities and chronic pelvic inflammatory disease (PID) in women.[4–8] Genitourinary TB is a common variant of Extrapulmonary TB (EPTB) globally (27%), out of which FGTB alone contributing 9% of all EPTB cases.[4,9]

Mycobacterium tuberculosis (rarely Mycobacterium bovis and/or atypical mycobacteria) is the aetiological agent.[4–12] Genital TB usually spread from haematogenous or lymphatic route or direct spread direct from adjacent organs.[10] Hydrosalpinx, pyosalpinx, tubo-ovarian masses, dense adhesions and ectopic pregnancy[5–8] can be a fate from the genital TB after damage of fallopian tube from tuberculous endosalpingitis, exosalpingitis, interstitial TB salpingitis and Salpingitis isthmica nodosa.[5–8,10] Destruction of the endometrium with synechiae formation may lead to Asherman's syndrome and manifest as secondary amenorrhea and infertility.[13]

There is indiscriminate use of antitubercular drug due to the lack of reliable and universally acceptable diagnostic techniques, this has further complicated the scenario by enhancing the incidence of multi-drug resistant (MDR) and extensively drug-resistant (XDR) TB.[1] Out of several diagnostic methods, GeneXpert assay is being considered as gold standard for diagnosing genital TB.[14] Primary aim of our study was to detect the effectiveness of AFB BACTEC culture, molecular assay (TB-PCR) and histopathology in comparison to GeneXpert assay to diagnose FGTB. Secondary aim of our study is to correlate the clinical findings with diagnostic tests in the study.

2. Materials and Methods

The study was carried out in a medical college and hospital of eastern part of India with a tertiary health care facility. It is a prospective observational study conducted in between the first day of January 2018 to 30^{th} June 2019 i.e. eighteen months' period.

The Institutional Ethics Committee approved the study and the study was performed in accordance with its recommendations and with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975 that was revised in 2013 and informed consent was obtained from all participants for being included in the study.

The study participants were recruited during the study period from the visited patients of outpatient department of Gynaecology and Obsteatrics. Study participants were those meeting inclusion and exclusion criteria. Data were collected in hard copy format and the adopted sampling method was systemic random sampling.

Under inclusion criteria, study participants were to be 18-60 years age group with complaints of menstrual irregularities or pelvic inflammatory disease (PID) or post-menopausal bleeding or infertility from female partners. Women with menstrual irregularity were included in the study in the form of menorrhagia, polymenorrhoea or menorrhagia as per standard definitions and excluding the structural causes (PALM) of PALM-COEIN (FIGO-2011).[15] Patients with menstrual irregularities were included in the study after failed medical treatment. Both primary and secondary type of female infertility patients were included in study as participants. Diagnosed patients of endocrinological disorder and/or coagulopathy were excluded from study participants. Women unfit for operation under general anesthesia were also excluded from the study.

Under general anesthesia, selected patients were put under premenstrual diagnostic laparoscopy, hysteroscopy operation and endometrial sampling by dilatation & curettage (D & C). Endometrial tissues were collected both in normal saline for TB-PCR, AFB BACTEC Culture and GeneXpert assay and also in formalin solution for histopathology examination (HPE). Patients were diagnosed as FGTB if report for genital tuberculosis was positive in any of the methods. Investigation named GeneXpert assay was considered as gold standard to diagnose of genital TB.[16,17]

2.1. The following investigations were used as an instrument in our study

BACTEC Culture: BACTEC culture was a radiometric culture and released carbon dioxide by bacteria was measured. The culture was performed using automated BACTEC Mycobacterial Growth Indicator Tube 960 (MGIT960) based on modified Middlebrook 7H9 Broth with an oxygen-sensitive fluorescent detection technology.

MOLEUCULAR Assay (TB-PCR): The test was based on the amplification and simultaneous detection of target DNA of the mycobacterial genome using Real-Time Polymerase Chain Reaction (RT-PCR), the target being sequence specific amplicons fluorescence intensity exceeding fluorescence intensity at threshold cycle of the amplification curve. The analysis was done by Roter-Gene Q machine.

GeneXpert System or GeneXpert assay is a cartridge based nucleic acid amplification test (CBNAAT): It uses heminested real time PCR to amplify and simultaneously detect Mycobacterium tuberculosis complex (MTBC) and resistance to rifampin (RIF) within 100 minitues.[17] Due to constraints of our study objectives, we had not collected data for drug resistance.

Histopathology: For histopathological studies a portion of the endometrial tissue was fixed in 10% Formalin, routine processing was done, stained with haematoxylin and eosin. Presence of caseating granuloma surrounded by epithelioid cells, lymphocytes and plasma cells and giant cells are diagnostic of tuberculosis.

Demographic data i.e. age, parity and Body Mass Index (BMI) of each patient was recorded. Body Mass Index (BMI) was categorized by measuring height (metre) and weight (kilogram) at the time of hospital attendance of the patient in our study. Depending on the measurement, BMI (in kg/m^2) was categorized into underweight (<19.9), normal (20.0 – 24.9), overweight (25.0 – 29.9), obesity (30.0 –35.0), morbid obesity (≥35.0).[18] Findings of ultrasonography (USG), diagnostic laparoscopy and hysteroscopy operation of all patients were recorded.

The collected data were computed in a Microsoft Excel 2007 spreadsheet and statistical data analysis was performed with SPSS (IBM SPSS Statistics for Windows, Version 24.0) software. Cohen's kappa was used to assess the agreement between different study variables. Diagnostic accuracy, sensitivity, specificity, positive predictive value and negative predictive value were calculated using the 2×2 crosstab method on the SPSS software to compare the findings of different diagnostic tools; considering the diagnosis by GeneXpert assay as de facto gold standard.

3. Results

In our study, out of sixty-two patients, 33.9% (21/62) patients belonged to 21-30 years and 31-40 years age groups each, followed by 19.4% (12/62), 6.5% (4/62) and 6.5% (4/62) belonged to 41-50 years, less than 21 years and over 50 years age groups respectively. Mean and median age of presentation was 34.79±10.38 years and 33 years respectively with a range of 19-62 years. In our study most of the patients 56.4% (35/62) were nulliparous followed by next common 19.4% (12/62) were primiparous. (Table 1)

According to BMI, most of them 45.2% (28/62) were from overweight group in our study, followed by 22.5% (14/62), 21.0% (13/62) and 11.3% (7/62) belonging to group of normal, obese and morbidly obese respectively according to our classification.[18] The mean BMI of patients were 24.85±3.42 $kg/m^{2\cdot}$ (Figure 1)

In our study, primary infertility was the most common 48.4% (30/62) complain/symptom, followed by 22.6% (14/62), 17.7% (11/62) and 11.3% (7/62) belonging to menstrual irregularities, secondary infertility and post-menopausal bleeding per vagina respectively. (Table 2)

We had done the different screening investigations during our study, out of them, ultrasonography showed only 4.8% (3/62) patients had tubo-ovarian mass i.e. suggestive of genital TB. On laparoscopy, 29% (18/62) patients showed suggestive features of genital TB and 19.4 % (12/62) patients showed normal findings. During diagnostic hysteroscopy, synechiae in uterine cavity was found in 14.5% (9/62) patients. (Table 3)

In our study, considering as gold standard, GeneXpert assay was used to diagnose genital TB. Other tests i.e. histopathology (HPE), AFB BACTEC culture and TB-PCR were also used in our study for diagnosis of genital TB to measure validity of the tests. For HPE, sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy were measured as 30.77%, 97.96%, 80%, 84.21% and 83.87% respectively. For measuring validity of AFB BACTEC Culture to diagnose genital TB, sensitivity was 46.15%, specificity 95.92%, PPV 75%, NPV 87.04% and accuracy 85.48%. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy for TB-PCR were 23.07%, 75.51%, 20%, 78.72% and 64.52% respectively.(Table 4)

The diagnostic reliability of histopathology (HPE), AFB BACTEC Culture and TB-PCR for detecting genital TB was measured by Cohen's kappa after comparing with GeneXpert assay. For HPE, Cohen's kappa came out to be 0.37 (95%, CI 0.08 to 0.66), which indicates fair agreement. Between the two methods, i.e. AFB BACTEC Culture compared with GeneXpert assay had showed moderate agreements as evident from kappa value 0.489 (95%, CI 0.20 to 0.77). There was no agreement evident in between the TB-PCR and geneXpert assay as value of Cohen's kappa was -0.013 (95% CI -0.25 to 0.23).(Table 4)

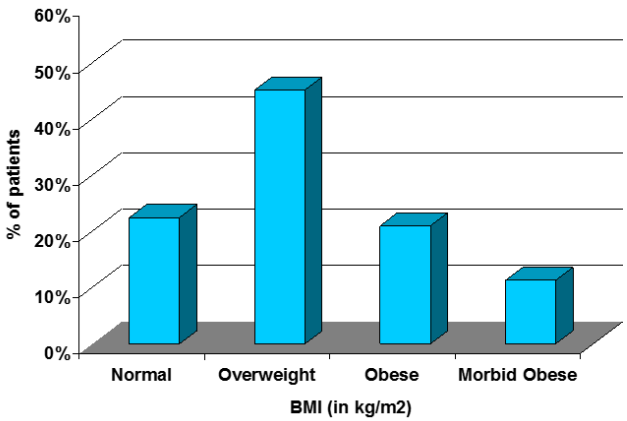

Fig. 1: Distribution of BMI of the patients according to WHO

4. Discussion

Most of the time, FGTB is a silent disease and India is in an endemic zone of the disease. Common gynaecologic conditions can be diagnosed as genital TB in high degree of suspicions. The GeneXpert assay is a new diagnostic technique to diagnose FGTB. There were several studies conducted for that purpose in recent times to document its usefulness, but there is paucity of data as very few study had compared the efficacy of the tests with all four diagnostic tests i.e. histopathology (HPE), AFB BACTEC Culture and TB-PCR.

In our study, most of the women i.e. 33.9% were from each age group of 21-30 years and 31-40 years' i.e. within reproductive age groups and mean age of 34.79±10.38

Table 1: Distribution of age and parity of the patients.

Age group (in years)	**Number**	**Percentage (%)**	
<21	4	6.5	Mean ± SD: 34.79±10.38
21-30	21	33.9	
31-40	21	33.9	Median: 33
41-50	12	19.4	
>50	4	6.5	Range: 19-62
Total	62	100.0	
Parity of patients			
0	35	56.4	Mean ± SD: 1.85±0.91
1	12	19.4	
2	8	12.9	Median: 2
3	6	9.6	Range: 1-4
4	1	1.7	
Total	62	100.0	

Table 2: Distribution of symptomatic presentation of the patients

Complain/Symptoms at presentation	**Number**	**Percentage (%)**
Primary Infertility	30	48.4
Secondary Infertility	11	17.7
Menstrual irregularities	14	22.6
Post-Menopausal Bleeding Per vagina	7	11.3
Total	62	100.0

Table 3: Ultrasonography (USG), Laparoscopy and hysteroscopy findings suggestive for genital TB and along with incidental findings.

Different Investigations	**Findings**	**Number**	**Percentage (%)**
	Presence of Tubo-ovarian mass	3	4.8
USG findings of lower abdomen	PCOD	23	37.1
	Suggestive features of endometriosis	6	9.7
	Normal findings	24	38.7
	Thickened ET	6	9.7
	Total	62	100.0
	Suggestive of genital TB	18	29.0
	PCOD	24	38.7
Laparoscopy findings	Endometriosis	8	12.9
	Normal findings	12	19.4
	Total	62	100.0
	Normal uterine cavity	41	66.1
	Synechiae in uterine cavity	9	14.5
Hysteroscopy findings	Presence of fibroid or endometrial polyp	10	16.1
	Polypoidal endometrium	2	3.3
	Total	62	100.0

among study participants.

Similar result was found by Namavar et al[19] where the mean age of the patients were 30.4 years. A study by Patel at al[20] observed the highest incidence of FGTB between 21-30 years of ages. A retrospective study conducted by JL Potter & group[21] reported mean age of patients as 37.9±14.3 and Mondal[22] found age range of the patients between 17 to 45 years with a mean of 26.3.

In our study, most of the patients 56.4% were nulliparous and 19.4% primiparous. Almost similar finding of 45% patients nulliparous and 27.5% were primiparous seen in the study of Kanti et al.[17]

Nearly half of the patients 48.4% were suffering from primary infertility and 17.7% were from secondary infertility. Menstrual complain in the form of menstrual irregularities 22.6% and post-menopausal bleeding 11.3% were present in considerable number of patients.

Table 4: Accuracy of different tests to diagnose genital TB

Name of the tests	Finding of the test to diagnose genital TB	GeneXpert findings to diagnose genital TB			Validity of different tests to diagnose genital TB				Cohen's kappa
		Positive report to diagnose genital TB	Negative report to diagnose genital TB	Total	Sensitivity	Specificity	Positive predictive value	Negative predictive	Accuracy	
HPE Findings to diagnose genital TB	Positive	4	1	5 (8.1%)	30.77%	97.96%	80%	84.21%	83.87%	Weighted Kappa 0.371 95% CI 0.08 to 0.66
	Negative	9	48	57 (91.9%)						
	Total	13 (21%)	49 (79%)	62 (100.0%)						
AFB BACTEC Culture	Positive	6	2	8 (12.9%)	46.15%	95.92%	75%	87.04%	85.48%	Weighted Kappa 0.489 95% CI 0.20 to 0.77
	Negative	7	47	54 (87.1%)						
	Total	13 (21%)	49 (79%)	62 (100.0%)						
TB-PCR	Positive	3	12	15 (24.2%)	23.07%	75.51%	20%	78.72%	64.52%	Weighted Kappa -0.013 95% CI -0.25 to 0.23
	Negative	10	37	47 (75.8%)						
	Total	13 (21%)	49 (79%)	62 (100.0%)						

The study findings were almost similar with Deshai RM et al[23] where 48% women had primary infertility and 12% had secondary infertility. Farhana et al[24] had shown that infertility was the most common presenting complaint in 59.77% of patients including primary and secondary types, that was slightly lower than our study findings.

The laparoscopic findings, suggestive of genital TB were 29% in our study. Similar result was found by P. Kumar et al[25] where laparoscopy was positive in 29.11 % patients. In another study, Thangappah et al[26] reported laparoscopic evidence of tuberculosis in 59.7% of patients and Mala et al[27] reported laparoscopic visualization alone was able to detect 86.6% cases which were much higher than our study findings.

In our study, hysteroscopy finding of synechiae in uterine cavity, was present in 14.5% patients suggestive of tuberculosis. The study by P Kumar et al[25] reported hysteroscopy evidence of tuberculosis in 48.73% cases. In another study, Deshai RM et al[23] found 52% infertile women who underwent diagnostic hysteroscopy and laparoscopy as a part of evaluation for infertility were diagnosed to have genital TB which were higher than our study.

In our study, considering the substantial differences of different tests to diagnose genital TB, we mostly concentrated on sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy. When histopathology findings in our study were analysed, 8.1% samples were positive for endometrial tuberculosis which was comparable with study of Thangappah et al[26] where 6.9% endometrial samples were positive for tuberculosis by histology.

In the present study, diagnostic accuracy of histopathology was 83.87% with sensitivity of 30.77%, specificity 97.96%, positive predictive value 80.00% and negative predictive value of 84.21% where Thangappah et al[26] found lower Sensitivity 10.7% on histopathology as against our study.

The results of our study as well other studies confirm the fact that histopathology (HPE) is a test with low sensitivity but very high specificity. The inherent limitation of HPE is that the diagnosis is not specific for TB as it can be present in the variety of other chronic inflammatory conditions.

In our study BACTEC culture was positive for TB in 12.9% patients, similar finding was reported by P. Kumar et al,[25] Bharti Malhotra et al[28] and Goel et al.[29] In Bhanu et al,[30] study culture was positive in 3.2% and in study of Monika et al[31] culture was positive in 1.59% which were lower than our study. In another study, Jindal & group[32] culture was positive in 46.7% and by Saxena at al[33] 22% was found positive for TB by culture which are higher than our study.

In this study the diagnostic accuracy of BACTEC culture to diagnose genital TB was 85.48% with Sensitivity of

46.15%, specificity of 95.92%, positive predictive value of 75.00%, negative predictive value as 87.04%. Radhika et al[34] also found that BACTEC had a sensitivity of 40% with a specificity of 90% comparable to our study.

In the present study, TB-PCR was positive in 24.2% patients. Similar result was found in Bharti Malhotra et al[28] where TB-PCR was positive in 23.78% and in study of Goel et al[29] TB-PCR was positive in 22.2%. In two separate study, Monika et al[31] and Indu Goutam & group[35] were found positive in 3.6% and 10 % of cases respectively for TB-PCR which were lower than those in our study. In a study PCR was found positive result in 38.5% samples whereas Gunjan Sribastava et al[36] found 86% samples positive by PCR. Another study by Thangappah et al[26] reported PCR positive in 36.7% of patients and Bhanu et al[30] demonstrated PCR was positive in 56.0% patients, which were higher than our study.

In a systematic review and meta-analysis by Carlos Altez-Fernandez[37] identified and giving information on PCR and GeneXpert MTB/RIF tests. All PCR studies were "in-house" tests, with different gene targets and had several quality concerns therefore did not proceed with a pooled analysis. GeneXpert studies were of good quality and not heterogeneous, pooled sensitivity was 0·87 (0·66–0·96) and specificity was 0·91 (0·84–0·95). PCR studies were highly heterogeneous. Among geneXpert assay, specificity was favorable with an acceptable confidence interval. Gunjan Shrivastava et al,[36] concluded that PCR was not reliable for TB due to false positive or negative result.

For detecting genital TB in our study by TB PCR test, sensitivity were 23.07%, specificity 75.51%, positive predictive value20%, negative predictive value 78.72% and accuracy 64.52%. Study by Thangappah et al[26] reported sensitivity of PCR was 57.15% and by Radhika et al[34] showed a sensitivity and specificity for TB PCR test were 62.5% and 54% respectively which were higher than those found in our study.

Out of 62 samples, 66.12% (41/62) were positive by the combination of all methods used, but only 4.8% (3/62) were positive by all four methods used. Therefore, only single test is not enough for diagnosis of FGTB.[29]

There were certain limitations in our study, such as small sample size (i.e. 62 patients), thus larger sample size is required to get greater impact from the study. Due to the secondary nature of genital TB, organisms may be meagre or scarce in endometrium and may vary with menstrual cycles, so sampled endometrium did not represent infections always or infection may be located in fallopian tubes. Observer bias also can be there as histopathological reports of different observers were used for data collection. So, to conclude, although there were certain limitations but our study establishes usefulness of histopathology, AFB BACTEC culture and TB-PCR in comparison to GeneXpert for diagnosis of genital TB.

5. Conclusion

Our study showed sensitivity and specificity of different tests i.e. AFB BACTEC culture, molecular assay (TB-PCR) and histopathology had comparable efficacy to GeneXpert test for genital TB diagnosis. The GeneXpert test was very useful specially in low resource areas in where more chances of dropouts would occur if more time consuming tests are adopted. Results of all the four tests were not being positive in considerable number of patients, so multiple tests are required to be adopted to detect genital TB, otherwise some patients can be missed. Larger case control study needed to draw correlation of findings of laparoscopic and hysteroscopy with positivity of genital TB from endometrial tissue to establish more meaningful inference of clinical findings.

6. Acknowledgment

The authors would like to acknowledge all the patients who participated in the study and provided valuable information and their cooperation for the study.

7. Authors' Contributions

All authors exclusively contributed in this work and read and approved the final manuscript.

8. Declaration of Patient Consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

9. Source of Funding

None.

10. Conflicts of Interest

There is no conflict of interest.

References

1. World Health Organization. Global tuberculosis report 2018. Geneva: World Health Organization; 2018. Available from: https://apps.who.int/iris/handle/10665/274453.
2. WHO Global Tuberculosis Programme. (1994). TB: a global emergency, WHO report on the TB epidemic.1994; Geneva: World Health Organization. WHO/TB/94.177. Available from: https://apps.who.int/iris/handle/10665/58749.
3. Central TB Division, Directorate General of Health Services. India TB. Report: Revised National Tuberculosis Control Programme: Annual status report. New Delhi. Ministry of Health and Family Welfare; 2018.

4. Grace GA, Devaleenal DB, Natrajan M. Genital tuberculosis in females. *Indian J Med Res*. 2005;145(4):425–36. doi:10.4103/ijmr.IJMR_1550_15.
5. Kumar S, Sharma JB. Female genital tuberculosis. In: Sharma S, Mohan A, editors. Tuberculosis. Delhi: Jaypee; 2015. p. 362–71.
6. Neonakis IK, Spandidos DA, Petinaki E. Female genital tuberculosis: A review. *Scand J Infect Dis*. 2011;43(8):564–72. doi:10.3109/00365548.2011.568523.
7. Sharma JB. Tuberculosis and obstetric and gynaecological practice. In: Studd J, Tan S, Chervenak F, editors. Progress in obstetrics and gynaecology. vol. 18. Philadelphia: Elsevier; 2008. p. 395–27.
8. Sharma JB. Current diagnosis and management of female genital tuberculosis. *J Obstet Gynaecol India*. 2015;65(6):362–71. doi:10.1007/s13224-015-0780-z.
9. Pesut D, Stojsić J. Female genital tuberculosis - a disease seen again in Europe. *Vojnosanit Pregl*. 2007;64(12):855–8. doi:10.2298/vsp0712855p.
10. Schaefer G. Female genital tuberculosis. *Clin Obstet Gynecol*. 1976;19(1):223–39. doi:10.1097/00003081-197603000-00016.
11. Duggal S, Duggal N, Hans C, Mahajan RK. Female genital TB and HIV co-infection. *Indian J Med Microbiol*. 2009;27(4):361–3. doi:10.4103/0255-0857.55461.
12. Ali AA, Abdallah TM. Clinical presentation and epidemiology of female genital tuberculosis in Eastern Sudan. *Int J Gynaecol Obstet*. 2012;118(3):236–8. doi:10.1016/j.ijgo.2012.04.005.
13. Sharma JB, Roy KK, Pushparaj M, Gupta N, Jain SK, Malhotra N, et al. Genital tuberculosis: An important cause of Asherman's syndrome in India. *Arch Gynecol Obstet*. 2008;277(1):37–41. doi:10.1007/s00404-007-0419-0.
14. Vadwai V, Boehme C, Nabeta P, Shetty A, Alland D, Rodrigues C, et al. Xpert MTB/RIF: a New Pillar in Diagnosis of Extrapulmonary Tuberculosis? *J Clin Microbiol*. 2011;49(7):2540–5. doi:10.1128/JCM.02319-10.
15. Sinha P, Yadav N, Gupta U. Use of Hysteroscopy in Abnormal Uterine Bleeding: An Edge Over Histopathological Examination. *J Obstet Gynaecol India*. 2018;68(1):45–50.
16. Pandey P, Pant ND, Rijal KR, Shrestha B, Kattel S, Banjara MR, et al. Diagnostic Accuracy of GeneXpert MTB/RIF Assay in Comparison to Conventional Drug Susceptibility Testing Method for the Diagnosis of Multidrug- Resistant Tuberculosis. *PLoS One*. 2017;12(1):e0169798. doi:10.1371/journal.pone.0169798.
17. Kanti V, Seth S, Gupta S, Verma V, Singh A, Maurya G, et al. Comparison of the Efficacy of the Cartridge-Based Nucleic Amplification (CBNAAT)/Xpert Test and Histology of Genital Tissues in Diagnosing Female Genital Tuberculosis. *Cureus*. 2021;13(5):e15000. doi:10.7759/cureus.15000.
18. Nuttall FQ. Body Mass Index: Obesity, BMI, and Health: A Critical Review. *Nutrition Today*. 2015;50(3):117–28. doi:10.1097/NT.0000000000000092.
19. Jahromi B, Parsanezhad ME, Ghane-Shirazi R. Female genital tuberculosis and infertility. *Int J Gynaecol Obstet*. 2001;75(3):269–72. doi:10.1016/s0020-7292(01)00494-5.
20. Patel S, Dhand PLA. Hospital Based Study on Female Genital Tuberculosis in Central India. *Int J Med Res Rev*. 2016;4(2):227–32.
21. Potter J, Leddy S, Kunst H, White V. Female Genital Tuberculosis: The long road to diagnosis. *Thorax*. 2014;69(2):156–7. doi:10.1136/thoraxjnl-2014-206260.313.
22. Mondal SK. Histopathologic analysis of female genital tuberculosis: a fifteen-year retrospective study of 110 cases in eastern India. *Turk Patoloji Derg*. 2013;29(1):41–5. doi:10.5146/tjpath.2013.01146.
23. Desai RM, Kumar S, Brindini U. Female genital tuberculosis: a clinicopathological study. *Int J Rep Contracept Obstet Gynecol*. 2016;5(8):2780–3.
24. Farhana A, Zahoor D, Manzoor M, Kanth F. Evaluation of Xpert MTB/ RIF Assay for the Detection of Female Genital Tuberculosis in a Tertiary Care Center- A Descriptive Cross-sectional Study. *Microbiol Res J Int*. 2018;23(2):1–6. doi:10.9734/MRJI/2018/39636.
25. Sankar MM, Kumar P, Munawwar A, Kumar M, Singh J, Singh A, et al. Usefulness of multiplex PCR in the diagnosis of genital tuberculosis in females with infertility. *Eur J Clin Microbiol Infect Dis*. 2013;32(3):399–405. doi:10.1007/s10096-012-1755-y.
26. Thangappah RBP, Paramasivan CN, Narayanan S. Evaluating PCR, culture & histopathology in the diagnosis of female genital tuberculosis. *Indian J Med Res*. 2011;134(1):40–6.
27. Mala YM, Prasad R, Singh N, Baweja CP, Tripathi R, Yedla N, et al. Role of laparoscopy in diagnosing genital tuberculosis in suspected women: A cross-sectional study from a tertiary care hospital in Northern India. *Indian J Tuberc*. 2018;65(1):23–9. doi:10.1016/j.ijtb.2017.08.010.
28. Malhotra B, Sinha P, Hooja S, Vyas L. Rapid Diagnosis of Genital Tuberculosis by Real-time Polymerase Chain Reaction. *J South Asian Feder Obst Gynae*. 2012;4(1):39–42. doi:10.5005/jp-journals-10006-1170.
29. Goel G, Khatuja R, Radhakrishnan G, Agarwal R, Agarwal S, Kaur I, et al. Role of newer methods of diagnosing genital tuberculosis in infertile women. *Indian J Pathol Microbiol*. 2013;56(2):155–7. doi:10.4103/0377-4929.118670.
30. Bhanu NV, Singh UB, Chakraborty M, Suresh N, Arora J, Rana T, et al. Improved diagnostic value of PCR in the diagnosis of female genital tuberculosis leading to infertility. *J Med Microbiol*. 2005;54(Pt 10):927–31. doi:10.1099/jmm.0.45943-0.
31. Agrawal M, Roy P, Bhatia V, Dutt S, Gaur R. Role of microbiological tests in diagnosis of genital tuberculosis of women with infertility: A view. *Indian J Tuberc*. 2019;66(2):234–9.
32. Jindal N, Gainder S, Dhaliwal LK, Sethi S. The Role of MGIT 960 Culture Medium in Resolving the Diagnostic Dilemma for Genital Tuberculosis Patients Presenting with Infertility. *J Obstet Gynaecol India*. 2018;68(2):123–8. doi:10.1007/s13224-017-1077-1.
33. Saxena R, Shrinet K, Jain M. Comparative study of genital tuberculosis diagnosis in women with infertility. *Int J Scientific Res*. 2017;6(7):648–9.
34. Radhika AG, Bhaskaran S, Saran N, Gupta S, Radhakrishnan G. Comparison of diagnostic accuracy of PCR and BACTEC with Lowenstein-Jensen culture and histopathology in the diagnosis of female genital tuberculosis in three subsets of gynaecological conditions. *J Obstet Gynaecol*. 2016;36(7):940–5. doi:10.1080/01443615.2016.1174829.
35. Indu G, Shantanu V, Charul V, Kishan VC. To Study Association of Female Genital Tuberculosis Symptomatology with Endometrial Biopsy Tb Pcr. *J Gynecol Women's Health*. 2016;1(5):555574. doi:10.19080/JGWH.2016.01.555574.
36. Shrivastava G, Bajpai T, Bhatambare GS, Patel K. Genital tuberculosis: Comparative study of the diagnostic modalities. *J Hum Reprod Sci*. 2014;7(1):30–3. doi:10.4103/0974-1208.130817.
37. Altez-Fernandez C, Ortiz V, Mirzazadeh M. Diagnostic accuracy of nucleic acid amplification tests (NAATs) in urine for genitourinary tuberculosis: a systematic review and meta-analysis. *BMC Infect Dis*. 2017;17(1):390. doi:10.1186/s12879-017-2476-8.

Author biography

Ritu Mahata, Assistant Professor

Subrata Das, Professor

Amrita Gupta, Senior Resident

Cite this article: Mahata R, Das S, Gupta A. Evaluation of culture, molecular assay (TB-PCR), GeneXpert system and histopathology for detection of genital tuberculosis. *Panacea J Med Sci* 2022;12(3):615-621.