*ovale* infection, hence chloroquine was continued for 3 days. After treatment, blood smear became negative for plasmodia. Follow-up instructions were given and postpartum eradication with primaquine was planned. The remainder of her pregnancy was uneventful, and she delivered a healthy baby weighing 2664 g at $41^{+0}$ weeks of gestation.

SARS-CoV-2 infection causes immune system impairment that leads to higher vulnerability to other infections and reactivation of latent infections.[2] *P. ovale* infection was diagnosed 5 months after her journey to Burkina Faso. Since the incubation period of malaria ranges between 10 and 17 days, primary malaria infection was excluded, and the final diagnosis was a relapse of *P. ovale* infection. This is in accordance with a reported median of 17 weeks (range 2–60 weeks) between primary infection and first relapse of *P. ovale*.[3] The primary infection was presumably asymptomatic.[4] SARS-CoV-2 infection occurred in March, which could have facilitated *P. ovale* resurgence by impairing the woman's immune response.

In the present study, the patient's presentation was similar in the two admissions, and SARS-CoV-2 infection was the initial diagnostic hypothesis on both occasions. Many febrile diseases can mimic COVID-19, and SARS-CoV-2 infection itself may facilitate the onset or reactivation of infectious diseases. In the middle of the COVID-19 pandemic, we should not overlook other infectious diseases with similar clinical presentations.

## CONFLICTS OF INTEREST

The authors have no conflicts of interest.

## AUTHOR CONTRIBUTIONS

FP and BS conceived and designed this study. MP, RC, CZ and BS contributed substantially to the acquisition of the data. MP, RC, CZ, ES, FP and BS contributed to the interpretation of the results and drafted the paper. MP, RC, CZ, ES, FP and BS revised and approved of the final version of the manuscript.

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Received: 15 February 2021 | Accepted: 11 March 2021 | First published online: 29 March 2021
DOI: 10.1002/ijgo.13671

Gynecology

# Identification of SARS-CoV-2 in the vaginal fluid and cervical exfoliated cells of women with active COVID-19 infection: A pilot study

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**Keywords:** cervical exfoliated cells, COVID-19 infection, SARS-CoV-2, vaginal fluid

SARS-CoV-2 has been identified in nasopharyngeal secretions, feces, urine, semen, and tears.[1] Foundational research about the presence of SARS-CoV-2 in the female genital tract may help to determine the risk of sexual transmission, as well as the risk of mother-to-child

**TABLE 1** Baseline clinical characteristics and laboratory results.

| Case | Age | Menopausal status | Parity | Co-morbidities | Presenting complaints | Diagnosis at admission | Severity | SARS-COV–2 (OP&NP swabs) by RT-PCR | | Vaginal swab by RT-PCR | Cervical swab by RT-PCR | Vaginal swab by Panther System (with RLU value) | Cervical swab by Panther System |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Result | CT value (lowest) | | | | |
| 1 | 27 | Premenopausal | 2 | - | Asymptomatic | Ectopic pregnancy | - | Positive | 23 | Negative | Negative | Positive - 651 (RLUX1000) | Negative |
| 2 | 58 | Postmenopausal | 5 | - | Asymptomatic | Cervical carcinoma | - | Positive | 29 | Negative | Negative | Negative | Negative |
| 3 | 70 | Postmenopausal | 2 | - | Sore throat | URTI | Mild | Positive | 24 | Negative | Negative | Negative | Negative |
| 4 | 42 | Surgical menopause | 2 | - | Fever and sore throat | URTI | Mild | Positive | 30 | Negative | Negative | Negative | Negative |
| 5 | 70 | Postmenopausal | 3 | - | Fever, breathlessness, and sore throat | COVID–19-related pneumonia | Moderate | Positive | 21 | Negative | Negative | Negative | Negative |
| 6 | 65 | Postmenopausal | 3 | - | Asymptomatic | Ovarian carcinoma | - | Positive | 28 | Negative | Negative | Negative | Negative |
| 7 | 54 | Surgical menopause | 3 | DM, HTN | Fever and breathlessness | COVID–19-related pneumonia | Moderate | Positive | 28 | Negative | Negative | Negative | Negative |
| 8 | 48 | Premenopausal | 3 | TB, hyperthyroidism | Asymptomatic | Ovarian carcinoma | - | Positive | 30 | Negative | Negative | Negative | Negative |
| 9 | 54 | Postmenopausal | 4 | DM | Fever and sore throat | COVID–19-related pneumonia | Moderate | Positive | 28 | Negative | Negative | Negative | Negative |
| 10 | 44 | Surgical menopause | 4 | - | Asymptomatic | Ovarian carcinoma | - | Positive | 18 | Negative | Negative | Negative | Negative |
| 11 | 45 | Premenopausal | 0 | - | Asymptomatic | Ovarian carcinoma | - | Positive | 27 | Negative | Negative | Negative | Negative |
| 12 | 61 | Postmenopausal | 5 | - | Asymptomatic | Ovarian carcinoma | - | Positive | 27 | Negative | Negative | Positive - 1021 (RLUX1000) | Negative |
| 13 | 40 | Premenopausal | 3 | DM | Fever and breathlessness | COVID–19-related pneumonia | Moderate | Positive | 23 | Negative | Negative | Positive - 662 (RLUX1000) | Negative |
| 14 | 52 | Postmenopausal | 3 | DM, HTN | Fever and breathlessness | COVID–19-related pneumonia | Moderate | Positive | 24 | Negative | Negative | Negative | Negative |
| 15 | 39 | Premenopausal | 2 | - | Asymptomatic | Large uterine fibroids | - | Positive | 17 | Negative | Negative | Negative | Negative |

Abbreviations: CT, cycle threshold; DM, diabetes mellitus; HTN, hypertension; NP, nasopharyngeal; OP, oropharyngeal; RLU, relative light unit; RT-PCR, reverse transcriptase-polymerase chain reaction; TB, tuberculosis; URTI, upper respiratory tract infection.

transmission during labor. The present study aimed to assess the presence of SARS-CoV-2 in vaginal fluid and cervical exfoliated cells of women with active COVID-19 infection. This study is registered with the Clinical Trial Registry of India (CTRI/2020/09/027618). Ethical approval for this study was obtained from the local institutional ethics committee (AIIMS/IEC/20/575).

This prospective study which was conducted at a tertiary care center included 15 women with active COVID-19 infection (both symptomatic and asymptomatic), diagnosed by reverse transcriptase-polymerase chain reaction (RT-PCR) from nasopharyngeal (NP) and oropharyngeal (OP) samples from November 25, 2020, to December 12, 2020. After obtaining informed written consent, vaginal ($n$ = 15) and cervical ($n$ = 12) swabs were collected. Three women with surgically absent cervices only had vaginal swabs collected. Samples for vaginal fluid and cervical exfoliated cells were obtained from the posterior fornix of the vagina and ectocervix using a speculum. Swabs were rotated for at least five seconds and extracted. All samples were kept in a viral transport medium (VTM), immediately transported to the microbiology laboratory, and treated as per the WHO standard protocol for laboratory diagnosis of SARS-CoV-2.[2] Briefly, RNA extraction was performed from the first aliquot of VTM fluid in a magnetic bead-based automated system (Kingfisher™ Flex System; Thermo Fisher Scientific, Waltham, MA, USA) followed by real-time RT-PCR using the Taqpath™ (Thermo Fisher Scientific, Waltham, MA, USA) COVID-19 combo kit (for N, S, and ORF1b targets) in a QuantStudio™ 7 thermocycler (Thermo Fisher Scientific, Waltham, MA, USA). Subsequently, a second sample aliquot was processed for transcription mediated amplification (TMA) in an FDA-approved closed system called the Hologic Panther System (M/s Hologic Ltd, Manchester, UK). Post amplification target (ORF1ab) was detected by nucleic acid hybridization in terms of relative light units (RLU).

Table 1 presents the baseline clinical characteristics and laboratory results of the 15 participants. Mean age of participants was 51.26 years (range: 27–70 years). SARS-CoV-2 virus was not detected in vaginal and cervical samples by RT-PCR test; however, it was identified in the vaginal fluid of three (20%) participants with the TMA Panther System. Out of these three participants, two were premenopausal and one was postmenopausal; one was symptomatic with COVID-19-related pneumonia (moderate), and the other two had asymptomatic COVID-19 infection and were admitted for gynecological indications.

We could only find one study which reported detection of SARS-CoV-2 in vaginal swabs,[3] while other case studies did not identify the presence of SARS-CoV-2 in vaginal fluid.[4,5] The detection rate in the present study was 20%, which might be explained by the higher analytical sensitivity and specificity of TMA-based technology than RT-PCR testing.[6,7]

The strengths of the study were its prospective nature, inclusion of both reproductive age and postmenopausal women with mild to moderate COVID-19 disease severity, and utilization of two different testing techniques (RT-PCR & TMA). However, the small sample size and short study period are potential limitations. A larger cohort and longer duration of study would produce more robust results.

This pilot study demonstrated that a negative RT-PCR test result does not rule out the possibility of a low level of SARS-CoV-2 in the female genital tract of women with confirmed COVID-19 infection.

## CONFLICTS OF INTEREST

The authors have no conflicts of interest.

## AUTHOR CONTRIBUTIONS

KK and DK proposed the idea for the analyses. RK and DD collected the samples and relevant data. DK and RS performed the laboratory analysis. KK drafted the manuscript with direction from DK and JC. AB, PP and JC critically evaluated the manuscript. All authors approved the final version of the manuscript.

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