Incidence of COVID-19 after pulmonary function tests: a retrospective cohort study

Incidencia de COVID-19 posterior a realizar pruebas de función respiratorias: estudio de cohorte retrospectivo

Incidência de COVID-19 após testes de função pulmonar: um estudo de coorte retrospectivo

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Las pruebas de función respiratorias (PFR) se utilizan para el diagnóstico y seguimiento de patologías pulmonares. Durante la realización de estas pruebas los pacientes y los técnicos que las realizan podrían contagiarse de COVID-19. Evaluamos la frecuencia de COVID-19 dentro de dos semanas de la realización de la PFR. Solamente uno de los 278 pacientes que realizaron una PFR contrajo COVID-19. El desarrollo de COVID-19 posterior a una PFP es bajo y estas pruebas son seguras si se siguen las recomendaciones internacionales.

Key Points:

Current knowledge:

Exposure to Pulmonary Function Tests (PFT) has been associated with a higher risk of viral transmission across patients and health care staff. The frequency of SARS-CoV-2 infection following PFT is uncertain.

Contribution of the article to the knowledge?

The incidence of COVID-19 after PFT was 0.36% (95% CI 0.01-20%), 3.6 per 1,000 patients. Performing PFT, following international recommendations, during coronavirus pandemic may be considered safe, with a low frequency of SARS-CoV-2 infection.

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Abstract:

Introduction: It has been proposed that exposure to pulmonary function tests (PFT) could be associated with a higher risk of viral transmission. The frequency of the Coronavirus Disease 2019 (COVID-19) transmission after performing PFT is unknown. We aimed to assess the incidence of COVID-19 after a PFT at an academic teaching facility in Buenos Aires, Argentina. **Materials and methods:** We conducted a retrospective cohort study including all consecutive adult patients that performed PFT between April 1, 2020 and September 30, 2020. Patients with prior COVID-19 were excluded. We defined a 15-day time window to ascertain PFT related COVID-19. The primary outcome was ascertained by consulting a national database, which has information on all patients with nasopharyngeal swabs for SARS-CoV-2 in Argentina. **Results:** We included 278 patients who performed a PFT. Fifty percent were women, the mean age was 54 years (SD 18), and the main comorbidities were obesity (31%), smoking (31%), hypertension (29%), and chronic lung disease (28%). 414 PFT were performed: 270 spirometries, 80 diffusion lung capacity of carbon monoxide, 40 six-minute walk tests and 19 plethysmographs. Main indication for performing PFT was anesthetic preoperative risk assessment. Swabs were collected from 27 patients (10%). Twenty-two swabs (81%) were taken according to surgical protocols; five swabs (19%) were taken due to clinical suspicion of COVID-19, with only one testing positive. The cumulative incidence of COVID-19 after PFT was 0.36% (95% CI 0.01-20%). None of the technicians developed symptomatic disease. **Conclusion**: Given the right setting and strict adherence to international recommendations, the SARS-CoV-2 infection after having a PFT appears to be low, which follows that these procedures can be performed safely for both patients and staff.

Keywords: COVID-19; SARS-CoV-2; pulmonary function tests; aerosol spray; biosecurity.

Resumen:

Introducción: Se ha propuesto que las pruebas de función respiratorias (PFR) podrían estar asociadas con un mayor riesgo de transmisión viral. La frecuencia de presentar la enfermedad por coronavirus 2019 (COVID-19) después de realizar una PFR es desconocida. El objetivo del estudio fue estimar la incidencia de COVID-19 después de llevar a cabo una PFR, en un Hospital Universitario de la ciudad Autónoma de Buenos Aires, Argentina. **Materiales y métodos:** Se realizó una cohorte retrospectiva que incluyó a todos los pacientes que realizaron una PFR entre el 1 de abril de 2020 y el 30 de septiembre de 2020. Se excluyeron los pacientes con antecedentes de COVID-19. Definimos una ventana de tiempo de 15 días para determinar la presencia de COVID-19 relacionada con la realización de la PFR. El resultado primario se determinó consultando una base de datos nacional, que contiene información sobre todos los pacientes que se han realizado hisopados nasofaríngeos para detección del SARS-CoV-2 en Argentina. **Resultados:** Se incluyeron 278 pacientes, el 50% fueron mujeres, el promedio de edad fue de 54 años (DE 18) y las principales comorbilidades fueron: obesidad (31%), tabaquismo (31%), hipertensión (29%) y enfermedades respiratorias crónicas (28%). Se realizaron 414 PFR: 270 espirometrias, 80 difusiones de monoxido de carbono, 40 pruebas de caminata de los seis minutos y 19 pletismografias. La principal indicación de la PFR fue la evaluación pre operatoria o anestésica. A 27 pacientes (10%) se les realizó un hisopado nasofaríngeo para búsqueda de SARS-CoV-2. Veintidós hisopados (81%) se solicitaron por evaluación pre quirúrgica, cinco hisopados (19%) por sospecha clínica de infección y solamente uno fue positivo. La incidencia de COVID-19 fue de 0.36% (IC95% 0.01-20%). Durante el período del estudio ninguno de los operadores que realizaron las PFR presentaron síntomas compatibles con COVID-19. **Conclusión:** Siguiendo las recomendaciones internacionales, la frecuencia de detección de COVID-19 después de las PFR parece ser baja, por lo que estos procedimientos se podrían llevar a cabo de forma segura tanto para los pacientes como para el personal.

Palabras clave: COVID-19; SARS CoV-2; pruebas de función pulmonar; aerosoles; bioseguridad.

Resumo:

Introdução: Foi proposto que os testes de função respiratória (TFR) poderiam estar associados a um risco aumentado de transmissão viral. O risco de desenvolver doença coronavírus 2019 (COVID-19) após a realização de um TFR é desconhecido. O objetivo do estudo foi estimar a incidência do COVID-19 após a realização de uma TFR, em um Hospital Universitário da Cidade Autônoma de Buenos Aires, Argentina. **Materiais e métodos:** Foi realizada uma coorte retrospectiva que incluiu todos os pacientes submetidos a TFR entre 1º de abril de 2020 e 30 de setembro de 2020. Pacientes com história de COVID-19 foram excluídos. Definimos uma janela de tempo de 15 dias para determinar a presença de COVID-19 relacionada ao desempenho do TFR. O desfecho primário foi determinado por consulta a um banco de dados nacional, que contém informações sobre todos os pacientes que fizeram swabs nasofaríngeos para detecção de SARS-CoV-2 na Argentina. **Resultados:** Foram incluídos 278 pacientes, 50% eram mulheres, a idade média foi de 54 anos (DP 18) e as principais comorbidades foram: obesidade (31%), tabagismo (31%), hipertensão (29%) e doenças respiratórias crônicas (28%). 414 TFR foram realizados: 270 espirometrias, 80 difusões de monóxido de carbono, 40 testes de caminhada de seis minutos e 19 pletismógrafos. A principal indicação de TFR foi a avaliação pré-operatória ou anestésica. 27 pacientes (10%) foram submetidos a swab nasofaríngeo para pesquisa de SARS-CoV-2. Foram solicitados 22 swabs (81%) para avaliação pré-cirúrgica, cinco swabs (19%) para suspeita clínica de infecção e apenas um foi positivo. A incidência de COVID-19 foi de 0,36% (IC 95% 0,01-20%). Durante o período do estudo, nenhum dos operadores que realizaram o TFR apresentou sintomas compatíveis com COVID-19. **Conclusão:** Seguindo as recomendações internacionais, a taxa de detecção de COVID-19 após PFRs parece ser baixa, de modo que esses procedimentos podem ser realizados com segurança para pacientes e equipe.

Palavras-chave: COVID-19; SARS-CoV-2; testes de função respiratória; aerossóis; contenção de riscos biológicos.

INTRODUCTION

Since the outbreak of the pandemic of Coronavirus Disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), health care systems have been put under a considerable amount of strain, and the activity of laboratories of pulmonary function tests (PFT) has been limited or haulted[1]. As inhalation of infective respiratory droplets is known to be the predominant way of virus transmission[2] and the flows generated while performing PFT is high[3,4], exposure to this procedure has been associated with a higher risk of viral transmission across patients and health care staff[5,6]. Thus, the American Thoracic Society (ATS) and the European Respiratory Society (ERS) have recommended that PFT be performed only when there is a high likelihood that test results may substantially alter treatment decisions or prognosis[5,6]. Recommendations include the rational use of level-3 personal protective equipment (PPE) and a screening of patients with nasopharyngeal swabs for SARS-CoV-2 ARN, if available, before the procedure. All PFT generate aerosol particles[3-4], but is has been proposed that the potential risk of contagion is different depending on the test performed. Practices such as bronchial provocation tests, cardiopulmonary exercise testing, six-minute walk test, and maximum voluntary ventilation might have higher risk of contagion than spirometry and measurement of carbon monoxide diffusing capacity[7]. Cases of cross-infection acquired from PFT, although rare, have been reported[8], including infections with Mycobacterium tuberculosis[9].

Given that the risk of COVID-19 transmission following PFT is unknown, we aimed to assess the incidence of COVID-19 after PFT in a tertiary care teaching hospital in Buenos Aires, Argentina.

METHODS

Study design and setting

We conducted a retrospective cohort study comprising all adult patients who consecutively attended the PFT unit at *Hospital Italiano de Buenos Aires,* Argentina between April 1, 2020, and September 30, 2020. Patients with a history of COVID-19 were excluded. A single team of three technicians was in charge of all PFT, which were performed in three different rooms equipped with high-efficiency particulate absorbing (HEPA) filters. The technicians followed local and international recommendations[5-7,10]. Patients did not undergo nasopharyngeal swab testing before PFT.

Data collection and Outcomes

Demographic and comorbidity data of patients were recorded using electronic medical records. The primary outcome was to assess the incidence of COVID-19 following PFT. We defined a 15-day time frame to detect PFT-related COVID-19 infection. The primary outcome was ascertained by consulting the nationwide database *Sistema Integrado de Información Sanitaria Argentino* (SISA), which collects data of all patients undergoing nasopharyngeal swabs for SARS-CoV-2 in Argentina[11].

Statistical analyses

Continuous variables were expressed as mean with standard deviation (SD), and categorical variables were reported as frequency and percentage. The cumulative incidence of COVID-19 (%) was calculated as the total number of patients with positive reverse transcriptase-polymerase chain reaction (RT-PCR) for SARS-CoV-2 at the end of the follow-up divided by the total number of participants who underwent PFT. All analyses were performed with Stata v.13 software.

This study has been approved by the Institutional Review Board of our hospital.

RESULTS

Demographic and Clinical Characteristics

We included 278 patients who performed PFT. The characteristics of the study population are summarized in **table 1**. Fifty percent were female, the mean age was 54 years (SD 18) and the main comorbidities were obesity (31%), smoking (31%), hypertension (29%), and chronic lung disease (28%). Seventy percent of the population had comorbidities regarded as risk factors for the development of severe coronavirus disease[12,13].

Table N°1: Baseline characteristics, reason for requesting pulmonary function tests and spirometry results.

Variables	n= 278
Age in years, mean (SD)	53.51 (17.79)
Female, % (n)	54 (149)
Comorbidities, % (n)	
Hypertension	29 (82)
Obesity	31 (87)
Smoking	31 (86)
Chronic obstructive pulmonary disease	6 (18)
Asthma	19 (52)
Coronary heart disease	3 (7)
Cancer	12 (33)
Chronic heart failure	3 (9)
Diabetes	9 (24)
Immunosuppression	4 (10)
Interstitial Lung Disease	7 (19)
None	5 (15)
Reason for requesting the study, % (n)	
Pre-surgical or pre-anesthesia	32 (90)
Dyspnea study	18 (50)
Follow.up of Asthma	16 (44)
Chronic cough study	7 (19)
ILD Follow.up	7 (19
Pre-administration of drugs	4 (12)
Lung transplant follow up	4 (10)
COPD follow up	2 (6)
Pulmonary hypertension follow up	1 (4)
Neuromuscular disease follow up	1 (4)
Others	8 (21)
Pulmonary function test done, % (n)	
Spirometry	97(270)
Diffusion lung capacity of carbon monoxide	31 (85)
Six minute walk test	14 (40)
Plethysmography	7 (19)
Result of Spirometry, % (n)	
Normal	62 (172)
Suggestive of restriction	18 (50)
Obstruction	13 (35)
Mixed ventilatory defect	5 (13)

Pulmonary Function Tests

414 PFTs were performed, 86% (N=355) tests of theoretical low risk of contagion (spirometry and diffusion lung capacity of carbon monoxide) and 14% (N=59) of theoretical high risk of contagion (six-minute walk test and plethysmography). Spirometry was the most performed PFT, mainly yielding normal values. The main indications for performing PFT were anesthetic preoperative risk assessment and a history of chronic obstructive pulmonary disease (COPD).

Outcomes

Figure 1 shows the flow chart of nasopharyngeal swabs testing. Swabs were collected from 27 patients (10%) during the 15-day time frame. Twenty-two swabs (81%) were taken according to surgical protocols; five swabs (19%) were taken due to clinical suspicion of COVID-19, with only one testing positive. The patient with COVID-19 was a 26-year-old man with lung transplant, who performed a spirometry and six-minute walk test seven days before the infection. The cumulative incidence of COVID-19 after PFT was 0.36% (1/278, 95% CI 0.01-20%), 3.6 per 1,000 patients. None of the technicians developed symptomatic disease.

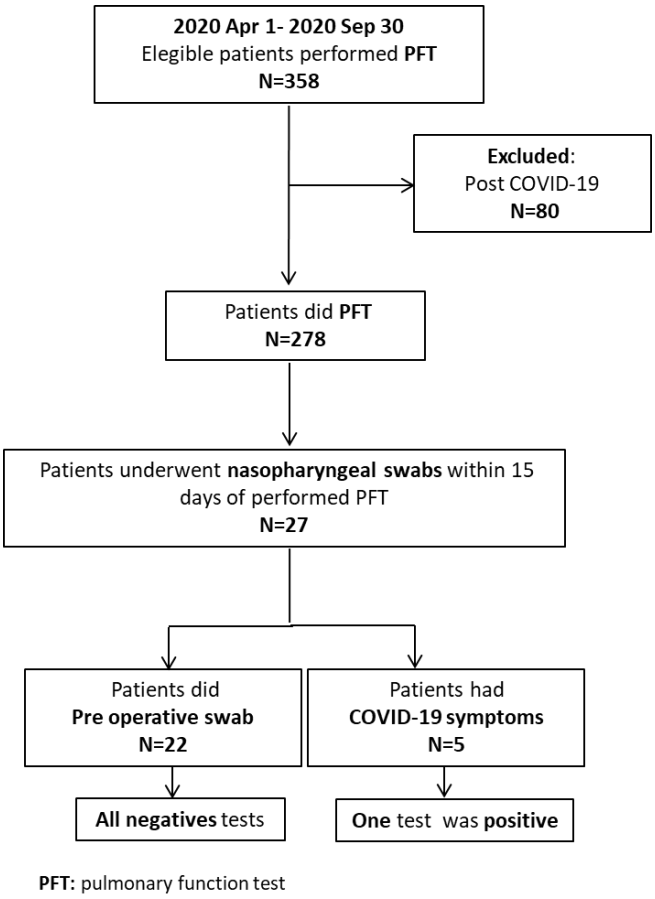

Figure N° 1. The flow chart of nasopharyngeal swabs performed after pulmonary function test

DISCUSSION

Principal findings

In this study, we estimated the incidence of COVID-19 after performed PFT. The incidence of COVID-19 was 3.6 cases per 1000 persons in the 15 days after performed PFT. The results of our study suggest that, given the right setting and observance of compliance with the existing recommendations, performing PFT during coronavirus pandemic may be considered safe, with a low frequency of COVID-19. To our knowledge, there are no similar studies published to date.

The study population was heterogeneous, ranging from pre-surgical evaluation to lung transplant follow up. The risk of infection when performing PFT may change depending on the context of community viral circulation. During the study period, Argentina had a high viral circulation with a cumulative incidence of COVID-19 of 4 700 per 100 000 population[14]. The low frequency of infection in our study may have been associated with the measures taken when performing PFT: the ventilation of the environment, the use of antimicrobial filters, the protection of the airways and mucous membranes with high level PPE, and hand washing. In agreement with ATS and ERS, we consider that the indications of the PFT should be limited to those that significantly modify a medical decision for the risk of COVID-19. Most of the patients who performed PFT had risk factors for developing severe COVID-19[12-13].

When the study was conducted, the majority of the population was not vaccinated for COVID-19. With vaccination, the incidence of COVID-19 after PFT could be lower.

Strengths and limitations of study

Strengths of this report include that it is the first study to assess development COVID-19 after performing PFT, and that a national database was used to evaluate the swabs performed.

There are many limitations to our study. It's single center nature precludes generalization to other populations. The risk of infection could not be estimated due to the lack of a control group. Due to the study design we cannot demonstrate a cause-and-effect relationship between PFT and SARS-Cov-2 infection. Exposure to PFT is clearly not the only risk factor to become infected with SARS-Cov-2. None of the health care personnel or patients were evaluated with serological methods for subclinical COVID-19 and the incidence of COVID-19 may be underestimated. This might be the strongest limitation since around 20% of COVID-19 infections are considered to be asymptomatic[15,16].

Future Research

Given the dynamic changes in SARS-Cov-2 circulation worldwide, we believe that studies to investigate the infectious potential of PFT are needed. Prospective studies could be conducted. For instance, if all the study population undergo RT- PCR for SARS-Cov-2 before and 2 weeks after performing PFTs to detect asymptomatic COVID-19, a strongest cause and effect relationship could be determined. Also, a study with a larger sample size and a control group would be relevant to estimate the risk of COVID-19 after PFT.

CONCLUSION

Given the right setting and strict adherence to international recommendations, the frequency of symptomatic SARS-CoV-2 infection after performing a PFT appears to be low, even in the absence of a vaccine. These procedures were performed safely for both patients and staff. Further studies are needed to confirm our findings.

Limitations of responsibility:
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Conflict of interest:
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