Evaluate the Effectiveness of Four Alternative Approaches for the Classical Cough Test During the Urodynamic Study in the Context of the COVID-19 Global Epidemic Situation

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Research Article

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Abstract

Objective

To evaluate the four different alternatives to the classical cough test during a urodynamic study in the context of the COVID-19 pandemic.

Materials and Methods

Patients who needed to undergo a urodynamic study (UDS) at the West China Hospital of Sichuan University between April 2021 and May 2021 were randomly selected according to the inclusion and exclusion criteria. During the UDS process, we used four alternative methods to the "cough test": 1) quickly pressing the bladder area, 2) performing the Valsalva maneuver, 3) performing the Kegel maneuver, and 4) letting the patient close their mouth while doing cough test. The "cough" waveform data were obtained and compared with the classical cough test.

Results

120 patients (89 men, 31 women) were included in the study. There was no statistical difference between the cough waveform induced by the Valsalva maneuver compared with the classical cough test ($P=0.150$), no statistical difference between cough with closing mouth and classical cough test ($P=0.255$), no significant difference between pressing quickly on the bladder area and classical method ($P=0.087$), and there was a significant difference between the data obtained by the Kegel maneuver and the classical method ($P<0.05$). The average "cough" amplitude obtained was 73.14 ± 22.48 cm H₂O, 66.17 ± 17.12 cm H₂O, 82.93 ± 18.95 cm H₂O, 26.50 ± 8.68 cm H₂O, and 68.90 ± 20.32 cm H₂O by the classical cough test, by quickly pressing the bladder area, by the Valsalva maneuver, by the Kegel maneuver, and by coughing with a closed mouth, respectively.

Conclusion

Quickly pressing the bladder area, performing the Valsalva maneuver, and letting the patient close their mouth while doing the cough test can all provide effective cough waveforms and amplitudes.

Trial registration:

No.2021–183.

1. Introduction

Urodynamic study (UDS) is generally used to describe the measurements that assess the function and dysfunction of the lower urinary tract using an appropriate method[1]. The aim of urodynamics is to make clinical observations while taking these measurements to understand the underlying causes of the patient's lower urinary symptoms and to identify the pathophysiological processes involved. In 2002, the International Continence Society (ICS) had published the first version of "Good Urodynamic Practices (GUP)[2]," which had updated versions in 2013–2015 and 2015–2016[3]. The GUP is the official international guidelines for UDS, which is currently the most recognized urodynamic technical guideline in the world, and has detailed descriptions of the three major elements that include the relevant test measurements and procedures, quality control, and accurate interpretation and analysis of UDS reports[2]. In the section of "Pressure Signal Quality Control: Qualitative and Quantitative Plausibility," the minimum criteria for urodynamic quality control were specified. This section clarified that the "cough" test was an important way to check whether the signal was "alive." GUP also emphasized that we must do cough tests throughout the entire UDS process; from the beginning to the end of the test, cough tests should be performed once every 50 mL filled-volume.

However, in December 2019, a highly contagious viral pneumonia caused by the novel coronavirus (COVID-19) was first reported in Wuhan, China[4], which soon spread throughout China; subsequently, COVID-19 cases were reported around the world, and the World Health Organization (WHO) declared the outbreak of a public health emergency[5]. Generally, infected people spread virus particles when they speaking, breathing, coughing, or sneezing[6]; similar to other viral diseases, the main transmission routes include person-to-person transmission, airborne transmission, and other modes of transmission[7]. Studies have shown that aerosols exhaled by an infected person's breathing, talking, and sneezing can live for approximately 3 h and travel up to 7–8 meters. The airborne transmission potential of the COVID-19 virus must be considered in prevention and control efforts, and the transmission of viral aerosols must be effectively reduced by wearing protective equipment[8]. Because the COVID-19 virus is highly contagious, being in contact with infected patients or carriers of the virus becomes very dangerous, exposing the health provider to a high risk of infection.

To ensure the quality of UDS, we must conduct multiple cough tests during the entire UDS process to verify whether the signal is "alive". However, in the current context of the COVID-19 pandemic, especially in some underdeveloped or developing countries. A patient coughing repeatedly inadvertently increases the chance of virus transmission even with some basic protection measures. Reducing the risk of exposure of urodynamicists during UDS is very important. In addition, by following the standard protection approach, such as wearing masks and protective face screens, this problem can also be solved by finding alternative approaches to replace the classical cough test. The purpose of this study was to evaluate the effectiveness of some alternatives that may replace the classical cough test for COVID-19.

2. Methods And Materials

Patients who needed to undergo UDS at the West China Hospital of Sichuan University between April 2021 and May 2021 were randomly selected according to the inclusion criteria.

2.1 Inclusion Criteria

Patients who were selected in the study met the following study enrollment criteria: 1) aged > 18 years; 2) with a clear medical history; 3) with a normal cognitive function and can cooperate with researchers; 4) no surgical history of the anus, abdomen, lungs, throat, and pelvic floor area; and 5) with a negative nucleic acid test results for COVID-19.

2.2 Exclusion Criteria

The patients who met the following criteria were excluded from the study: 1) could not cooperate with the researcher's instructions, 2) had been previously diagnosed with COVID-19, and 3) being diagnosed with other respiratory infections.

2.3 Urodynamic Study Process

All UDS were performed using catheters with standard measurements and a UDS equipment with an air catheter system; sterile saline (37°C) was used as the filling medium. For patients with non-neurogenic bladder dysfunction, the filling rate was 60–90 mL/min; for patients with neurogenic bladder dysfunction, the filling rate was 10–30 mL/min. All patients were in a sitting position when taking the test, and all UDS procedures strictly referred to the GUP guidelines[2, 9]. During the UDS process, the "cough" waveform data were obtained using five "cough test" methods: 1) classical cough test, 2) Quickly pressing the bladder area, 3) Performing the Valsalva maneuver, 4) Performing the Kegel maneuver, and 5) Letting the patient close their mouth while doing cough test.

2.4 Medical Ethics Approval

This study was approved by the Medical Ethics Committee of the West China Hospital of Sichuan University (2021–183), and the study was conducted in strict accordance with the Declaration of Helsinki. All enrolled patients signed an informed consent form.

2.5 Statistical Analysis

Statistical analysis was performed using the SPSS software. The "cough" wave's amplitudes from the five different approaches were presented as mean $\pm$ SD. Student's t-test was used for the statistical comparison of urodynamic results. Statistical significance was set at $P < 0.05$.

3. Results

3.1 Baseline information of enrolled patients

A total of 120 patients (89 men, 31 women) were included in the study, with an average age of 42 ± 22.45 years and 51 ± 14.58 years for male and female patients, respectively. Among the patients, 22 were diagnosed with neurogenic bladder dysfunction, and 98 were diagnosed with non-neurogenic bladder dysfunction (Table 1).

3.2 Characteristics of “cough” waveforms obtained by the five different cough methods

The five different cough methods described in 2.3 were performed during the UDS of all enrolled 120 patients, and the different amplitudes were recorded. The average “cough” amplitude obtained was 73.14 ± 22.48 cm H₂O, 66.17 ± 17.12 cm H₂O, 82.93 ± 18.95 cm H₂O, 26.50 ± 8.68 cm H₂O, and 68.90 ± 20.32 cm H₂O by the “Classical cough test”, by “Quickly pressing the bladder area”, by “Performing the Valsalva maneuver”, by “Performing the Kegel maneuver”, and by “Letting the patient close their mouth while doing cough test”, respectively. We compared the cough amplitude obtained by the classical cough test with that obtained by other cough methods. The analysis showed that there was no statistical difference between the data obtained by the “classical cough test” and by “quickly pressing the bladder area” ($P=0.087$), by “performing the Valsalva maneuver” ($P=0.150$), and by “letting the patient close their mouth while doing the cough test” ($P=0.255$). However, there was a significant difference between the data obtained by “performing the Kegel maneuver” and the “classical cough test” ($P<0.05$) (Table 2).

3.3 The “cough” waveform data obtained by the five different cough methods compared with the initial intravesical pressure

The data obtained by the “classical cough test”, by “quickly pressing the bladder area”, by “performing the Valsalva maneuver”, and by “letting the patient close their mouth while doing the cough test” were not statistically different with that of the initial intravesical pressure ($P<0.05$); however, there was a statistical difference between the data obtained by “performing the Kegel maneuver” and the initial intravesical pressure ($p=0.60$) (Table 3).

3.4 Characteristics of different subtypes of “cough” waveforms

In this study, we found that several “cough waveforms” induced by “alternative approaches” often represent two different subtypes. For example, we found that the waveform induced by “performing the Valsalva maneuver” often appears in two types: the Type 3 waveform characterized by a “towering shape” and “sharp shape”; and the Type 4 waveform characterized by a “platform shape.” We also found two subtypes in the waveforms induced by “performing the Kegel maneuver”: the Type 1 waveform characterized by a “low waveform shape” and the Type 2 waveform characterized by a “weak waveform shape” (Figure 1).

3.5 The characteristics of “cough” waveforms obtained by the five different methods in one same UDS process

All of the five methods could produce “cough” waveforms, but when compared with the waveform induced by “classical cough tests”, the waveform amplitude induced by “performing the Kegel maneuver” was generally smaller and sometimes more difficult to observe and record. “Performing the Valsalva maneuver” method can always produce a higher waveform amplitude than other methods. Compared to the “sharp shape” waveform obtained by the “classical cough test”, the waveform obtained by “performing the Valsalva maneuver” was a “high platform shape”. Waveforms obtained by “letting the patient close their mouth while doing the cough test” and “quickly pressing the bladder area” were similar to those obtained by the “classical cough test” (Figure 2).

4. Discussion

The rapid spread of COVID-19 is attributed to airborne particles exhaled by infected but often asymptomatic individuals[10]. Personal protective equipment (PPE) is commonly used to filter airborne pathogenic particles when inhaled into the lungs. In the era of COVID-19, the role of face masks has expanded to reduce aerosol emissions from the respiratory system, because airborne diseases have been identified as one of the main routes of infection[11, 12]. Although PPE can be the primary approach for preventing the spread of COVID-19 between doctors and patients, it may be a better choice to reduce the transmission rate by reducing the formation of iatrogenic aerosols, such as by substituting the classical cough test with some effective alternative methods. Only by fundamentally reducing the generation of potential pathogenic aerosols can help urodynamicists be kept safe. This study mainly verified four alternatives to the classical cough test for the quality control function.

Valsalva test plays an important role in the UDS of stress urinary incontinence (SUI). In 1993, McGuire's study showed that the Valsalva Leak Point Pressure could be used to identify the different types of SUI[13]. The main mechanism of the Valsalva test is to induce the appearance of SUI by increasing the abdominal pressure, and during the Valsalva maneuver, increased intra-abdominal pressure is generated and expelled toward the urethra[14]. In the present study, we found that there was no statistical difference between the cough waveform induced by “performing the Valsalva maneuver” compared with that of the classical cough pattern ($p=0.150$); however, it can be found in the data that the average amplitude of the “cough pattern” induced by “performing the Valsalva maneuver” is higher than that of the “classical cough test” (82.93 ± 18.95 vs. 73.14 ± 22.48), which is also the highest among the four alternative methods. The cough waveforms induced by “performing the Valsalva maneuver” has a “platform shape.” “Quickly pressing the bladder area” has a similar mechanism as “performing the Valsalva maneuver”, which can also obtain a similar cough waveform as the classical cough method (66.17 ± 17.12 vs. 73.14 ± 22.48). This method is also commonly done in children who are unable to comply with the classical cough test. Coughing with a closed mouth can obtain the waveform that is mostly close to that of the classical cough test (68.90 ± 20.32 vs. 73.14 ± 22.48), but this approach has the same limitations as the classical cough test, such as in some children or deaf-mute patients could not cooperate with the urodynamicists’ instruction. Both methods can reduce the production of aerosols that may contain potential pathogens.

Pelvic floor muscle exercises have been the first-line treatment for pelvic floor dysfunction since Arnold Kegel introduced them half a century ago[15]. Its main principle is to increase the function of the pelvic floor muscles through training. The adult urinary bladder is located anteriorly in the pelvic cavity and behind the pubic bones[16]. In this study, we found that although “performing the Kegel maneuver” could induce the waveform, the amplitude of the obtained waveforms was small (26.50 ± 8.68 vs. 73.14 ± 22.48), and some of them could not even be identified. The difference was statistically significant ($P < 0.05$) when compared to the classical cough test. Concurrently, the pelvic floor muscles are in the pelvic cavity, and patients may intuitively feel them; thus, many patients cannot accurately contract to the pelvic floor muscles. Clinicians usually use biofeedback therapy to help patients feel the pelvic floor muscles[17]. Because there is a statistical difference between the Kegel method and the classical method, while most patients cannot accurately complete the Kegel maneuver, we do not think it is an effective alternative method.

It should be emphasized that regardless of which of the above alternatives are used, PPE remains the most basic and effective form of infection prevention. In our single-center experience, we used surgical or N95 masks and protective face screens as the standard prevention approach. We also routinely let patients take the COVID-19 nucleic acid test before receiving UDS, although we are aware that due to the cost of nucleic acid testing, it cannot be carried out in all areas. The findings of this study aim to have a positive effect on reducing the urodynamicists' risk of COVID-19 infection.

5. Conclusions

Through this study, we preliminarily verified that “Quickly pressing the bladder area”, “Performing the Valsalva maneuver”, and “Letting the patient close their mouth while doing the cough test” can obtain effective cough waveforms and amplitudes. They can all be alternative approaches to the classical cough test in the context of the COVID-19 pandemic.

Declarations

Authors' contribution: Xiao Zeng: Data collection and data analysis, manuscript writing; Shuang Liu: Data collection and data analysis; SiHong Shen: manuscript writing; Hong Shen: Protocol development, data collection; DeYi Luo: Project development.

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Tables

Table1. Baseline data of enrolled patients

Gender	Case Number	Age mean±SD [#]	Neurogenic bladder	None-neurogenic bladder	Aircathetersystem
Male	89	42 ± 22.45	13	76	89
Female	31	51 ± 14.58	9	22	31

[#]SD:StandardDeviation.

Table2. Different kinds of alternatives compared with the classical cough test

Approach	Amplitude (mean ± SD) [#] cmH ₂ O	P value	Case Number(n)
Cough test(classic)	73.14 ± 22.48	N/A*	120
Quickly pressing the bladder area	66.17 ± 17.12	0.087	120
Performing the Valsalva maneuver	82.93 ± 18.95	0.150	120
Performing the Kegel maneuver	26.50 ± 8.68	<0.05	120
Letting the patient close their mouth while performing a cough test	68.90 ± 20.32	0.255	120

*N/A Not Available[#]SD:Standard Deviation ALL urodynamic study system was aircatheters system ACS
P<0.05 shows statistically significant 1cmH₂O=0.133kpa.

Table 3. The “cough” waveform data obtained by the five different cough methods compared with the initial intravesical pressure

Methods(amplitude)	Initial intravesical pressure (mean ± SD) [#] cmH ₂ O	p
Cough test(classic)		<0.05
Quickly pressing the bladder area		<0.05
Performing the Valsalva maneuver	25.5±5.07	<0.05
Performing the Kegel maneuver		=0.60
Letting the patient close their mouth while performing a cough test		<0.05

[#]SD:Standard Deviation;P<0.05 shows statistically significant 1cmH₂O=0.133kpa.

Figures

Figure 1

See image above for figure legend.

Figure 2

See image above for figure legend.