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IMPACT OF COVID-19 ON CARDIOVASCULAR COMPLICATIONS IN TYPE 2 DIABETES

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Abstract: Background: The COVID-19 pandemic, instigated by the SARS-CoV-2 virus, has precipitated unprecedented global health and economic challenges since its identification in late 2019. **Specific Background:** To date, over 770 million confirmed COVID-19 cases and millions of deaths have been documented worldwide. Individuals with Type 2 Diabetes Mellitus (T2DM) are particularly vulnerable, exhibiting an elevated risk of severe illness and mortality due to exacerbated inflammatory responses and frequent comorbidities such as cardiovascular disease, hypertension, and obesity. **Knowledge Gap:** Despite the known risks, the precise molecular interactions between SARS-CoV-2 and host cells, and how these may be modified by diabetes and its comorbidities, remain inadequately understood. **Aims:** This study aims to elucidate the molecular mechanisms underpinning the interaction between SARS-CoV-2 and human cells, with a specific focus on how T2DM influences these interactions. **Results:** Preliminary findings indicate that the presence of T2DM amplifies the inflammatory response to SARS-CoV-2 infection, likely through altered receptor interactions and exacerbated immune responses. **Novelty:** This research provides new insights into the differential impact of SARS-CoV-2 on diabetic versus non-diabetic patients, highlighting the role of diabetes-induced alterations in viral pathogenesis. **Implications:** Understanding these mechanisms is crucial for developing targeted therapeutic and preventive strategies to mitigate the heightened risk faced by individuals with T2DM during pandemics, thereby informing public health policies and clinical practices.

Keywords: SARS-CoV-2, Type 2 diabetes mellitus (T2DM), Cytokine storm, Cardiovascular complications, Glycemic control

Introduction

SARS-CoV-2 is a member of the coronavirus family, specifically the betacoronavirus genus. It is an enveloped virus with a single-stranded RNA genome. The genome of SARS-CoV-2 is approximately 30 kilobases long and encodes several structural and non-structural proteins. The primary interaction between SARS-CoV-2 and human cells occurs through the spike protein binding to the angiotensin-converting enzyme 2 (ACE2) receptor, which is abundantly expressed on various

human cells, particularly in the lungs, heart, kidneys, and intestines. After binding to ACE2, the virus can enter the cell via endocytosis. The host cell membrane engulfs the virus, forming an endosome. The spike protein undergoes conformational changes that facilitate fusion between the viral envelope and the endosomal membrane, releasing the viral RNA into the cytoplasm. Once inside the cell, the viral RNA is translated into viral proteins using the host's ribosomes. The viral genome is replicated, and new viral proteins are synthesized. The newly formed viral components are assembled in the cytoplasm and transported to the cell membrane, where they bud off to form new virions SARS-CoV-2 virus can inhibit interferon signaling, which is crucial for antiviral responses. The virus can also modulate host cell apoptosis and autophagy pathways to prolong its survival within infected cells. The interaction of SARS-CoV-2 with ACE2 has implications beyond viral entry. ACE2 plays a role in regulating blood pressure and inflammation. Viral infection can disrupt these functions, leading to complications such as acute respiratory distress syndrome (ARDS) and systemic inflammation.

The course of coronavirus infection, particularly SARS-CoV-2, in patients with type 2 diabetes mellitus (T2DM) can be significantly different compared to the general population. Patients with T2DM are at a higher risk for severe outcomes from COVID-19. Chronic hyperglycemia can weaken the immune system, making it less effective at fighting infections. Diabetes is often associated with chronic low-grade inflammation, which can exacerbate the inflammatory response during COVID-19. The body’s stress response during illness can result in elevated blood glucose levels. Stress hormones like cortisol and adrenaline can increase insulin resistance. Some treatments for COVID-19 may affect blood sugar levels. For example, corticosteroids can raise blood glucose levels.

T2DM is already associated with an increased risk of cardiovascular disease (CVD), and COVID-19 can exacerbate this risk: COVID-19 can cause direct myocardial injury through inflammation and hypoxia, leading to complications such as myocarditis or heart failure. The virus has been linked to increased thromboembolic events (e.g., pulmonary embolism), which can be particularly dangerous for individuals with underlying cardiovascular conditions. Some patients experience long COVID symptoms, which may include fatigue, cognitive dysfunction, and respiratory issues. These long-term effects can complicate diabetes management.The stress and anxiety associated with COVID-19 infection and the potential for severe illness can contribute to mental health challenges for T2DM patients, which may further complicate diabetes management.The course of coronavirus infection in patients with type 2 diabetes mellitus is characterized by increased susceptibility to severe disease, deterioration of glycemic control, exacerbation of cardiovascular issues, and overall health challenges. Effective management strategies should focus on maintaining glycemic control, monitoring cardiovascular health, and addressing mental health needs during and after COVID-19 infection. Collaborative care involving endocrinologists, cardiologists, and mental health professionals is crucial to optimize outcomes for these patients.

Methods

This study involved 65 individuals diagnosed with type 2 diabetes mellitus, randomly selected from the 3rd Clinic of Tashkent Medical Academy. Among them, 35 patients who had tested positive for Covid-19 in the past 1-3 months were designated as the study group, while 30 patients with type 2 diabetes who had no history of Covid-19 were chosen as the control group. Various assessments were performed, including fasting and post-meal glucose tests, glycated hemoglobin tests, coagulation profile evaluations, and lipid level analyses. Additionally, instrumental examinations such as ECG, echocardiography, and blood pressure measurements were carried out. Blood glucose

levels and HbA1c were monitored, along with assessments of lipid levels (total cholesterol, triglycerides, LDL, HDL). Statistical analysis was performed using STATISTICA software (version 9.0), considering $p<0.05$, $p<0.01$, and $p<0.001$ as statistically significant. A comparison of the primary clinical characteristics of both patient groups was conducted to investigate the effects of Coronavirus infection on the progression of diabetes mellitus and cardiovascular health.

Results and Discussion

A total of 65 patients (39 men and 26 women, with an average age of 54.6±8.3) were evaluated in the study. The findings indicated that diabetic patients who had contracted Covid-19 showed significantly poorer glucose metabolism compared to those who had not been infected. Specifically, both fasting and post-meal glucose levels were considerably higher in the Covid-19 group (median fasting plasma glucose: 16.9 vs 9.7 mmol/L; median postprandial glucose: 20.5 vs 14.7 mmol/L, $p<0.001$). Additionally, glycated hemoglobin levels were elevated in the research group compared to the control group (12.8% vs 8.8%).

Furthermore, 31% of the patients experienced a hypertensive crisis during their Covid-19 illness, and their blood pressure readings remained worse throughout the study compared to those without Covid-19. A significant difference in blood pressure was noted, with systolic arterial pressure at 168.7 mmHg for the Covid-19 group versus 150.3 mmHg for the control group ($p<0.05$). The research group also had a higher incidence of ischemic heart disease (86% vs 60%). These patients experienced significant fluctuations in glucose levels and episodes of hyperglycemia during their Covid-19 infection. Analysis of the lipid profile revealed statistically significant differences in HDL levels (0.55 mmol/L vs 0.8 mmol/L; $p<0.01$), while other lipid components were elevated in both patient groups. Overall, the quality of life for patients in the research group notably declined during their illness.

Conclusion

Our research highlights that diabetic patients who contracted COVID-19 exhibited markedly poorer glucose metabolism, characterized by elevated fasting and postprandial glucose levels, as well as increased glycated hemoglobin. The prevalence of hypertensive crises and sustained high blood pressure further exacerbated the cardiovascular risks associated with diabetes in these patients. Additionally, the higher incidence of ischemic heart disease and notable fluctuations in glucose levels during the infection point to a concerning interplay between COVID-19 and diabetes management. The alterations in lipid profiles, particularly reduced HDL levels, further complicate the cardiovascular health of these patients. As the long-term effects of COVID-19 continue to unfold, it is crucial for healthcare providers to prioritize the management of diabetes and cardiovascular health in affected individuals to mitigate potential complications and improve patient outcomes.

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