

The efficacy of vocal rehabilitation in dysphonia after COVID19 infection

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Received: 04/05/2022

Accepted: 28/05/2022

Published: 03/06/2022

Abstract:

This study aimed to verify the effectiveness of voice rehabilitation exercises in rehabilitating voice quality in two cases suffering from hoarseness resulting from complications of infection with the Corona virus. In collecting the data, we relied on a GRBAS scale, the PRAAT software to identify the maximum phonation time (MPT), and finally, the voice handicap index. The study concluded that vocal rehabilitation has a positive effect on improving sound quality based on the indicators adopted by the study in the evaluation.

Keywords: Dysphonia ; covid19; vocal rehabilitation

1- Introduction

Sound is a vibrational wave that moves through the air or solid objects. The human voice is the mean that transmits the linguistic message. It is produced by the vocal cords in the larynx by the passage of air rushing from the lungs under the influence of the force of the diaphragm pushing into the larynx. Furthermore, the vocal cords move thanks for the The cartilaginous structure of the larynx, as well as the presence of a nervous system which works to move and to ensure the flexibility of the larynx.

The changes that occur in the human voice as a result of an organic or functional defect in the larynx lead to a change in the physical properties of the human voice; which leads to a change in the patient's perception of his voice , weakness of his vocal efficacy; in addition to psychological and occupational effects. The causes of hoarseness vary, which leads to a multiplicity of symptoms ; therefore, the methods of rehabilitation vary, but the goal remains clear, which is to restore either the vocal ability or at least improve the voice while making the patient accept the changes that occur.

Voice rehabilitation care in case of hoarseness depends on a set of pillars, the most important of which are training in vocal comfort, relaxation, correcting body posture, correcting breathing, and rehabilitating vocal behavior. The results of voice rehabilitation vary according to the variables of the type of hoarseness, age, duration of injury, and regular exercise.

This study aims to highlight an emerging topic in the SLP field, which is the vocal rehabilitation of dysphonia cases in people who have been infected with the Corona virus. Keeping pace with the global momentum in providing studies on the various symptoms associated with infection by corona According to a number of variables, the incidence of hoarseness after discharge from the hospital among people with coronavirus is high. All this highlights the importance of our study.

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2- Problem :

Corona virus appeared in Wuhan city in China in December 2019 . The basic symptom of Covid 19 is atypical pneumonia with unfamiliar reason. In February 2020, the Chinese Center for Disease Control announced that the virus causing this pneumonia had been identified and called it SARS-COV2 or Covid19.

There is a wide spectrum of symptoms associated with covid infection, ranging from asymptomatic infection to pneumonia that leads to severe respiratory problems, and symptoms are mild at 80% and often include fever, fatigue with dry cough, and a loss of taste and smell is noted in a percentage of between 34 % to 87% of cases (Mao, Jin et al. 2020, Wang, Hu et al. 2020) .

There are many research data on the symptoms associated with covid infection, it was recently considered hoarseness of the voice as one of the manifestations of coronavirus infection ; moreover, there are many factors associated between covid infection and hoarseness including vagus neuropathy, edema, infections, viral infections, vocal cord paralysis resulting from severe coughing or vomiting, 'intubation injuries, including granulomas (Saniasiaya, Kulasegarah & al. 2021)

The prevalence of voice disorders is between 6.6% and 29.9% of the population, as the percentage rises due to the influence of several factors, the most important of which are the profession. Voice disorder affects on the quality of life in the professional, social, communicative and psychological fields ; in addition to limiting the activities of daily life that require the use of the voice (de Almeida, da Cunha et al. 2020).

Leis-Cofiño, Sánchez et al. (2021) indicates that 19.8% of cases infected with the Coronavirus suffer from hoarseness due to the effects of artificial respiration : thus, coughing, and hoarseness is associated with the appearance of dysphagia , while (Buselli, Corsi et al. 2020, Naunheim, Zhou et al. 2020) suggests that 20% of people infected with corona show symptoms of hoarseness , or complete loss of voice.

Looking at a set of data related to the emergence of hoarseness, the study (Lechien, Chiesa-Estomba et al. 2020) found differences in the emergence of hoarseness associated with infection with the Corona virus, as the study included 188 cases infected with Corona, 26.8% of them had hoarseness, while most of them were women , as well as smokers.

The main question of our study revolves around the effectiveness of vocal rehabilitation with hoarseness after infection with the Corona virus.

3- Study concepts :

3-1Functional dysphonia :

There are several changes in the characteristics of the voice due to the misuse of the voice. It can affect various levels, such as breathing, the larynx, resonance ,and pronunciation, it can also effect also coordination between these levels. In addition to this, other symptoms appear ;such as discomfort and pain in the muscles of the larynx and the neck. Voice's characteristics of people with functional dysphonia are characterized by the use of thoracic breathing with pressure on the larynx. The beginning of phonation is a violent vote, a change in the quality of the voice. It is characterized by roughness and stress with the misuse of resonant cavities. Also excessive muscle tension in the larynx, neck, and shoulders (Ribeiro, De Oliveira et al. 2017).

3-2 Nodules:

It is a swelling on the back of the true vocal cords in the first third of them. It can affect adults and children. The incidence of infection is high in people who use their voices excessively or after exposure to sound shock, the entry of a foreign body into the respiratory tracts, or as a result of inflammation in the larynx. In females, the incidence of nodules is high.

The nodules affect the closing of the vocal cords ; making the voice hoarse and breathing difficult, which leads to an increase in vocal asthenia and fatigue when the patient speaks (Karkos and McCormick 2009), as well as a decrease in the vocal pitch with an overworking of the larynx (Ylmazer, Süzer et al. 2019).

3-3 Therapeutic exercises :

The exercises suggested by the speech therapist specialist vary. They aim to reduce the manifestations of voice disorders according to a number of variables, including the cause, age, profession, etc. In our study, different exercises were suggested for the two cases according to the symptoms and cause as well.

We have relied on a set of data to diagnose the patients so that we can develop an effective treatment plan, including the type of hoarseness and its symptoms, its cause, in addition to the results of the evaluations that we have carried out. The exercises focused on correcting the body's posture in sitting, standing, and during phonation, correcting breathing, relaxation, and the last exercises of the vocal series.

4-Recent studies:

Despite the recent data studies on the coronavirus, we found a set of previous studies on dysphonia after infection with coronavirus, through which we used scientific databases like *Science Direct, Springer, and Pub Med*.

Study (Hashim, Venkatesan et al., 2020):

This study aims to develop a knowledgeable reference by adopting the case study approach for a patient suffering from complications in the upper airways as a result of his stay in intensive care due to infection with the Corona virus, including hoarseness of voice as a result, and pain in the throat. When performing flexible laryngoscopy, it was observed that there was a nodule in the cord left vocal. Treatments have been conservatively offered for this condition, which is to improve the viscosity of the vocal cords through steam inhalation and vocal comfort with vocal rehabilitation. The results showed a significant improvement in the voice quality of this patient

Study (Lechien, Chiesa-Estomba et al. 2020)

This study aims to determine the extent of hoarseness and its characteristics among a group of cases infected with COVID-19 in mild and medium degrees. The study sample consisted of 702 patients across 19 hospitals in Europe. The sample members were classified according to age, gender, ethnicity, tobacco consumption, comorbidities, and general and ENT symptoms. The symptoms of hoarseness and ENT disorders were evaluated using four-degree scale. A comparison was made between the data of cases with and without hoarseness, and the correlation between the severity of hoarseness and the various variables was studied by Bayesian analysis.

This study found that a quarter of people who were infected with the Corona virus showed symptoms of hoarseness. It can be considered one of the symptoms of infection with this virus, and that its symptoms were more severe compared to people who had not had hoarseness as a result of infection with Corona previously.

Study (Korkmaz and Güven, 2021)

The case study method was used to describe the dysphonia as a symptom after infection with the coronavirus. The study sample consisted of one case, a 57-year-old woman, who suffered from a gradual loss of voice during infection with the Corona virus, with no history or specific cause, and using laryngoscopy . It was shown that the left vocal cord does not move, which forms a gap between the two vocal cords estimated at between 5 and 6 mm during sound production. This gap was repaired by laxative injection to the laryngeal muscles, with vocal rehabilitation.

The mechanism of vocal cord paralysis in this case remains idiopathic and unclear, so it is suspected to be due to infection with the Corona virus, and laryngeal nerve paralysis may represent part of a broad spectrum of neurological symptoms of COVID-19. When voice changes occur in patients during infection with this virus, the possibility of vocal cord paralysis due to peripheral nerve damage caused by COVID-19 should be considered.

When we examined previous studies that dealt with the relationship between infection with the Corona virus and voice disorders, we noticed their reliance on the case study approach, and this is normal due to the lack of previous data on this subject, as well as most of these studies relied on self-assessment methods for voice and were conducted in hospitals. This is due to the difficulty of moving cases to conduct voice assessment in places designated for that purpose.

5- Method and Tools:

5-1 Method and sample

In this study, we used the case study method in order to achieve the goal of the study. This approach was chosen due to the limited number of the study sample, and it is also the most appropriate approach to describe emerging or rare disorders . The majority of post-Corona hoarseness sufferers do not receive vocal rehabilitation, as it is since the beginning of the pandemic, only two cases have come to our clinic in which hoarseness is present as a symptom accompanying the infection with Corona. The case study approach is widely used in the medical and psychological fields, as well as in SLP. It depends on describing individual cases and turbulent and pathological mechanisms (Pedra, Tavares-Oliveira et al. 2016)

The study sample consists of two cases infected with the Corona virus; they suffered from hoarseness after COVID-19 infection. The first case involves a man aged 65, and the second involves a woman aged 45.

5-2 Tools :

5-2-1 GRBAS Scale:

There are many tools used to assess the disturbed voice. The acoustico-perceptive scales are widely used due to their ease of application and their ability to give valuable information about the state of the voice during the first session. Among these scales, the most widely used

is the GRBAS scale, which was introduced by researcher Hirano (1981), who belongs to the Japanese Society of SLP and Phoniatry, (Ann and No 1994) The assessment of voice by the GRABAS scale uses audio samples, usually fixed, in addition to continuous and automatic speech. The applicability of this scale includes all voice disorders regardless of the causes. The assessment method is simple and quick. It suggests noting five factors suggested by Hirano in its first version and the sixth factor added by Morsomme (2001). The factors are: Roughness (R), Breathness (B), Asthenia (B), Strain (S), and Instability (I) are the grades.

These factors are estimated according to four grade levels: 0 = normal, 1 = mild, 2 = moderate, and 3 =severe. (Silva, Simes-Zenari et al. 2012).

5-2-2 PRAAT software :

Praat is a software for sound and voice analysis, developed by Paul Boersma and David Winenk from the phonetics department of Amsterdam University. We used this software to study the maximum time of phonation. It's an aerodynamic parameter by which sublaryngeal pressure is estimated and sound flow is calculated.

The maximum time of phonation is tested by sitting upright and pronouncing the phoneme (a) with normal and comfortable frequency and intensity, after making an inhalation for as long as possible, and repeating this for three times with a minute difference between each repetition and the next. The MPT for men ranges between 25 and 35 seconds, and for women, between 15 and 25 seconds. In each case, having a MPT of less than 10 seconds is considered an indicator of the presence of a voice disorder(Maslan, Leng et al. 2011).

5-2-3 Voice Handicap Index (VHI)

This test was developed and published by Jacobson and colleagues in 1997 with the aim of self-assessment of voice disorder severity. This scale consists of 30 items divided into three axes related to the functional, physical, and emotional symptoms of hoarseness. Each axis contains 10 items, evaluated by the frequency of their occurrence through an estimate scale that expresses the numbers 0 (never), 1 (rarely), 2 (sometimes), and 4 (always). A score is obtained for each axis when combined together, we get the total score, which ranges from 0 to 120 degrees, in the light of which the severity of the disorder is determined. (Madeira and Tomita, 2010).

The individual's score on the scale is judged according to the following criteria:

- 0 to 30: minimal vocal impairment
- 31 to 60 degrees: cases with nodules, benign tumors or cysts
- Cases of vocal fold paralysis or severe scarring (Jacobson, Johnson, and 1997)

6- Results

6-1 First case presentation :

This case is for a 65-year-old man who does not suffer from any chronic diseases. He showed symptoms of a strong fever, difficulty breathing, loss of smell and taste, severe chills, severe cough, fatigue and exhaustion with weakness in the joints. It was initially thought that these were symptoms of common influenza, but after a medical examination in a COVID service hospital, a positive PCR examination confirmed that he was infected with the Corona

virus. The blood oxygen saturation decreased to a level of 85%, forcing him to be admitted to the hospital on January 15, 2021.

A group of medications were introduced to reduce symptoms, which included anti-inflammatory and anticoagulants, in addition to zinc, vitamin C, and antipyretics. The case remained under hospitalization and the use of oxygen in the hospital, but with the deterioration of the patient's condition, he was admitted to the intensive care unit where the oxygen was delivered to the lungs by intubation for 10 days, after which he was taken out of the intensive care and remained under medical follow-up until he left the hospital.

The case underwent a home convalescence under breathing with an air condenser. After this, the case noticed that the voice remained turbulent with pain in the right side and a roughness in the voice, with fatigue when speaking and the inability to raise the voice, which prompted him to conduct an examination with the ENT doctor. The specialist doctor performed a nasofibroscope, and he noticed the presence of kissing nodules on the edges of the left vocal fold.

The doctor prescribed a group of anti-inflammatory drugs for the upper respiratory tract with an emphasis on vocal comfort, as well as undergoing vocal rehabilitation for a period of three months at a rate of two sessions per week. This case was submitted for an SLP examination. We prepared a voice state report, which included personal data, case history, and voice SLP examinations, using the voice handicap index (VHI), PRAAT software, and the GRBAS scale.

6-2 Second Case presentation :

The case is of a 45-year-old woman who had symptoms similar to mild influenza at the beginning of March 2021, then these symptoms developed into a severe dry throat with high body temperature, severe cough, and fatigue with pain in the joints. This case was forced to go to the hospital, where a PCR test was conducted, which confirmed infection with the Corona virus. The oxygen saturation rate in the blood reached 75%, which forced doctors to patient hospitalization. The case required dependence on oxygen during the treatment period for 10 days, and after she was discharged from the hospital for 21 days. After the recovery period, the patient noticed the inability to raise the voice and call, with stress and pain in the throat when speaking, in addition to the feeling of pain and stiffness in the muscles of the throat and shoulders.

This case underwent a specialized examination by the ENT doctor, who performed a laryngoscopy, which found that she suffered from a slight inflammation of the vocal cords as a result of vocal stress, with a glottal leak as a result of poor closure of the vocal cords during the phonation process.

A group of anti-inflammatory and allergy medications were prescribed for the upper respiratory tract with antiseptics. The doctor advised this case to vocal comfort and referred her to an SLP examination, noting the need to take care of the SLP at a rate of two sessions per week for a period of two months. We conducted an assessment using the Voice Handicap Index (VHI), also using the PRAAT software, and finally, the GRBAS scale.

7- Results presentation :

As we mentioned previously, we used self-assessment data collection tools represented by the Voice Disability Scale (VHI) and the GRBAS scale, and another objective tool represented by the maximum phonation time using PRAAT software. We conducted these assessments in

two phases: the first before the vocal rehabilitation, and the second at the end of it. We obtained the following results :

Test	Pre-test	Post-test	Pre-test	Post-test
	Case 1(men)		Case 2(women)	
G	2	0	3	1
R	3	0	3	1
B	3	0	1	0
A	2	0	3	0
S	1	0	3	0
I	3	0	2	0

Table (1) : GRBAS test results .

When we compare the results of the pre and post measurements for the two cases in the GRBAS scale scores, it appears that there is an improvement in all the variables included in the assessment, as the severity of hoarseness decreased, voice quality improved, the disappearance of harshness, and other symptoms such as weakness, fatigue, and instability, which we can consider an indication of the efficacy of vocal rehabilitation exercises in the cases we have studied.

	Pre-test	Post-test
Case 1(men)	14 sec	29 sec
Case 2(women)	12 sec	22 sec

Table (2) : MPT results with Praat software .

The comparison of the maximum phonation time (MPT) using the PRAAT software showed an improvement between the two measurements, as the first measurement for the first case (man) was 24 seconds and the second case (woman) 12 seconds, which are lower levels than the MPT of typical people, which ranges from 25 to 35 seconds in men and 15 to 25 seconds in women.

The maximum phonation time for the first case (man) has improved, reaching 29 seconds, which is within the acceptable range. In the second case (a woman), the maximum phonation time has reached 22 seconds, which is also at the required level.

	Pre-test	Post-test
Case 1(men)	120 / 78	120/ 15
Case 2(women)	120 /85	120 / 19

Table (3) : Voice handicap index(VHI) results .

When comparing the results of the vocal handicap scale, we find that the pre-measurement for the first case is obtained at 120/120, while in the post-measurement the patient obtains 15/120. In the second case (women), the result of the pre-test was 85/120. After the exercise application, the VHI score decreased to 19/120.

This result is an index of voice improvement and the decreasing severity of symptoms. These results are logical when we know that all test items are negatively oriented, given their search for symptoms of hoarseness.

Discussion :

In the comparison of the results obtained after the vocal rehabilitation in the SLP clinic of the two cases, it was found that there was a clear improvement in all the evaluation indicators that we have taken into consideration, as we found that the results of the GRBAS scale, the maximum phonation time, as well as the vocal handicap index.

As we mentioned previously, the first case was suffering from hoarseness as a result of the presence of nodules in the vocal cords as a result of intubation use for artificial respiration. The second case suffered from functional hoarseness. Both cases had hoarseness as a symptom or as a result of infection with the Corona virus.

During vocal rehabilitation, we encountered a set of features that are characteristic of people with hoarseness caused by coronavirus infection. This is characterized by weakness in respiratory performance, with fatigue, and a lack of loudness even after leaving the hospital for long periods. This is what constitutes an obstacle during care and may increase the treatment period, or make improvement limited, but with the passage of time, we noticed that the impact of infection with the Corona virus began to diminish. It decreased, which led to an improvement in the voice characteristics, and this was confirmed in the results of the pre and post measurement.

Hoarseness is considered a symptom for many people infected with the Coronavirus. Azzam, Samy & colleagues (2021) suggested that 79% of them suffer from hoarseness and 18.8% suffer from vocal weakness. This is what prompted many researchers to use the symptoms of hoarseness as a diagnostic factor for infection with the virus. In this context Despotovic, Ismael & al. (2021), developed a diagnostic model that depends on comparing the type of voice, cough, and breathing of people infected with COVID-19 with a computerized database based on a prediction model for infection.

Dysphonia in people infected with the Corona virus can be temporary, starting during the early stages of infection as a result of the decrease in air pressure coming from the larynx, which results in a decrease in the fundamental frequency and voice volume. This symptom disappears after recovery and a rest period, and it can continue even after recovery. Vocal rehabilitation must be adapted to the specifics of hoarseness in such cases, taking into account the age group as well as the cause of hoarseness. Voice rehabilitation depends on rehabilitating the respiratory capacity while increasing the flexibility of the larynx and working to increase the flexibility of the vocal cords.

Conclusion:

As a result, much research is focused on developing computer models for the early detection of corona infection via spectral analysis of the human voice and comparison with a database.

The purpose of this study was to determine the efficacy of vocal rehabilitation in the treatment of dysphonia caused by Covid19 infection. It is found that the SLP exercises are efficacious in improving voice quality.

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