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Case Study

COVID-19's effects on symptoms associated with benign prostatic hyperplasia

Maja Sofronievska Glavinov[1,2] · Tanja Petrovska[1,3] · Jasminka Chabukovska Radulovska[1,3] · Shenol Tahir[1,4] · Stefan Arsov[1]

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Abstract

Purpose The objective of this study was to identify the relationship between COVID-19 and lower urinary tract symptoms in patients with benign prostatic hyperplasia.

Materials and methods Data from forty outpatients who had recovered from COVID-19 and had previously been diagnosed with and treated medically for benign prostatic hyperplasia were assessed. Pre- and post-COVID-19 assessments were also conducted for prostate volume, total serum PSA concentration, and lower urinary tract symptoms. Hospitalizations related to COVID-19, the time interval between COVID-19 recovery and urologist referrals, and comorbidities were considered. Independent Student's t-tests or chi-square tests were used to compare changes in all variables. For the Spearman rank correlation analysis, only variables with a univariate analysis of $p < 0.10$ were included in the multiple regression models, with the significance threshold set at two-tailed $p < 0.05$.

Results After COVID-19, there was an increase in IPSS (12.87 ± 3.76), total serum PSA (1.56 ± 0.87), and prostate volume (10.68 ± 11.73). Multiple linear regression analysis of the independent predictors of IPSS increase revealed pre-COVID-19 IPSS with intermittency and straining as leading symptoms and bladder catheterization during COVID-19. Pre-COVID-19 frequency and nocturia status were found to be independent predictors of increased blood volume, hospital treatment for COVID-19, and bladder catheterization. A weak stream, UTI, and hypertension were found to be independent predictors of a PSA increase. The time from COVID-19 recovery to urologist referral was shorter in patients with post-COVID-19 IPSS increase ($p < 0.05$).

Conclusion Determining the predictors of the effects of COVID-19 on worsening BPH symptoms is essential for continued monitoring and treatment.

Keywords Benign prostatic hyperplasia · COVID-19 · Lower urinary tract symptoms · SARS-CoV-2

✉ Maja Sofronievska Glavinov, maja.sofronievska@ugd.edu.mk; Tanja Petrovska, tanja.petrovska@ugd.edu.mk; Jasminka Chabukovska Radulovska, jasmika.radulovska@ugd.edu.mk; Shenol Tahir, senol.tahir@ugd.edu.mk; Stefan Arsov, stefan.arsov@ugd.edu.mk | [1]Faculty of Medical Sciences, Goce Delcev University, 2000 Stip, North Macedonia. [2]Urology Department, University Surgery Hospital St. Naum Ohridski, Skopje, North Macedonia. [3]Radiology Department, University Surgery Hospital St. Naum Ohridski, Skopje, North Macedonia. [4]Visceral Surgery Department, University Surgery Hospital St. Naum Ohridski, Skopje, North Macedonia.

1 Introduction

The histological characteristic of benign prostatic hyperplasia (BPH) is an increase in the number of epithelial and stromal cells in the transitional zone, which causes an enlargement of the prostatic volume and bladder outlet obstruction [1]. Since it is an androgen-dependent disorder, a substantial decrease in the serum levels of free testosterone, androstenedione, dehydroepiandrosterone sulfate (DHEAS), Δ5-androstenediol, and 17-hydroxypregnenolone, along with a significant increase in sex hormone-binding globulin (SHBG), LH, and FSH, leads to an increase in prostate volume [2]. This prostatic enlargement causes lower urinary tract symptoms (LUTS) as a clinical manifestation of the disorder, which can be either irritative or obstructive [3]. In clinical practice, the most widely used assessment tool for determining the severity of LUTS is the validated International Prostate Symptom Score questionnaire (IPSS). This questionnaire comprises seven questions about the presence of urinary frequency, urgency, nocturia, the sensation of incomplete bladder emptying, straining, intermittency, and weak stream, with the addition of a final question describing the patient's quality of life concerning urinary symptoms [4]. Digital rectal examination (DRE), ultrasound measurement of prostate volume, postvoid residual urine, and monitoring of serum levels of total prostate-specific antigen (PSA) are additional methods used in the diagnosis of benign prostatic hyperplasia (BPH) [5].

Over 6 million people have died as a result of the coronavirus infection caused by SARS-CoV-2, which has spread like a pandemic throughout the world and mostly manifests as respiratory system symptoms but has also affected other systems, such as the urinary system, due to the binding affinity to the angiotensin-converting-enzyme-2 (ACE2) receptor, which is present in the blood vessels, adipose tissue, pancreatic beta cells, prostate, and lungs [6]. When bound, this disease can cause various conditions to worsen if it is present prior to COVID-19, including diabetes, cardiovascular disease, metabolic syndrome, and the onset of LUTS [7].

Research on the relationship between the severity of COVID-19 and worsening of lower urinary tract symptoms, as well as identifying the predictors of worsening BPH-related symptoms, was initiated by the clinical observation that patients with prior COVID-19 urged a visit to the urological outpatient clinic due to worsening of lower urinary tract symptoms.

2 Materials and methods

The study is an analysis of data from forty outpatients who had recent COVID-19 and had previously been diagnosed with and treated medically with tamsulosin 0.4mg once daily for benign prostatic hyperplasia. The Ethics Committee of the University Surgery Clinic "Sv. Naum Ohridski", Skopje, North Macedonia approved the study protocol (IEB No. 234/23). Written informed consent was obtained and patients who didn't give consent were excluded from the study. The patients who met the inclusion criteria had to have at least one confirmed SARS-CoV-2 infection, either with or without hospital medical treatment, and a history of BPH diagnosis and medical treatment with tamsulosin 0.4 mg once daily, who visited a urologist one month before COVID-19 as their regular check-up for BPH. The study excluded patients who were admitted to intensive care units (ICUs), patients diagnosed with prostate cancer and patients who had episodes of acute urinary retention (AUR) before COVID-19.

The International Prostate Symptoms Score (IPSS) was used to evaluate lower urinary tract symptoms, transabdominal ultrasound was used to measure prostate volume, and total serum PSA concentration was measured in the same laboratory. Hospitalization due to COVID-19, length of hospital stays (days), insertion of a urinary catheter during COVID-19 due to acute urinary retention (AUR), comorbid conditions, and the interval between COVID-19 recovery and urologist referral were also considered.

Pre- and post-COVID-19 assessments of IPSS, prostate volume, and total serum PSA concentration were performed with chi-square tests or independent Student's t-tests depending on the relationships between the variables. The correlations were analyzed with the Spearman rank method. In the multiple regression (linear, logistic, or Cox) models, we used only the variables that had $p < 0.10$ in the univariate analysis. SPSS statistical software (version 26.0 SPSS, Inc., Chicago, IL) was used; two-tailed $p < 0.05$ was considered to indicate statistical significance. The data are shown as the mean ± standard deviation unless otherwise specified.

3 Results

According to the results, there were no missing data points, and all 40 patients had all the parameters available. Table 1 displays the quantitative characteristics of the study subjects, which included an increase in IPSS, an increase in the serum total PSA concentration, and an increase in prostate volume after COVID-19 recovery. There was a post-COVID-19 increase in IPSS, PSA, and prostate volume (12.87 ± 3.76; 1.56 ± 0.87; 10.68 ± 11.73, respectively).

As shown in Table 2. 65% of the patients were hospitalized due to COVID-19 symptoms, and 20% of all patients underwent urinary catheterization as a result of acute urinary retention (AUR) regardless of hospitalization. More than half of the patients (55%) with COVID-19 had urinary tract infections (UTIs), and the most common symptoms during infection with SARS-CoV-2 were nocturia, urgency, and frequency (95%, 92.5%, and 97.5%, respectively). Diabetes (52.5%) and hypertension (67.5%) were the two comorbidities present in more than half of the patients.

The Spearman correlation coefficients and p values, as shown in Table 3, revealed a correlation between post-COVID-19 IPSS increase and duration of hospital stay ($p < 0.01$) and between post-COVID-19 IPSS increase and urinary tract infection (UTI) ($p < 0.05$). Incomplete bladder emptying and intermittency dominance in pre-COVID-19 IPSS also correlated with post-COVID-19 IPSS increase ($p < 0.05$ and $p < 0.01$, respectively). Additionally, a correlation between the increase in prostate volume and the increase in PSA ($p < 0.01$) was found.

In Fig. 1, a scatter plot of IPSS increase and duration of COVID-19 (days) divided according to bladder catheterization is given. We found that there was a significant positive correlation between the duration of COVID-19 and the post-COVID-19 IPSS increase in catheterized patients ($p < 0.01$).

The results of multiple linear regression analysis of the independent predictors of IPSS increase, prostate volume increase, and PSA increase are presented in Table 4. We found that the independent predictors of increased volume were increased IPSS before COVID-19 infection, duration of SARS-CoV-2 infection (day), duration of hospital treatment for COVID-19, duration of bladder catheterization during COVID-19, nocturia, and increase in PSA levels ($p < 0.05$).

Independent predictors of increased IPSS were increased IPSS before COVID-19; time between COVID-19 recovery and urologist referral; bladder catheterization during COVID-19; intermittency; straining; and increased PSA ($p < 0.05$). Finally, the independent predictors of increased PSA levels were increased IPSS before SARS-CoV-2 infection, time between COVID-19 recovery and urologist referral, weak stream, urinary tract infection during COVID-19, hypertension, increased prostate volume, and increased IPSS ($p < 0.05$).

4 Discussion

The usual follow-up and evaluation of BPH progress is once per year, but the patients who suffered SARS-CoV-2 infection needed earlier control check-ups (mean 164.25 days, SD 68.27). The time from the last regular check-up and the reassessment of variables after COVID-19 was not long enough to make significant changes in the size of the prostate, IPSS & PSA rise under physiological circumstances. According to EAU Guideline, 81% of patients with BPH on regular watchful waiting are clinically stable after a mean follow-up of 17 months and the treatment failure rate for 5 years is 21% [8].

Several authors have documented the detrimental effects of COVID-19 on patients with benign prostatic hyperplasia (BPH) who experience lower urinary tract symptoms (LUTS) [9–12]. According to recent study results, age,

Table 1 Quantitative parameters of the subjects included in the study

Variable	Mean	Standard deviation
Age (years)	65.15	9.29
Time from COVID-19 to urologist referral (days)	164.25	68.27
Duration of COVID-19 (days)	15.48	5.67
IPSS before COVID-19	12.48	2.45
IPSS after COVID-19	25.35	4.50
IPSS increase	12.87	3.76
PSA before COVID-19	1.56	0.87
PSA after COVID-19	3.07	2.20
PSA increase	1.51	2.12
Prostate volume before COVID-19	45.60	11.64
Prostate volume after COVID-19	56.28	16.42
Volume increase	10.68	11.73

Values are presented as the mean and standard deviation and are for all included subjects

IPSS International Prostate Symptom Score, *PSA* prostate-specific antigen

Table 2 Qualitative parameters of the subjects included in the study

Variable	Count (N)[a]	Column (%)[b]
Hospital treatment of COVID-19		
No	26	65.0
Yes	14	35.0
Catheterization during COVID-19		
No	32	80.0
Yes	8	20.0
Diabetes		
No	19	47.5
Yes	21	52.5
Hypertension		
No	13	32.5
Yes	27	67.5
Incomplete emptying		
No	24	60.0
Yes	16	40.0
Intermittency		
No	30	75.0
Yes	10	25.0
Frequency		
No	2	5.0
Yes	38	95.0
Urgency		
No	3	7.5
Yes	37	92.5
Weak stream		
No	29	72.5
Yes	11	27.5
Straining		
No	27	67.5
Yes	13	32.5
Nocturia		
No	1	2.5
Yes	39	97.5
Urinary tract infection		
No	18	45.0
Yes	22	55.0

Values are given as a count[a] and percentage[b] of the category of a variable

pre-COVID-19 IPSS, and positive urine culture results were identified as predictors of urine retention post-COVID-19. This is of great importance because of the shift in IPSS-related BPH progression and the influence of treatment [10]. Recently, it was discovered that there is a notable difference in the use of stored IPSSs among male patients before, during, and after COVID-19 [13].

The current study validates previous research findings that patients with COVID-19 may have changes in urinary symptoms. Even though elderly males were more prone to worsening LUTS during COVID-19, which could be the only manifestation of SARS-CoV-2 infection [14], in our study, patient age was not identified as a predictor of worsening LUTS. Like Nebeeh et al., our study also showed a correlation between worsening LUTS and bladder catheterization caused by AUR. Additionally, a correlation between the worsening of LUTS during hospital stays and urinary tract infection (UTI) was found.

According to the study's findings, nocturia, frequency, urgency, larger prostate volume, and higher serum PSA before SARS-CoV-2 infection were found to be predictors of worsening LUTS. Similarly, Daryanto et al. concluded in

Table 3 Correlations of measured parameters

Variable	IPSS increase	Volume increase	PSA increase
IPSS increase			
Spearman's rho	1.000	0.035	0.014
Sig. (2-tailed)		0.828	0.930
Volume increase			
Spearman's rho	0.035	1.000	**0.517****
Sig. (2-tailed)	0.828		0.001
PSA increase			
Spearman's rho	0.014	**0.517****	1.000
Sig. (2-tailed)	0.930	0.001	
Age			
Spearman's rho	0.117	−0.042	−0.019
Sig. (2-tailed)	0.471	0.796	0.908
Pre-COVID-19 IPSS			
Spearman's rho	**0.789****	−0.123	0.038
Sig. (2-tailed)	0.000	0.448	0.815
Post-COVID-19 IPSS			
Spearman's rho	−0.016	−0.311	0.062
Sig. (2-tailed)	0.921	0.051	0.706
Pre-COVID-19 PSA			
Spearman's rho	−0.158	0.009	−0.103
Sig. (2-tailed)	0.330	0.955	0.526
Post-COVID-19 PSA			
Spearman's rho	0.014	**0.404****	**0.798****
Sig. (2-tailed)	0.933	0.010	0.000
Pre-COVID-19 prostate volume			
Spearman's rho	−0.167	0.034	0.029
Sig. (2-tailed)	0.304	0.836	0.860
Post-COVID-19 prostate volume			
Spearman's rho	−0.074	**0.606****	0.223
Sig. (2-tailed)	0.652	0.000	0.166
Time from COVID-19 recovery to urologist referral			
Spearman's rho	0.292	−0.139	−0.292
Sig. (2-tailed)	0.067	0.392	0.068
Duration of COVID-19			
Spearman's rho	0.332*	−0.124	0.002
Sig. (2-tailed)	0.036	0.448	0.988
Hospital treatment of COVID-19			
Spearman's rho	**0.461****	0.002	−0.023
Sig. (2-tailed)	0.003	0.989	0.889
Catheterization during COVID-19			
Spearman's rho	**0.501****	−0.144	0.027
Sig. (2-tailed)	0.001	0.376	0.868
Incomplete emptying			
Spearman's rho	**0.449****	−0.140	−0.124
Sig. (2-tailed)	0.004	0.390	0.447
Intermittency			
Spearman's rho	**0.375***	−0.075	0.040
Sig. (2-tailed)	0.017	0.644	0.806
Frequency			
Spearman's rho	0.160	−0.259	−0.109
Sig. (2-tailed)	0.325	0.106	0.502

Table 3 (continued)

Variable	IPSS increase	Volume increase	PSA increase
Urgency			
Spearman's rho	0.190	−0.194	−0.004
Sig. (2-tailed)	0.240	0.231	0.980
Weak stream			
Spearman's rho	0.176	−0.046	−0.289
Sig. (2-tailed)	0.279	0.777	0.071
Straining			
Spearman's rho	0.270	−0.283	−0.294
Sig. (2-tailed)	0.093	0.077	0.066
Nocturia			
Spearman's rho	−0.160	0.209	0.215
Sig. (2-tailed)	0.323	0.196	0.183
UTI			
Spearman's rho	**0.344***	−0.146	−0.104
Sig. (2-tailed)	0.030	0.368	0.521
Diabetes			
Spearman's rho	0.235	0.217	0.137
Sig. (2-tailed)	0.144	0.178	0.401
Hypertension			
Spearman's rho	0.105	0.123	0.081
Sig. (2-tailed)	0.521	0.450	0.620

PSA prostate specific antigen, *IPSS* International Prostate Symptom Score, *UTI* urinary tract infection
p-value and rho of Spearman correlation for all included subjects; *p < 0.05 (bold) and **p < 0.01 (bold)

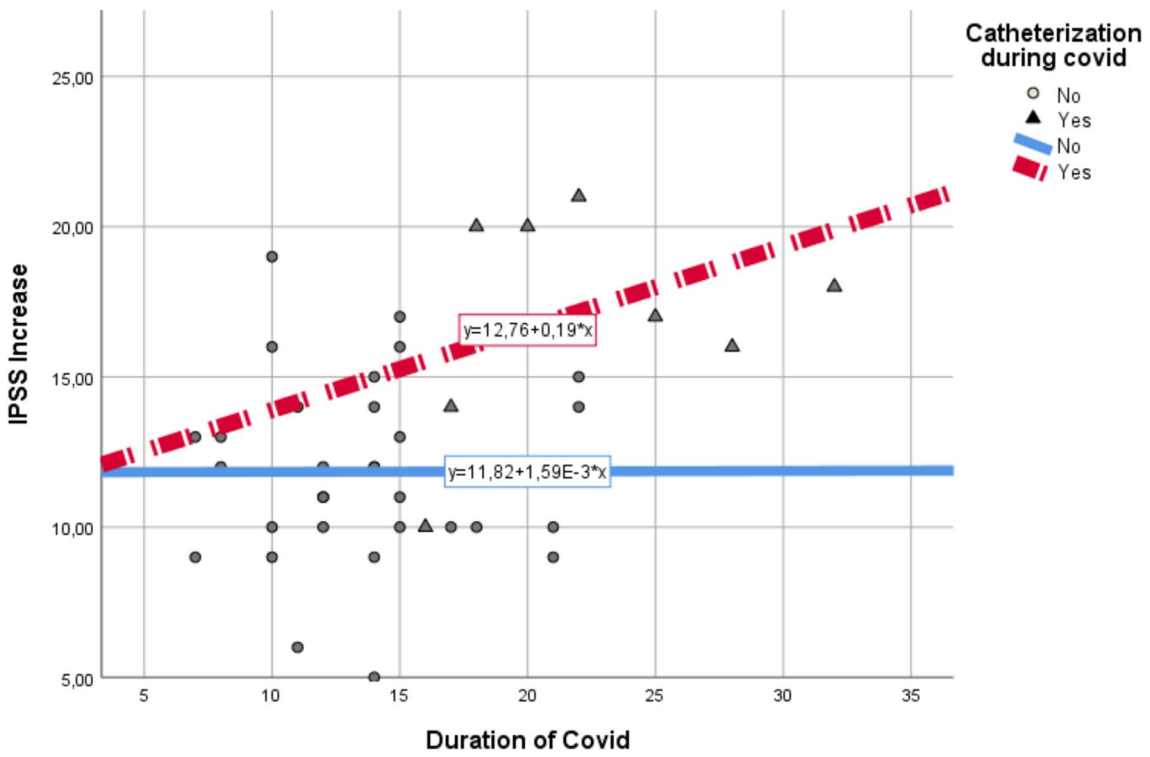

Fig. 1 Scatter plot of IPSS increase and duration of COVID-19 divided according to catheterization status

Table 4 The final model of multiple linear regression analysis of IPSS increase, PSA increase, and volume increase

Dependent variable	B	p value[a]
Prostate volume increase		
Pre COVID-19 IPSS	−1.938	0.007
Time post COVID-19 to urologist	0.061	0.037
Hospital treatment	9.987	0.043
Urinary catheter	−9.989	0.083
Frequency	−26.354	0.001
Nocturia	26.48	0.033
PSA increase	1.911	0.017
IPSS increase		
Pre COVID-19 IPSS	−0.509	0.013
Post COVID-19 IPSS	0.019	0.009
Urinary catheter	4.729	0
Intermittency	2.092	0.054
Straining	1.756	0.077
PSA increase	0.422	0.059
PSA increase		
Pre COVID-19 IPSS	0.346	0.023
Time post COVID-19 to urologist	−0.011	0.032
Weak stream	−1.334	0.088
UTI	−1.444	0.056
Hypertension	−1.465	0.057
Volume increase	0.05	0.087
IPSS increase	0.233	0.026

COVID-19 corona virus disease 19, *IPSS* International Prostate Symptom Score, *PSA* prostate-specific antigen, *UTI* urinary tract infection

[a] $p < 0.05$ is significant

their study that the three most common symptoms in the lower urinary tract are urgency, nocturia, and frequency, and their severity may increase after contracting COVID-19 infection [9]. Of 55% of patients with UTI after COVID-19, 20% were catheter-associated, and the remaining 35% were not associated with acute retention and catheter insertion. Recent data suggest that COVID-19 has a negligible effect on catheter-associated urinary tract infections (UTIs) [15, 16]. Additionally, it has been confirmed that the presence of the SARS-CoV-2 virus correlates with increased urine retention, hematuria, and UTI [17].

A higher IPSS prior to COVID-19, particularly as a result of obstructive symptoms (intermittency and incomplete bladder emptying); higher total PSA levels prior to COVID-19; and bladder catheterization were found to be independent predictors of worsened lower urinary tract symptoms. Urinary catheter placement in all patients (20%) was due to acute urinary retention, regardless of hospital stay due to COVID-19 [15–17]. The correlation of PSA with urinary catheter placement and duration was not found useful in this study since nontraumatic urethral catheterization has little effect on PSA levels and urethral catheterization does not increase PSA levels and free/total PSA on the condition that it is performed using sterile precautions and atraumatically [18, 19].

A high pre-COVID-19 IPSS, long hospital stays due to COVID-19, bladder catheterization during COVID-19, and high total serum PSA before COVID-19 were identified as independent predictors of an increase in prostate volume after SARS-CoV-2 infection. Additionally, patients who were treated in a hospital setting for COVID-19 and those who experienced an episode of acute urinary retention during COVID-19 were found to have significantly increased prostate volume following virus infection. Considering that SARS-CoV-2 infection in patients with BPH causes noticeable increases in the serum level of total PSA during the active phase of the illness [11], our study's findings that the increase in the post-COVID-19 prostate volume was correlated with the total serum PSA concentration are consistent with the literature. Although it has been reported that even in the acute stage of infection, SARS-CoV-2 RNA is not found in prostate tissues [20], it is obvious that the binding affinity of SARS-CoV-2 for ACE2 and the androgen receptor (AR) in prostate tissue triggers

inflammatory and intracellular metabolic impairment mechanisms, which in turn leads to an increase in PSA and an increase in prostate volume [21].

One of the limitations of our research is that although total serum PSA levels increase after COVID-19, we were not able to completely rule out a PSA increase after immunization since COVID-19 vaccination is linked to a slight increase in PSA [22]. Additionally, the small patient population is a limitation of this study, but this can be explained by the restrictions in place during COVID-19 outbreaks and patients' anxiety about visiting hospitals. The fact that every patient in the study was monitored as an outpatient further limits the scope of the analysis of biochemical inflammatory parameters. However, this was caused by a shift in the priorities for medical and surgical care during the pandemic, which led to the postponement of all elective outpatient appointments including the assessment by uroflowmetry and post voidal residual urine and surgical procedures to free up space and resources for patients with COVID-19. Nonetheless, the study complied with other studies' recommendations for a thorough assessment of prostatic status in outpatients using pertinent questionnaires (IPSS) and PSA serum level monitoring.

5 Conclusion

To highlight the impact of COVID-19 on the progression of BPH-related lower urinary tract symptoms and estimate the changes in these symptoms, identifying the factors that contribute to the worsening of BPH-related lower urinary tract symptoms after COVID-19 recovery is preferable. Determining these factors is especially crucial for the ongoing management and follow-up of these patients and should be the subject of further investigations.

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Data availability The datasets generated and analyzed during the current study are not publicly available because the study was done at the institutional and not at the national level but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate All experiments were performed in accordance with relevant guidelines and regulations. The Ethics Committee of the University Surgery Clinic "Sv. Naum Ohridski", Skopje, North Macedonia approved the study protocol (IEB No. 234/23). Written informed consent was obtained.

Competing interests The authors declare no competing interests.

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