Voice Quality and Vocal Tract Discomfort Symptoms in Patients With COVID-19

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Summary: Introduction. Dysphonia and laryngeal problems are some of the manifestations of the COVID-19 pandemic due to respiratory disease as a primary effect of COVID-19. The aim of the present study was to investigate voice quality and vocal tract discomfort symptoms in patients with COVID-19.

Materials and methods. Forty-four COVID-19 patients with a mean age of 49.61 ± 16.48 years and 44 healthy subjects with a mean age of 48.52 ± 13.8 years participated in the study. The voice quality of the participants was evaluated using auditory-perceptual evaluation with the Grade, Roughness, Breathiness, Asthenia, and Strain (GRBAS) scale. The vocal tract discomfort symptoms of the participants were assessed using the Persian version of the VTD scale.

Results. Patients with COVID-19 had higher scores in all items of the GRBAS, including grade, roughness, breathiness, asthenia, and strain, than healthy subjects, and these differences were statistically significant ($P < 0.05$). Among the GRBAS parameters, grade had the highest effect size and asthenia had the lowest effect size in both speech tasks. The COVID-19 patients had a greater frequency of vocal tract discomfort symptoms than healthy subjects in all items of the VTDp scale and these differences were statistically significant ($P < 0.05$) in the following items: burning, tight, dry, pain, sore, irritable, and lump in the throat. The most and the least effect size in frequency of the vocal tract discomfort symptoms were related to dry (d = 1.502) and tickling (d = 0.157), respectively. Also, COVID-19 patients had more significant severity in all items of the VTDp scale except tight and tickling. The most and the least effect size in severity of the vocal tract discomfort symptoms was related to dry (d = 1.416) and tickling (d = 0.152), respectively.

Conclusion. The present study suggests that COVID-19 patients have more deviations in voice quality than healthy subjects. Moreover, mild vocal tract discomfort is prevalent in patients with COVID-19, and patients have more frequent and severe physical discomforts of the vocal tract than healthy subjects.

Key Words: Voice−COVID-19−Vocal Tract Discomfort−Voice disorders.

INTRODUCTION

Coronaviruses can lead to respiratory disease that can be a serious danger to public health.[1-3] A new type of coronavirus was reported in the last months of the year 2019 in China.[1] The disease caused by this new type of coronavirus was called COVID-19 by the World Health Organization.[2,4] COVID-19 appears to be more easily transmitted than previous types of coronavirus diseases.[1,5,6] COVID-19 became a world pandemic and so far has led to more than 190 million cases and more than four million deaths worldwide as of July 2021.[7]

Patients with COVID-19 have reported many symptoms related to digestion and upper respiratory infection, including vomiting, sore throat, cough, pharyngeal erythema, sneezing, rhinorrhea, acute respiratory distress, and pneumonia.[8] COVID-19 can cause shortness of breath and exhalation difficulties, leading to the lack of sufficient energy for appropriate phonation.[9] Moreover, some upper respiratory symptoms of patients with COVID-19 such as cough, pharyngeal erythema, and sore throat can be associated with problems of voice production.[10,11] Thus, patients with COVID-19 may experience symptoms related to abnormal voice production and laryngeal function.[9,12] In a study by Lechien et al (2020), nearly 25% of COVID-19 patients reported dysphonia as one of their symptoms.[13]

Although voice production may be affected in some patients with COVID-19, few studies have investigated the effects of COVID-19 on voice quality, laryngeal problems, and throat symptoms in these patients. More studies in this regarded are needed for better insights about clinical presentation of dysphonia and vocal tract problems in these patients,[13] so that intervention awareness and approaches can be more responsive. The aim of the present study was to investigate the voice quality and vocal tract discomfort symptoms in patients with COVID-19.

MATERIALS AND METHODS

Participants

A total of 88 subjects, 44 patients with COVID-19 and 44 healthy subjects, participated in the study. Each group had 24 men and 20 women. The mean age of the COVID-19

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patients and healthy subjects was 49.61 ± 16.48 and 48.52 ± 13.8 years, respectively. The inclusion criteria for the healthy subjects were as follows: nonsmoking, no previous history of laryngeal or voice disorders, no history of respiratory disorders, and no history of reflux disease. An individual who had traveled during the pandemic and had contact with a person with COVID-19 was excluded from the study. Healthy subjects were volunteers from the staff of the Semnan University of Medical Sciences.

The COVID-19 patients were people who were hospitalized at the Kowsar Hospital in Semnan, Iran. Patients were assessed while they were being hospitalized for at least 5 days and while they had the ability to speak and participate in the study. Patients with COVID-19 who were in the intensive care unit at the time of the study were not enrolled in the study due to their inability to perform tasks and their health condition. None of the patients were intubated and did not use mechanical ventilation during their hospitalization. Patients with only mild to moderate COVID-19 participated in the study.[14] Diagnostic methods for COVID-19 corresponded to World Health Organization guidance and included the following: swab test and a chest computed tomographic (CT) scan.[15] The CT scan was a faster determinate of a diagnosis of COVID-19 than the swab test, and a positive result on a reverse-transcriptase polymerase chain reaction confirmed the diagnosis of the COVID-19 based on the CT scan.

Recording instrumentation and speech samples

Sustained vowels and connected speech were used for auditory-perceptual evaluation. The participants were instructed to sustain a stable /a/ vowel for at least 5 seconds at their habitual loudness and pitch. The connected speech included counting from zero to 20in a comfortable, habitual manner of pitch, loudness, and voice quality. The speech samples were collected in a quiet room. We used a Zoom H5 handy recorder (Zoom Corporation, Tokyo, Japan) with a sampling rate of 44.1 kHz and 24-bit. The voice recorder was held on a tripod at a 30 cm distance with a 45° from subject's mouth. After recordings, voice samples were transferred to a computer for auditory-perceptual evaluation.

Auditory-perceptual evaluation

The auditory-perceptual evaluation was conducted based on the Grade, Roughness, Breathiness, Asthenia, and Strain (GRBAS) scale. The Japan Society of Logopedics and Phoniatrics introduced the GRBAS scale and it has been used in many studies in the field of voice and voice therapy.[16] The GRBAS scale is used by researchers and clinicians for rating voice quality using a 4-point Likert scale with the following judgments: 0 = normal, 1 = mild impairment, 2 = moderate impairment, and 3 = severe impairment.[16,17]

Two speech-language pathologists (SLPs) with more than 10 years of experience in the field of voice assessment who were blind to the aim and procedure of the study conducted the auditory-perceptual evaluation. The speech samples of both sustained vowel and connected speech were divided into two equal groups, each group being composed of the same number and types of both COVID-19 and healthy subjects. The SLPs conducted evaluations independently in two sessions with 1 day intervals. The speech samples of the participants were presented randomly to the raters in a quiet room with headphones. The level of headphones volume was set to a comfortable level for each rater. The SLPs were free to listen to any speech sample as many times as desired. Ten percent of the samples were randomly re-evaluated to calculate the inter-rater and intra-rater reliability. Data obtained from the raters were entered into SPSS software for analysis.

Vocal tract discomfort

The Persian version of the VTD (VTDp) scale was used for evaluating the vocal tract discomfort of the participants. The VTD of Mathieson[18] was translated into Persian and validated by Torabi et al.[19] The Persian VTDp has good validity and reliability.[19] Each of the COVID-19 patients and healthy subjects was requested to complete the VTDp. The VTDp scale has two sections comprised of the frequency and severity that quantify specific physical vocal tract discomforts. Each section of the VTDp includes the following eight items: burn, tight, dry, pain, tickling, sore, irritable, and lump in the throat. The frequency and severity of the items are rated separately by the patients using a seven-point Likert scale, from zero to six. Given that each section consists of eight items and each item's score is from zero to six, the overall score for each section (frequency or severity) is 0 to 48.[19,20]

Ethical consideration

Participation in the study was voluntary and participants were able to withdraw at any stage of the study. All participants completed an informed consent form. The study was approved by the Ethics Committee affiliated with Semnan University of Medical Sciences (IR.SEMUMS.REC.1399.238).

Statistical analysis

A descriptive statistical analysis was used to determine the mean, standard deviation, and frequency of the variables. The Kolmogorov-Smirnov test was used to evaluate the normality of the data. The Mann-Whitney *U* test was used to compare the variables between groups. The effect size of the Mann-Whitney *U* test was also calculated by dividing the z test statistic by the square root of the number of cases.[21,22] The Intraclass Correlation Coefficient was used for determining inter-rater and intra-rater reliability of the auditory-perceptual evaluations. SPSS software (version 21.0, SPSS Inc., Chicago, IL) was used to perform the statistical analysis. The significance level was set at $P < 0.05$ for all the statistical tests.

TABLE 1.
Comparison of the Auditory-Perceptual Assessment (GRBAS) Between Groups; N = 88

	Vowel /a/				Connected Speech			
GRBAS Parameters	COVID-19	Healthy	*P* values	Effect Size	COVID-19	Healthy	*P* values	Effect Size
Grade	1.07 (0.75)	0.27 (0.45)	**<0.001**	1.334	1 (0.8)	0.23 (0.42)	**<0.001**	1.244
Roughness	0.84 (0.68)	0.16 (0.37)	**<0.001**	1.282	0.7 (0.76)	0.11 (0.32)	**<0.001**	1.013
Breathiness	0.64 (0.71)	0.09 (0.29)	**<0.001**	1.066	0.61 (0.81)	0.14 (0.34)	**=0.001**	0.772
Asthenia	0.5 (0.69)	0.11 (0.32)	**=0.001**	0.726	0.48 (0.69)	0.14 (0.34)	**=0.006**	0.61
Strain	0.61 (0.68)	0.11 (0.32)	**<0.001**	0.942	0.55 (0.73)	0.16 (0.37)	**=0.005**	0.621

Notes: Mann-Whitney *U* Test. Mean ± SD of before and after Treatment, measures are reported. Significant p values are bolded.
Abbreviations: GRBAS, Grade, Roughness, Breathiness, Asthenia, Strain; SD, standard deviation.

RESULTS

Auditory-perceptual evaluation

Auditory-perceptual evaluation using the GRBAS scale revealed that the highest scores of the GRBAS parameters in patients with COVID-19 related to the G (grade) parameter in both the sustained vowel and connected speech (Table 1), and the lowest related to the asthenia (A) in both speech tasks. The patients with COVID-19 had higher scores in all items of the GRBAS scale for both the sustained vowel and connected speech than healthy subjects, and these differences were statistically significant ($P < 0.05$). Among the GRBAS parameters, grade had the highest effect size and the asthenia had the lowest effect size in both speech tasks. The patients' GRBAS scores ranged from 0.48 to 1.07 when combining the vowel and counting results, and thus essentially were between normal and "mild impairment," whereas the healthy subjects' GRBAS scores ranged from 0.09 to 0.27, close to the normal value of zero. Even though these values are relatively close, they do not overlap, *P* values are low and significant, and the effect sizes ranged from 0.61 to 1.33, suggesting meaningful and practical differences between the two groups, which is interpreted as perceptually salient differences (Table 1; the effect size was taken as the value of $r = |z|/ (n^{0.5})$, where r greater than 0.5 is considered to be a large effect [https://datatab.net/tutorial/Mann-Whitney-U-test]). It is noted that the Intra-class Correlation Coefficient for inter-rater and intra-rater reliability of the GRBAS scores were within 0.71 to 0.83 and 0.77 to 0.88 range, respectively.

Frequency of vocal tract discomfort symptoms

The most frequent vocal tract discomfort symptoms reported by COVID-19 patients were "dry" and "irritable", reported by 30 (68.2%) of the patients, followed by "soreness" (56.8%, n = 25), "pain" (50%, n = 22), "lump in the throat" (40.9%, n = 18), "burning" (36.4%, n = 16), "tightness" (34.1%, n = 15), and "tickling" (13.6%, n = 6) (Table 2).

The total score of the frequency of vocal tract discomfort symptoms among COVID-19 patients and healthy subjects were 8.64 ± 0.09 and 1.26 ± 0.25, respectively. A comparison of the VTDp frequency scores between the COVID-19 patients and the healthy subjects show that there was a statistically significant difference for all items except tickling ($P = 0.46$). The effect sizes ranged from small effect (tickling) to medium effect (tight) to large effect (burning, dry, pain, sore, irritable, and lump in the throat). It appears that, in general, COVID-19 patients experience a significantly higher frequency, although not exceptionally so, of vocal tract discomfort symptoms.

TABLE 2.
Comparison of the Frequency of VTD Between Groups; N = 88

Items	COVID-19 (N = 44)	Healthy Subjects (N = 44)	*P* values	Effect Size
Burning	0.84 (1.39)	0.18 (0.49)	***P* = 0.008**	0.589
Tight	0.84 (1.47)	0.23 (0.56)	***P* = 0.031**	0.472
Dry	2.14 (2.01)	0.14 (0.34)	***P* < 0.000**	1.502
Pain	1.45 (1.82)	0.11 (0.38)	***P* < 0.000**	1.073
Tickling	0.36 (1.16)	0.11 (0.38)	*P* = 0.462	0.157
Sore	0.82 (0.89)	0.11 (0.32)	***P* < 0.000**	1.124
Irritable	1.00 (0.91)	0.36 (0.81)	***P* < 0.000**	0.941
Lump in the throat	1.2 (1.7)	0.07 (0.81)	***P* < 0.000**	0.925
Total score of VTD	8.64 (0.09)	1.26 (0.25)	***P* < 0.000**	1.839

Notes: Mann-Whitney *U* Test. Mean ± SD measures are reported. Significant p values are bolded.
Abbreviations: VTD, vocal tract discomfort; SD, standard deviation.

TABLE 3.
Comparison of the Severity of VTD Between Groups; N = 88

Items	COVID-19 (N = 44)	Healthy Subjects (N = 44)	*P* values	Effect Size
Burning	1.00 (1.57)	0.18 (0.49)	**$P = 0.004$**	0.652
Tight	0.75 (1.4)	0.23 (0.56)	$P = 0.06$	0.41
Dry	1.89 (2.01)	0.16 (0.42)	**$P < 0.000$**	1.416
Pain	1.41 (1.84)	0.11 (0.38)	**$P < 0.000$**	1.054
Tickling	0.2 (0.55)	0.11 (0.38)	$P = 0.476$	0.152
Sore	0.75 (0.75)	0.14 (0.4)	**$P < 0.000$**	1.083
Irritable	0.98 (0.92)	0.36 (0.81)	**$P < 0.000$**	0.929
Lump in the throat	0.98 (1.4)	0.07 (0.25)	**$P < 0.000$**	0.921
Total score of VTD	7.95 (5.53)	1.36 (2.33)	**$P < 0.000$**	1.768

Notes: Mann-Whitney *U* Test. Mean ± SD measures are reported. Significant p values are bolded
Abbreviations: VTD, vocal tract discomfort; SD, standard deviation.

Severity of vocal tract discomfort symptoms

The results for the severity of the vocal tract discomfort symptoms nearly parallel the results for the frequency of the symptoms (Table 3). The total score of the severity section of the VTDp among patients with COVID-19 and healthy subjects were 7.95 ± 5.53 and 1.36 ± 2.33, respectively. There was a statistically significant difference for all items except tight ($P = 0.06$) and tickling ($P = 0.476$). The effect sizes ranged from small effect (tickling) to medium (tight) to large (burning, dry, pain, sore, irritable, and lump in the throat). It appears that, in general, COVID-19 patients experience a significantly greater intensity, although not exceptionally so, of vocal tract discomfort symptoms.

DISCUSSION

In the present study, the voice quality and vocal tract discomfort symptoms of patients with COVID-19 were studied to better understand the effects that the pandemic virus has on individuals. The results of the study suggest that COVID-19 patients have relatively low dysphonia and vocal tract discomfort symptoms, but significant higher scores (by *P* values and effect size) than healthy individuals (for both the sustained vowel /a/ and speech counting). All scores of the GRBAS parameters were low for the COVID-19 patients. Among the scores, "grade" had the highest score and "asthenia" had the lowest score in both mentioned speech tasks. These low scores on GRBAS can be justified by the mild to moderate severity of COVID-19 in the patients who participate in the study. A recent study that investigated acoustic voice parameters in COVID-19 patients reported that patients had higher jitter and shimmer and lower harmonics-to-noise ratio values and less maximum phonation times than healthy individuals.[9] In another study, Lechien et al investigated self-reported dysphonia in mild-to-moderate COVID-19 patients and reported that at least 25% of the patients were (self-reported as) dysphonic.[13] The results of the present and previous studies indicate that COVID-19 patients may encounter voice quality problems, although they might be mild. Dysphonia and voice quality impairments in COVID-19 patients can be related to laryngeal changes such as vocal fold inflammation or edema.[13] Given that an intact respiratory function is essential for normal voice production; respiratory problems in COVID-19 patients can be another probable secondary cause of voice problems in COVID-19 patients. More studies in the future are needed for determining the etiology of dysphonia in patients with COVID-19.

Vocal tract discomfort symptoms of the participants were evaluated with the Persian version of the VTD. The frequency of vocal tract discomfort symptoms in patients with COVID-19 was the more frequent for dry, followed by pain, lump in the throat, irritable, burning and tight, sore, and tickling. Also, the most to least severe VTD symptoms in patients with COVID-19 were dry, pain, burning, lump in the throat and irritable, tight and sore, and tickling, respectively. The patients with COVID-19 who participated in the study reported more frequent and severe symptoms than healthy subjects. These physical vocal tract discomforts in patients with COVID-19 are consistent with some additional symptoms present in these patients, including cough, sneezing, rhinorrhea, and vomiting.[9,23] Vocal tract discomfort symptoms are very annoying and important to patients,[24] resulting in negative changes and maladjustments in the voice production process,[25] and can reduce the patients' quality of life.[20,26]

CONCLUSIONS

This study suggests that mild voice quality impairments and vocal tract discomfort symptoms are prevalent in patients with COVID-19. The COVID-19 patients had normal to mild impairments in voice quality compared to the lack of voice quality problems in the healthy subjects. Moreover, the COVID-19 patients had more physical discomforts of the vocal tract. These results suggest that mild dysphonia and physical vocal tract discomforts appear to be common in COVID-19 patients and should be considered in the evaluation and management of COVID-19 patients.

CONFLICT OF INTEREST

The authors declare that there was no conflict of interests.

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