MEASURE OF MAXIMUM PHONATION DURATION (MPD) AND S/Z RATIO IN INDIVIDUALS WITH COVID-19

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Key words: COVID-19, MPD, S/Z Ratio, Respiration, Phonation, Voice, Non-COVID individuals, Speech in COVID-19

INTRODUCTION:

Respiration is a vital life sustaining and voice enabling process that results from the movement of support structures within the musculoskeletal system. For speech to be possible humans have learnt to use respiration for the purpose of phonation. Both speaking and singing require an exhalation (outgoing airstream) capable of activating vocal fold vibration.

Good breath support is a critical element of a good voice. The process of vocal tone production is called phonation. The disturbance of air column and movement of vocal folds causes voice. A client with a breathing deficiency for speech will have increased difficulty with longer speech task. Production of voice is depended on the interplay between muscular forces and aerodynamic events. Individuals with voice disorders frequently do not breathe normally and naturally. There are various tasks for assessing breath support. Voice is the laryngeal modification of pulmonary airstream further modified in vocal tract [Michael & Mendel (1971)]. Voice is the acoustic signal generated by larynx and vocal tract and considered as a multi-dimensional series of measurable event. That is, a single phonation could be analysed in different ways. The human voice conveys information about the speaker through paralinguistic features such as pitch, loudness, resonance, quality and flexibility. Speakers vary this paralinguistics to infuse their talk with emotion [Williomson, 2014].

The Maximum Phonation Duration is the longest time that a client can sustain a vowel sound at a comfortable pitch and loudness on a deep breath. Maximum Phonation Time (MPT) values can provide information regarding glottic integrity and respiratory support. Normative studies of MPT provide a wide variety of suggested guidelines for this measure. Age and gender variables are clearly both influential in determining normative ranges.

The S/Z ratio is a standard test of vocal function and also an indirect index of laryngeal airflow. It is obtained by timing the longest duration that a patient can sustain the individual phonemes S and Z, and then divides the two figures to obtain a numerical ratio. Unlike S, the voiced Z requires phonation (i.e., glottis vibration). Under normal circumstances, the ideal S/Z ratio is 1. About 95% of people who have problems with their vocal folds have an S/Z ratio of greater than 1 (Williamson, 2018).Different laryngeal and respiratory pathologies affect a person's ability to phonate a sound, which can be quantified using two measures, termed Maximum Phonation Duration (MPD) and S/Z ratio, which allow to assess the efficiency of the respiratory and phonatory system.

COVID-19 represents two spectrum of clinical manifestation that typically includes fever, dry cough and fatigue often with pulmonary involvement. SARS-COV-2 is highly contagious and most individuals within the population are largely susceptible to infants. The most common symptoms are fever, dry cough, fatigue; upper respiratory tract symptoms include Pharyngalgia, headache and myalgia. Approximately 20% of COVID-19 patients develop severe respiratory illness with an overall case fatality rate of about 2.3%. Patients with severe disease typically present with fever, dry cough, dyspnoea and bilateral pulmonary infiltrate on chest imaging (an overview of COVID-19, Shi. et.al Zhejiang University).

Pneumonia caused by severe acute respiratory syndrome corona virus 2 [SARS-COV-2] infection emerged in Wuhan city, Hubei province, China in December 2019.By February 11 2020 the WHO (World Health Organisation) officially named the disease resulting from infection with SARS-COV-2 as "CORONA VIRUS DISEASE 2019".Severe acute respiratory syndrome coronavirus2 (SARS-CoV-2), has caused morbidity and mortality at an unprecedented scale globally. Scientific and clinical evidence is evolving on the subacute and long-term effects of COVID-19, which can affect multiple organ systems. Acute COVID-19 usually lasts until 4 weeks from the onset of symptoms, beyond 4 weeks from the onset of symptoms.

METHODOLOGY:

Aim

The present study aimed to measure deviation in Maximum Phonation Duration (MPD) and S/Z ratio to identify the changes in phonation and respiration in post covid clients in comparison to normal individuals.

Participants

A total of 100 individuals in the age range of 18-60 years who were further divided into two groups (Group 1 - 50 individuals who were tested to have COVID positive; Group 2-50 normal individuals).

A detailed case history was administered to rule out the presence of breathing difficulty and other health related problems such as fever, dry cough, upper respiratory tract symptoms and fatigue in addition to the demographic data.

Each subject was evaluated with the following tasks:

1) Maximum Phonation Duration (/a/, /i/, /u/)

2) S/Z ratio

Criteria:

Inclusion criteria:

A total number of 100 individuals were included in the study, which included 50 subject's post-covid and 50 non-covid subjects. The non-covid subjects included in the study had good health condition with no respiratory issues and was included in the first group. The other 50 subject's post-covid within 3 months of covid attack were included in the second group.

Exclusion criteria:

Individual's post-COVID more than 3 months was not included in the study. Individuals having serious respiratory illness were also excluded.

Materials used:

1) Case History: Includes demographic data, other health related problems, covid symptoms, date tested covid positive, date tested covid negative and other associated problems

2) Consent Form: consent letter from the respective health departments of an area where the client belongs was taken in order to collect the samples.

3) Stop watch: To find out the longest possible duration of tasks given.

4) Voice recorder: The recorder used was GOLDWAVE 6.60

Procedure:

A detailed case history was administered before the sample was collected that includes demographic data, covid symptoms, data tested positive, date tested covid negative and other associated problems. The clients were asked to perform two tasks, i.e., MPD and S/Z ratio. For evaluating the MPD of /a/, the clients were instructed to "sit straight comfortably, take a deep breath and then prolong the vowel /a/ as long as possible with maximum inspiration, with comfortable loudness and pitch in one exhalation (manual aerodynamic measures). Same instructions were given for the MPD of vowel /i/ and vowel /u/. The clinician demonstrated the tasks, so that the client understands the procedure better. Three trials were recorded for each task and the best of it was selected. Voice samples were recorded in a quiet room with a stopwatch and a voice recorder. The second task was the S/Z ratio, another measure of phonation where subjects were instructed to sustain the individual phonemes /s/ & /z/ as long as they could; Instructions to the clients are as follows "Take a deep breath and make the longest /s/ you can." After the patient produces the sustained /s/, repeat the instruction using /z/. Clinician demonstrated the target responses as before and obtained the values. Three trails were taken and the best of it was selected. Voice samples were analysed using GOLDSWAVE 6.60 software. The S/Z ratio is calculated by dividing the longest duration of /s/ by of the longest duration of /z/.

Analysis of data:

A total of three trails were given, and the best of the three trails were considered as the maximum phonation duration (MPD). The values were recorded for each individual for all the tasks given i.e., MPD of /a/, /i/ and /u/. The mean values of the MPD of /a/ for both group 1 and group 2 were taken by adding all the values of 50 individuals and dividing it by 50. The same calculation method was done for the MPD of /i/ and /u/.



A total of three trails were given, and the best of the three trails were considered as the S/Z ratio. The mean values of S/Z ratio for both group 1 and group 2 were taken by adding all the values of 50 individual's S/Z ratio values and dividing it by 50.

	Total no. of S/Z ratio	
Mean value of S/Z ratio =	50	

RESULTS AND DISCUSSION:

Fig1: shows the comparison of maximum phonation duration between normals and post covid individuals



Fig2: Illustrates the comparison of s/z between normals and post covid individuals



The present study aimed to measure the MPD and S/Z ratio to rule out the changes in respiration and phonation in post-covid individuals in comparison to normal individuals. Post-covid individuals usually experience symptoms like upper respiratory tract infections including pharygalgia and myalgia, fever, dry cough, fatigue and breathing difficulties. Most patients reported severe breathing problems during the initial days of covid infection. They are facing these difficulties during activities like walking, climbing the stairs, running, doing household activities and so on. And these symptoms usually reduce to some extent after taking additional supplements. Like other respiratory illness, COVID-19 can cause lasting lung damage. Healthy individuals with no respiratory problems were able to do the tasks given to them and the values fall in between the normative range.

MPD:	Normal (non-covid)	Post-covid individuals	Difference
	individuals		
/a/	17.25	12.7	4.55
/i/	17.9	13.4	4.5
/u/	17.94	13.33	4.57
S/Z ratio	0.95	0.68	0.27

Table 2: Illustration of difference in MPD and S/Z ratio of non- covid and post- covid individuals.

The study results shows that there is a significant difference between the average mean of MPD and S/Z ratio in post-covid individuals and normal individuals. After analysing the data, the calculated average mean of vowel /a/ of non- covid individuals in the age range of 18-60 years was to be 17.25 which lies in the normative range of 15-35 seconds comparing both adult males and females. But post- covid individuals are having an average mean of 12.7 which is comparatively lower than the normative range. The average mean value of vowel /a/ between normal and post-covid individuals shows a difference of 4.55. This may be due to the infection of COVID-19 where the immune response disrupts normal oxygen transfer. Likewise in vowel /i/ the average mean was found to be 17.9 in normal and 13.4 in post-covid individuals with a difference of 4.5. The average mean of vowel /u/ was noted to be 17.94 in normal and 13.33 in post-covid individuals with a difference of 4.57.

After assessing the samples, the S/Z ratio value which is found to be 0.95 in normal and 0.68 in post-covid individuals with a difference of 0.27. For normal individuals the s/z ratio range is 0.9-1.1, which suggests normal respiratory ability and absence of a vocal fold pathology. The s/z ratio value of less than 0.9 indicates possible respiratory inefficiency. The S/Z ratio above 1.1, the greater the likelihood of laryngeal pathology.

CONCLUSION:

In healthy lungs, oxygen crosses the alveoli into tiny, nearby blood vessels known as capillaries. From here, oxygen is transported to the rest of your body. Respiratory tract organs facilitate the process of gas exchange, including the nostrils, oral cavity, the throat, trachea, bronchi, and lungs. The function of the pulmonary system is to extract the oxygen from the environment and provide for aerobic respiration at the cellular level. Oxygen is ultimately used to produce ATP, and carbon dioxide is breathed out with other metabolic byproducts.COVID-19 primarily infects the lungs in the affected individuals and in severe cases death due to ARDS (Acute Respiratory Distress Syndrome) and pneumonia. It is important to remember that it does not lead to ARDS and pneumonia in all the cases, which is an occurrence in most severe cases. With COVID-19, the immune response disrupts normal oxygen transfer. White blood cells release inflammatory molecules called 'chemokines' or 'cytokines', which in turn rally more immune cells to kill SARS-CoV-2-infected cells. The fallout from this ongoing battle between your immune system and the virus leaves behind pus, which is made up of excess fluid and dead cells (debris) in your lungs. This results in respiratory tract symptoms such as coughing, fever and shortness of breath. (Leilani Fraley, RN, MSN on june5,2020). Even though, a person infected with COVID-19 can be cured, it is important to understand that the factors that lead to fatality, include underlying illness (hypertension, diabetes, cardiac problems, respiratory issues) and individuals who are on immune-suppressing medications. In older individuals, the risk is higher, as the immunity decreases with age and they have higher disposition for other illness. (Narayana health.org). Our findings suggest that the variation in MPD and S/Z ratio values in post covid individuals is due to the reduced vital capacities. Many studies conclude that individuals post-covid tend to have breathing problems due to the infection caused by the COVID virus. Therefore, the infected lungs result in reduced respiratory control and changes in the rate of expiration. This poor respiratory control highly contributes to reduced MPD and S/Z ratio due to the inability to inhale and exhale efficiently by the individuals infected by COVID. This study can be further concluded deeply with various explanations based on different studies. Many researches are ongoing based on COVID-19 and its relation with breathing giving further insight about the topic.

Limitations:

1)Limited samples size.

2)Symptoms usually fade with time of onset of the problem.

3)Age range about 60 years are not included.

4) comparison between males and females were not considered for analysis.

Future Directions:

1)The sample size can be increased.

2)Follow up studies can be done on the same group between covid affected individuals comparing pre and post onset.3) Age interval groups can be minimised for better understanding of the study.

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