

# Changes in Phonatory Capacity post COVID-19 Infection

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**Abstract:** ***Purpose:** Coronavirus Disease 2019 (COVID-19) is an acute respiratory illness caused by the SARS-CoV-2 virus. Persons infected with COVID-19 may have reduced phonation duration as the virus will affect respiratory capacity. The effect of COVID-19 on voice can be estimated by measuring its impact on phonatory capacity using Maximum Phonation Time (MPT). **Methods:** We have been seeing in our institute that patients who have recovered from COVID-19, but continue experiencing shortness of breaths and difficulty in phonation for normal longer duration and this could be because of the insufficient sub glottal air pressure. Hence, to assess the effect of COVID-19 on voice, we have used Maximum Phonation Time (MPT) as the measurement tool for phonatory capacity. During MPT measurements, subjects were asked to take deep breath and on exhalation, phonate vowel /a/ as long as possible. MPT was recorded once during Pre COVID-19 infection and twice to Post COVID-19 infections. These results were compared using non parametric test with Man Whitney. **Results:** Results of this study shows a significant reduction in the duration of Post Covid MPT 1 from Pre Covid MPT and further significant reduction in Post Covid MPT 2 from Post Covid MPT 1. **Conclusion:** The results showed a long-standing reduction in the post COVID-19 samples recorded even after one year of COVID-19 Infection is due to the direct effect of virus on the lung capacity and this effect may depends on the varying degrees of severity of the infection also.*

**Keywords:** COVID-19, Respiratory illness, Sub glottal air pressure, Phonatory Capacity, Maximum Phonation Time (MPT)

## 1. Introduction

Corona virus disease (COVID-19) is an infectious disease caused by the SARS-CoV-2 virus [1]. The COVID-19 spectrum ranges from asymptomatic to moderate symptoms and even mortality. Older people and those with underlying medical conditions like cardiovascular disease, diabetes, chronic respiratory disease, or cancer are more likely to develop serious illness. COVID-19 disease primarily affects respiratory system. It resulted in symptoms that of pneumonia, acute respiratory distress syndrome, cough, sour throat, sneezing & upper respiratory tract infection (Rothan & Byrareddy, 2020). Since 2020, many mutated variants of COVID-19 were identified such as Delta, Beta, Omicron.

Production of voice involves 3 stages i. e., respiratory, phonatory and resonatory. In the respiratory stage, air exhaled by the lungs generates the force needed for the vibration of the vocal folds in the larynx (phonatory stage) required for the production of sound. Subglottal pressure is one of the most influential physiological parameters here which is controlled by the respiratory system. Expanding the lungs causes a pressure drop (inhalation) while compressing them produces an overpressure (exhalation). The subglottal pressure is controlled by both muscles and the elasticity of the thoracic-pulmonary unit. Its main function is to vary vocal loudness [2]. Typically, high sub glottic pressures often leads to loud voice and insufficient sub glottic air pressure will not allow the vocal folds to vibrate for longer duration. Therefore, when lungs do not function appropriately, there is impact on the normal voice production.

In our hospital, we have been seeing that patients, who have recovered from COVID-19, but continue experiencing

shortness of breaths and difficulty in phonation for normal longer duration. This could be because of the insufficient sub glottal air pressure. Other COVID-19 symptoms such as dry cough, sore throat, that is recurrent may show changes in vocal folds and can act as a risk in altering voice quality.

COVID-19 is comparatively novel virus (respiratory disease) which affects lungs. Voice, a precursor of speech, is very important in day to day life and is dependent on the proper functioning of the lungs as discussed above. It is possible as we are observing, that COVID-19 affect voice but how and the duration of effect is not known. The effect of COVID-19 on voice can be estimated by measuring its impact on phonatory capacity. Therefore, in this study we aimed to investigate the impact of COVID-19 on phonatory capacity.

## 2. Methodology

Maximum Phonation Time (MPT) is one of the aerodynamic measurements of voice production which also includes vital capacity and phonation quotient [3]. It is the longest period during which a person can sustain phonation of a vowel sound. Three such readings are taken and highest among them is taken as MPT for that patient [4]. Phonatory capacity is estimated using MPT.

We regularly record MPT in normal individuals (in our institute and hospital) as part of ongoing researches at our institute. For the purpose of this study, we retrospect our database and planned to measure MPT in the individuals who get infected by COVID-19 and we also had their MPT pre recorded in our database. We got 10 such individuals in whom the MPT was measured Pre covid infections. Demographic details of these patients are given in Table 1.

Post Covid MPT measurements were done in two times. Post Covid MPT 1 was recorded six months after COVID-19 infection and Post Covid MPT 2 was recorded after one year of Covid-19 infections.

During MPT measurements (both Pre and Post Covid infection) participants were asked to sit comfortably upright and take deep breath and on exhalation, phonate vowel /a/ as long as possible. Initially, examiner demonstrated task to the participants. Each participant performed three trails with a one-minute rest period between each trial and highest among them is taken as MPT for that subject. The duration was recorded with the help of a stopwatch.

**Table 1:** Demonstrates the demographic details of the participants.

Age range (Mean)	20.7±10SD
Gender	05 male & 05 female
Occupation	Students
Co-morbid conditions reported	Nil

### 3. Results

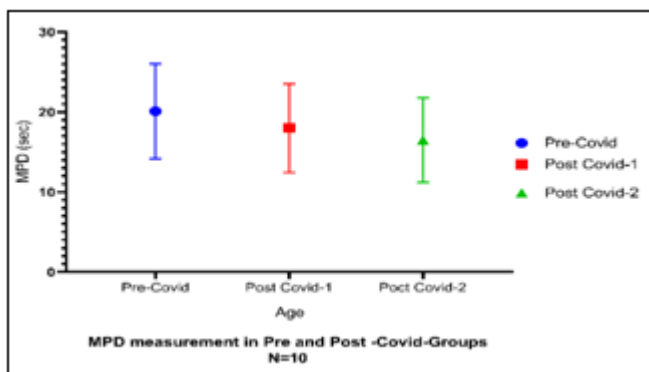
	Pre Covid MPT	Post Covid MPT-1	Post Covid MPT-2
Median	21	17.5	16.5
IQR	10.75	9.75	9.5
P- value of Mann Whitney	0.054	<b>0.02</b>	<b>0.01</b>
Minimum	13	12	11
Maximum	27	26	23

Note:  $p < 0.005$  is considered as the level of significance

Non parametric test with Man Whitney was used as the statistical measure to compare between pre and post COVID 19 MPT. P-value of Mann Whitney is considered as the level of significance.

**Table 2:** Non parametric test with Man Whitney shows the comparison between the Pre and Post COVID-19 MPT.

From Table 2, one can see that P value of Mann Whitney indicates a significant reduction in the duration of Post Covid MPT 1 from Pre Covid MPT and further significant reduction in Post Covid MPT 2 from Post Covid MPT 1. Post Covid MPT 1 and 2 were recorded with the gap of 6 months and one year respectively.



**Graph 1:** Difference in the MPT between Pre and Post COVID 19 infection.

### 4. Discussion

Recent evidence suggests that the lungs are the organ most affected by COVID-19 [5] with different pathophysiological events such as diffuse alveolar epithelium destruction, hyaline membrane formation, capillary damage and bleeding, alveolar septal fibrous proliferation, and pulmonary consolidation [6]. From previous experience with coronavirus lung involvement of severe acute respiratory syndrome (SARS) and Middle-East respiratory syndrome (MERS), radiological abnormalities, impairment of pulmonary function and reduced exercise capacity improve over time, but may persist in some for months or even years [7]. However, not much evidence is available regarding the degree of impairment of lung function in young adults who were not severely infected by SARS-CoV-2.

Voice production depends on a finely balanced relationship between the forces exerted by the intrinsic muscles of the larynx and the forces exerted by the air as it is exhaled from the lung. This occurs through what is called the aerodynamic-myoelectric theory of phonation, which states that the vibration of the vocal folds is induced by a combination of the aerodynamic, muscular, and elastic forces of the larynx [8]. An abnormal pulmonary function and a reduced pulmonary vital capacity affect voice quality and the maximum phonation time (MPT) [9]. According to a recent a prospective, cross-sectional, case-controlled study aimed to evaluate the phonatory function of recovered COVID-19 survivors by assessing the voice quality and MPT showed highly significant difference in the MPT between post COVID 19 infected group and control group [10].

The results obtained from Table 2 and Graph 1 suggests that there was no improvement in the MPT even after one year of COVID-19 infection as expected. Rather, it is evident that person who were infected with COVID-19 had some impact on their MPT values and it remained low even after 6 months to 1 year. Although all the subjects chosen for the test initially had no respiratory complications and eventually were affected by the Delta variant of SARS-CoV-2. So, this impact on their phonatory abilities could be because of the infection only. The results obtained in this study is in close correlation with the study done by Yasien et al (2022) [10].

To the best of our knowledge, most of the researches done on the effect of COVID-19 infection on the survivors are on the pulmonary functions. There are less research results available on the effect of COVID-19 on the laryngeal functioning. Many parameters can be used in describing the laryngeal function like assessment of voice quality, acoustic measurements, and aerodynamic measurements. This study has concentrated on MPT, one of the aerodynamic measurements, as it is quick, non-invasive, subjective and the commonly used clinical tool in the voice assessment.

### 5. Conclusion

From the data drawn, it is seen that the Maximum Phonation Time (MPT) was within the normal range for all before being infected, on the contrary even after six months to one year, the results showed a reduction in the post COVID-19

samples due to the direct effect of virus on the lung capacity. The long-standing effect seen in this study may depend on the varying degrees of severity of the COVID-19 infections also.

#### Conflict of Interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

#### Acknowledgments

We are delighted to thank all the participants who took part in the survey.

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#### TABLES AND FIGURES: