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Correlations Between COVID-19 Pneumonia and Long-Term Lung Injuries

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Abstract *This study investigates the correlation between COVID-19 pneumonia and long-term lung injuries through clinical, radiological, and biomarker analyses. Conducted prospectively at Azerbaijan Medical University, the study evaluated 210 patients from 2021 to 2023. Biomarkers such as KL-6, CRP, D-dimer, and ferritin were analyzed alongside clinical and spirometric parameters. Results revealed persistent lung injuries in 32% of cases, with fibrosis identified as a major contributor to functional decline. Elevated KL-6 and D-dimer levels were strongly associated with lung damage and inflammatory processes, suggesting their utility as biomarkers for monitoring post-COVID-19 complications. Radiological examinations and spirometry indicated significant decreases in lung function, including FEV1 and FVC levels. The study underscores the importance of long-term follow-up and individualized treatment strategies to mitigate the lasting effects of COVID-19 on lung health, highlighting the necessity for further research to optimize recovery and improve patients' quality of life.*

1. Introduction

The SARS-CoV-2 pandemic has caused more than 700 million confirmed infections and more than 6 million deaths worldwide. The natural progression, underlying pathophysiology, and long-term sequelae of SARS-CoV-2 infection remain incompletely understood. Many patients experience the continuation or resumption of various symptoms after an acute infection period, which severely affects their functional performance and quality of life. The term “Long COVID” has been defined by the World Health Organization (WHO) as a set of long-term symptoms that persist or develop within three months of COVID-19 and exist for at least two months. This condition presents significant clinical challenges for healthcare providers and imposes substantial social and economic burdens [1].

Within three months of recovery from COVID-19, many patients continue to experience a variety of symptoms, mostly respiratory and neuropsychological complaints [2]. Potential mechanisms that may cause Long COVID include persistence of viruses or their components, autoimmune

processes, metabolic and endocrine disorders, psychosocial factors, microvascular and mitochondrial dysfunction [3]. Long-term complications have been observed both after severe illness and after infections with some different pathogens. In the context of long-lasting COVID, changes in different organisms have been identified through diagnostic research offered by different societies. Additionally, sometimes the impact of minor organic changes on the etiological origin of complaints is usually limited [4].

Given the many patients recovering from COVID-19, Long-lasting COVID remains an unintended problem. Therefore, it is important to identify patients at risk of permanent disorder in a health condition and to carry out a logical risk classification for their diagnosis and treatment. Direct contact between diagnoses and subjective complaints expressed in different forms appears to be possible in everyday practice only to a limited extent [5]. When we look at it from a general perspective, the relationship between COVID-19 pneumonia and persistent lung injuries has not yet been fully understood. To understand the long-term effects of the disease, it is important to perform radiological, clinical, and biomarker levels evaluations. This study aims to contribute to existing knowledge by examining the pathophysiology, dynamics, and long-term effects of post-COVID-19 lung injuries.

3. Discussion

The results of the correlation analysis between COVID-19 pneumonia and persistent lung lesions revealed several important findings based on clinical and laboratory examinations of patients. The main objective of the study was to investigate the impact of COVID-19 on lung tissue and the long-term consequences of this effect. To conclude, the relationships between different biomarkers and clinical parameters were carefully analyzed.

An inverse correlation between KL-6 and TLC demonstrated a significant association between lung tissue damage and elevated KL-6 biomarker levels. This finding confirms that COVID-19 pneumonia induces significant inflammatory changes in lung tissue, which are directly correlated with elevated KL-6 levels. Thus, it can be concluded that KL-6 may be an important biomarker in monitoring lung injuries.

Furthermore, direct correlation between D-dimer and TCL analysis showed an interaction of inflammatory and thrombosis processes in lung lesions. COVID-19 pneumonia was found to increase the risk of thrombosis and be associated with lesions in the lungs. An increase in D-dimer acts as an indicator of the development of thrombosis in lung lesions. Additionally, a direct correlation was observed between CRP levels and TLC. This finding reveals the ongoing impact of COVID-19 on inflammatory processes in the lungs and how these effects negatively affect lung functions.

The direct correlation between KL-6 and D-dimer suggests that thrombosis is interrelated with pulmonary lesions and inflammatory processes in the respiratory system. This association is an important finding indicating the development of lung fibrosis caused by

COVID-19 and a higher risk of thrombosis in those patients. The direct correlation between D-dimer and CRP, further elucidates the interactions of inflammatory and thrombosis processes.

Radiological examinations have shown that lung fibrosis is observed in 32% of cases, indicating that COVID-19 pneumonia leads to persistent lung damage, resulting in fibrosis. Fibrosis leads to the progressive stiffening of lung tissue and subsequent loss of function. This severely limits lung function. Physical examinations and spirometric tests have demonstrated a significant decrease in FEV1 and FVC indicators. Specifically, FEV1 has been observed to be 60±12% and FVC 58±15%. These results highlight the substantial impact of lung injuries on respiratory function and underscore how persistent lung damage significantly diminishes patients' quality of life.

All these results highlight that the impact of COVID-19 pneumonia on the lungs is long-lasting and that persistent lung injuries require a readjustment of medical approaches. It is important to conduct additional research to further clarify this situation and improve treatment strategies. The results suggest that biomarkers and radiological changes play an important role in the follow-up of these patients, which may enable individualization of treatment approaches and improvement of patients' functional status.

Although there are similarities in the objectives of our study and the research by Robey et al. regarding the long-term effects of COVID-19, there are several key differences. Our study was conducted using a prospective method and was based on broader biomarker analyses (KL-6, CRP, D-dimer, ferritin, and other indicators). This approach provided more comprehensive information about the pathophysiological mechanisms of COVID-19 and its inflammatory effects [6]. Both studies found that KL-6 levels were elevated in COVID-19 patients and that this indicator was associated with the severity of lung damage. Additionally, our study emphasized the impact of other inflammatory indicators such as CRP and ferritin on the post-COVID-19 recovery process, and the correlation between these indicators was evaluated in detail. The research by Robey et al. primarily focused on lung function and presented biomarker analyses in a limited manner. In contrast, our study provided more comprehensive results through biomarker analyses and functional indicators. It was particularly emphasized that long-term complications were more severe in groups with a severe course of COVID-19. Furthermore, results such as the decrease in KL-6 overtime and the increase in oxygenation levels were obtained. While the effects of gender and age factors on the results were assessed in the study by Robey et al., our study primarily focused on inflammatory and functional indicators, and gender and age factors were not considered statistically significant. Additionally, our study presents detailed paired comparisons and changes over time, along with statistically significant differences between groups.

Consequently, both studies make important contributions in terms of investigating the

long-term effects of COVID-19. But while Robey et al.'s study focuses more on the physiological parameters of lung function, our study provides more extensive information on the sequelae of COVID-19 through biomarker analyses and functional indicators. These studies are extremely important in terms of understanding the long-term effects of COVID-19 and shaping post-pandemic recovery strategies.

Also, our study evaluated the dynamics of fibrotic changes after COVID-19 during long-term follow-up periods and found that these changes can be reversed in most cases. However, in another study, fibrosis cases were identified because of short-term follow-up (average 41.5 days), where fibrosis was detected in 41% of cases. Our study emphasized tracking the KL-6 biomarker in the long term, revealing a weak but significant correlation with CRP and D-dimer levels. By providing additional information to explain the relationship of KL-6 to fibrosis, we have revealed the significant potential of this biomarker in diagnosing and monitoring fibrotic changes after COVID-19. In the other study, CRP, d-dimer, ferritin, and troponin levels were shown to be significantly higher in the fibrotic group than in the non-fibrotic group, but KL-6 levels were not measured. This has limited the ability to validate fibrotic changes according to more specific biomarker levels [7].

Regarding radiological indicators, in our study the CT severity index was assessed at different follow-up periods and was found to decrease over time. This approach is advantageous for monitoring the progression and potential reversibility of fibrotic changes over time. In another study, however, the CT severity index was calculated based only on radiographic images in active disease during the hospitalization period and was noted to be significantly higher in the fibrotic group (mean 17) than in the non-fibrotic group (average 7).

Thus, our work has provided a more comprehensive approach to the long-term monitoring and diagnosis of post-COVID-19 fibrosis, offering greater insight into the dynamics and potential reversibility of fibrotic changes. Another study emphasized the correlation between fibrosis cases and early radiological and biomarker findings based on short-term follow-up results.

4. Conclusion

In conclusion, our study has more broadly evaluated the dynamics and reversal potential of post-COVID-19 fibrotic changes in long-term follow-up periods. This study examined the relationship of biomarkers such as KL-6, CRP, and d-dimer to fibrosis, highlighting the clinical significance of these indicators. Additionally, by showing a decrease in the CT severity score over time, it has been proven that fibrotic changes can be more accurately assessed through long-term follow-up. Another study, based on short-term follow-up results, emphasized the relationship between severe radiological indicators during the hospitalization period and elevated CRP, d-dimer, ferritin levels with the risk of fibrosis. While both studies contribute to the field of post-COVID-19 fibrosis diagnosis and tracking, long-term

follow-up offers superior results in terms of explaining the dynamics of fibrotic changes.

5. References

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