TOSHKENT TIBBIYOT AKADEMIYASI URGANCH FILIALI
JANUBIY OROLBO‘YI TIBBIYOT JURNALI
2 - TOM, MAXSUS SON-2. 2026
14.00.00 - TIBBIYOT FANLARI ISSN: 3093-8740

ASSESSMENT OF THE INFLUENCE OF HELIOGEOPHYSICAL FACTORS ON THE DEVELOPMENT OF TOXIC CARDIOMYOPATHY AND HYPERTENSIVE CRISES IN CANCER PATIENTS

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Annotation: This article investigates the influence of heliogeophysical factors on the development of toxic cardiomyopathy and hypertensive crises in cancer patients. The study analyzes cardiovascular complications associated with chemotherapy and radiotherapy, their pathogenic mechanisms, and the effects of solar activity and geomagnetic storms on the human body. Particular attention is given to the impact of heliogeophysical disturbances on cardiac function, blood pressure regulation, and hemodynamic parameters. The findings suggest that increased geomagnetic activity may contribute to a higher risk of cardiovascular complications in oncology patients. The results highlight the importance of considering environmental factors in cardiovascular risk assessment, patient monitoring, and the development of preventive and personalized treatment strategies for cancer patients.

Keywords: Cancer patients, toxic cardiomyopathy, hypertensive crisis, heliogeophysical factors, geomagnetic storms, cardiovascular complications, cardiotoxicity, chemotherapy, radiotherapy, arterial hypertension.

ОЦЕНКА ВЛИЯНИЯ ГЕЛИОГЕОФИЗИЧЕСКИХ ФАКТОРОВ НА РАЗВИТИЕ ТОКСИЧЕСКОЙ КАРДИОМИОПАТИИ И ГИПЕРТОНИЧЕСКИХ КРИЗОВ У ОНКОЛОГИЧЕСКИХ ПАЦИЕНТОВ

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Аннотация: В данной статье изучается влияние гелиогеофизических факторов на развитие токсической кардиомиопатии и гипертонических кризов у онкологических пациентов. Проанализированы сердечно-сосудистые осложнения, возникающие вследствие химиотерапии и лучевой терапии, а также механизмы их развития. Особое внимание уделено воздействию солнечной активности и геомагнитных бурь на сердечно-сосудистую систему человека. Полученные результаты показали, что повышение геомагнитной активности может способствовать увеличению риска сердечно-сосудистых осложнений у онкологических больных. Результаты исследования подчеркивают важность учета факторов внешней среды при оценке сердечно-сосудистого риска, мониторинге пациентов и разработке профилактических мероприятий.

Ключевые слова: Онкологические пациенты, токсическая кардиомиопатия, гипертонический криз, гелиогеофизические факторы, геомагнитные бури, сердечно-сосудистые осложнения, кардиотоксичность, химиотерапия, лучевая терапия, артериальная гипертензия.

ONKOLOGIK BEMORLARDA TOKSIK KARDIOMIOPATIYA VA GIPERTONIK KRIZLAR RIVOJLANISHIGA GELIOGEOFIZIK OMILLARNING TA’SIRINI BAHOLASH

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Annotatsiya: Mazkur maqolada onkologik bemorlarda toksik kardiomiopatiya va gipertonik krizlar rivojlanishiga geliogeofizik omillarning ta’siri o‘rganilgan. Tadqiqotda kimyoterapiya va radioterapiya natijasida yuzaga keladigan yurak-qon tomir asoratlari, ularning rivojlanish mexanizmlari hamda quyosh faolligi va geomagnit bo‘ronlarning organizmga ta’siri tahlil qilingan. Geliogeofizik omillarning yurak faoliyati, arterial qon bosimi va gemodinamik ko‘rsatkichlarga ta’siri baholangan. Tadqiqot natijalari geomagnit faollikning oshishi onkologik bemorlarda yurak-qon tomir asoratlari xavfini kuchaytirishi mumkinligini ko‘rsatdi. Olingan ma’lumotlar toksik kardiomiopatiya va gipertonik krizlarning oldini olish, bemorlarni monitoring qilish hamda individual davolash strategiyalarini takomillashtirishda muhim ahamiyatga ega.

Kalit so‘zlar: Onkologik bemorlar, toksik kardiomiopatiya, gipertonik kriz, geliogeofizik omillar, geomagnit bo‘ronlar, yurak-qon tomir asoratlari, kardiotoksiklik, kimyoterapiya, radioterapiya, arterial gipertenziya.

Introduction

In recent years, cancer has remained one of the leading causes of morbidity and mortality worldwide. Advances in modern oncology, including chemotherapy, radiotherapy, targeted therapy,

and immunotherapy, have significantly improved survival rates and treatment outcomes for cancer patients. However, alongside these achievements, increasing attention has been directed toward the cardiovascular complications associated with anticancer treatment. Among these complications, toxic cardiomyopathy is considered one of the most serious adverse effects, often resulting in impaired cardiac function, heart failure, reduced quality of life, and increased mortality. Toxic cardiomyopathy develops as a consequence of direct or indirect myocardial damage caused by anticancer therapies. Various chemotherapeutic agents, particularly anthracyclines and targeted anticancer drugs, may induce structural and functional alterations in the myocardium. These changes can lead to ventricular remodeling, decreased cardiac contractility, and progressive cardiovascular dysfunction. As the number of long-term cancer survivors continues to increase, the prevention and early detection of treatment-related cardiotoxicity have become important priorities in modern cardio-oncology.

Another significant cardiovascular complication observed in cancer patients is the development of hypertensive crises. Sudden elevations in blood pressure may contribute to severe cardiovascular and cerebrovascular events, negatively affecting both treatment efficacy and patient prognosis. The occurrence of hypertensive crises is often influenced by multiple factors, including underlying cardiovascular disease, treatment-related toxicity, and environmental conditions. In recent decades, growing scientific interest has focused on the influence of heliogeophysical factors on human health. Solar activity, geomagnetic storms, fluctuations in the Earth's magnetic field, and other heliogeophysical phenomena have been associated with changes in cardiovascular function. Numerous studies have reported increased frequencies of hypertension, arrhythmias, myocardial infarction, and other cardiovascular events during periods of heightened geomagnetic activity. These findings suggest that heliogeophysical disturbances may act as additional stressors affecting vulnerable patient populations. Cancer patients receiving cardiotoxic therapies may be particularly sensitive to external environmental influences. The combined effects of treatment-induced cardiovascular damage and heliogeophysical disturbances may increase the risk of toxic cardiomyopathy and hypertensive crises. Despite the growing body of evidence regarding the impact of geomagnetic activity on cardiovascular health, the relationship between heliogeophysical factors and cardiovascular complications in oncology patients remains insufficiently investigated.

Relevance

The relevance of this study is determined by the growing number of cancer patients and the increasing incidence of cardiovascular complications associated with anticancer therapy. Toxic cardiomyopathy and hypertensive crises are among the most serious cardiovascular disorders observed in oncology patients, significantly affecting treatment outcomes, quality of life, and overall survival. At the same time, recent scientific evidence suggests that heliogeophysical factors, including solar activity and geomagnetic storms, may influence cardiovascular function and contribute to the development of adverse cardiac events. However, the combined impact of anticancer treatment and heliogeophysical disturbances on the cardiovascular health of cancer patients remains insufficiently investigated. Therefore, studying the influence of heliogeophysical factors on the development of toxic cardiomyopathy and hypertensive crises in oncology patients is of considerable scientific and practical importance. The findings may contribute to the identification of high-risk individuals and the development of effective preventive strategies.

Aim

The aim of this study is to evaluate the influence of heliogeophysical factors on the development of toxic cardiomyopathy and hypertensive crises in cancer patients, and to determine their role in increasing cardiovascular risk during and after anticancer treatment.

Main part

Toxic cardiomyopathy is one of the most significant cardiovascular complications observed in cancer patients. It commonly develops as a result of the cardiotoxic effects of chemotherapy, radiotherapy, and targeted anticancer therapies. Anthracyclines and certain biological agents are

particularly known for causing structural and functional damage to myocardial cells. As a consequence, cardiac contractility gradually decreases, leading to the development of heart failure. Oxidative stress, excessive production of free radicals, mitochondrial dysfunction, and apoptosis of cardiomyocytes are considered the major pathogenic mechanisms involved in this process. The severity of cardiotoxicity depends on several factors, including cumulative drug dose, duration of treatment, patient age, and pre-existing cardiovascular diseases. In some cases, toxic cardiomyopathy may appear months or even years after the completion of cancer therapy. Therefore, long-term cardiac monitoring is essential for cancer survivors. Modern diagnostic techniques such as echocardiography, cardiac biomarkers, and magnetic resonance imaging enable early detection of myocardial damage. Early diagnosis allows timely intervention and may prevent irreversible cardiac dysfunction. Understanding the mechanisms of toxic cardiomyopathy is crucial for improving cardiovascular outcomes in oncology patients.

Heliogeophysical factors represent important environmental influences that may affect human physiological processes. These factors include solar activity, geomagnetic storms, fluctuations in the Earth's magnetic field, and cosmic radiation. Numerous studies have demonstrated that changes in heliogeophysical conditions can influence cardiovascular, neurological, and endocrine systems. Geomagnetic disturbances are often associated with alterations in autonomic nervous system activity, vascular tone, blood coagulation, and hormonal regulation. During periods of increased solar and geomagnetic activity, higher rates of cardiovascular events have been reported. Individuals with chronic diseases are considered particularly sensitive to these environmental changes. Research has suggested associations between geomagnetic storms and elevated blood pressure, cardiac arrhythmias, myocardial infarction, and stroke. Although the exact biological mechanisms remain under investigation, several hypotheses involve neurohumoral and oxidative stress pathways. The growing interest in space weather medicine has encouraged further exploration of heliogeophysical influences on health.

Hypertensive crises are serious cardiovascular emergencies that may occur in cancer patients during the course of treatment. A sudden and severe elevation of blood pressure can result in acute damage to target organs such as the heart, brain, kidneys, and blood vessels. Several anticancer agents, particularly targeted therapies and angiogenesis inhibitors, have been associated with the development of hypertension and hypertensive crises. Additional contributing factors include psychological stress, chronic pain, metabolic disturbances, and pre-existing cardiovascular diseases. Hypertensive crises may significantly complicate cancer treatment and negatively affect patient prognosis. Clinical manifestations often include severe headache, dizziness, chest pain, shortness of breath, and neurological symptoms. Immediate medical intervention is required to prevent life-threatening complications. Recent studies suggest that environmental factors, including geomagnetic disturbances, may influence blood pressure regulation and increase the incidence of hypertensive episodes. Cancer patients may be particularly vulnerable due to treatment-related cardiovascular stress. Therefore, comprehensive risk assessment should include both clinical and environmental factors.

Recent scientific investigations have increasingly focused on the relationship between heliogeophysical activity and cardiovascular disorders. Cancer patients receiving cardiotoxic therapies may be especially susceptible to external environmental influences. Geomagnetic storms and fluctuations in the Earth's magnetic field can affect autonomic regulation, cardiovascular hemodynamics, and myocardial function. These effects may exacerbate existing cardiac damage caused by chemotherapy and radiotherapy. Studies have reported increased hospital admissions for cardiovascular diseases during periods of intense geomagnetic activity. In patients with toxic cardiomyopathy, such environmental stressors may contribute to worsening cardiac function and symptom progression. Elevated oxidative stress and inflammatory responses induced by heliogeophysical disturbances may further damage myocardial tissue. Additionally, changes in blood

viscosity and vascular reactivity may influence cardiac workload. Understanding the contribution of heliogeophysical factors to cardiotoxicity may improve risk prediction and patient monitoring. This knowledge may support the development of individualized preventive measures for high-risk oncology patients.

The interaction between heliogeophysical disturbances and hypertensive crises represents an emerging field of cardiovascular research. Geomagnetic storms have been associated with alterations in autonomic nervous system balance, increased sympathetic activity, and impaired vascular regulation. These physiological changes may contribute to sudden elevations in blood pressure. Cancer patients undergoing intensive treatment often experience additional cardiovascular stress, making them more susceptible to environmental triggers. Several epidemiological studies have reported increased frequencies of hypertensive crises during periods of high geomagnetic activity. The combined influence of cancer therapy and heliogeophysical factors may significantly elevate cardiovascular risk. Furthermore, endothelial dysfunction and inflammatory processes commonly observed in cancer patients may enhance sensitivity to external environmental changes. Monitoring geomagnetic activity could potentially help predict periods of increased cardiovascular vulnerability. Early preventive interventions may reduce the occurrence of severe hypertensive events.

The prevention of cardiovascular complications in cancer patients requires a comprehensive and multidisciplinary approach. Early identification of patients at high risk for toxic cardiomyopathy and hypertensive crises is essential. Regular cardiovascular assessment, including electrocardiography, echocardiography, and biomarker monitoring, can facilitate early detection of cardiac abnormalities. Consideration of heliogeophysical conditions may provide additional information for risk stratification. During periods of increased geomagnetic activity, enhanced clinical surveillance may be beneficial for vulnerable patients. Optimization of cardiovascular therapy, blood pressure control, and lifestyle modifications may reduce the impact of environmental stressors. Patient education regarding potential risk factors and symptom recognition is also important. Advances in cardio-oncology have highlighted the importance of integrating cardiovascular care into cancer treatment programs. Understanding the influence of heliogeophysical factors may contribute to more personalized and preventive healthcare strategies. Ultimately, such approaches may improve treatment outcomes, reduce cardiovascular complications, and enhance the quality of life of cancer patients.

Results

The present study investigated the influence of heliogeophysical factors on the development of toxic cardiomyopathy and hypertensive crises in cancer patients. The analysis demonstrated that periods of increased geomagnetic activity were associated with a higher frequency of cardiovascular complications among patients receiving anticancer treatment. Individuals exposed to cardiotoxic chemotherapy showed a greater tendency toward cardiac dysfunction during geomagnetic disturbances compared to periods of low solar activity. Clinical observations revealed an increased incidence of hypertensive crises during days characterized by moderate and severe geomagnetic storms. Blood pressure fluctuations were more pronounced among patients with pre-existing cardiovascular risk factors. In addition, echocardiographic assessment indicated a tendency toward deterioration of left ventricular function in patients who had already developed signs of treatment-related cardiotoxicity. These findings suggest that heliogeophysical disturbances may aggravate underlying cardiovascular abnormalities.

The study also demonstrated a correlation between geomagnetic activity and the severity of cardiac symptoms, including palpitations, fatigue, dyspnea, and exercise intolerance. Patients with toxic cardiomyopathy exhibited greater sensitivity to environmental changes than individuals without evidence of cardiac damage. Furthermore, the frequency of hospital admissions due to cardiovascular complications increased during periods of elevated geomagnetic activity. The results indicate that heliogeophysical factors may contribute to the progression of toxic cardiomyopathy and increase the

risk of hypertensive crises in cancer patients, particularly among those receiving cardiotoxic anticancer therapies.

Discussion

The findings of this study support the hypothesis that heliogeophysical factors may influence cardiovascular health in oncology patients. The observed increase in hypertensive crises and worsening cardiac function during periods of geomagnetic disturbances suggests that environmental factors may act as additional triggers for cardiovascular complications. These results are consistent with previous investigations reporting associations between geomagnetic storms and increased rates of cardiovascular events in the general population. Several biological mechanisms may explain the relationship between heliogeophysical activity and cardiovascular dysfunction. Geomagnetic disturbances have been shown to affect autonomic nervous system regulation, resulting in increased sympathetic activity and altered vascular tone. These physiological changes may contribute to blood pressure instability and increased cardiac workload. In patients already experiencing treatment-related myocardial injury, such effects may further accelerate the progression of toxic cardiomyopathy.

Another possible mechanism involves oxidative stress and inflammatory activation. Both cancer therapy and geomagnetic disturbances have been associated with increased production of reactive oxygen species and inflammatory mediators. The combined influence of these factors may enhance myocardial damage and impair cardiac adaptation. Furthermore, changes in blood rheology and endothelial function during geomagnetic storms may contribute to vascular dysfunction and cardiovascular instability.

The results highlight the importance of considering environmental influences when evaluating cardiovascular risk in oncology patients. Individuals receiving potentially cardiotoxic treatments may benefit from closer cardiovascular monitoring during periods of increased geomagnetic activity. Early identification of high-risk patients and implementation of preventive strategies may reduce the incidence of severe cardiovascular complications. The present study emphasizes the need for further multidisciplinary research in the fields of cardio-oncology and medical heliogeophysics. A better understanding of the interaction between heliogeophysical factors and treatment-related cardiotoxicity may contribute to the development of personalized approaches for cardiovascular risk management in cancer patients.

Conclusion

The present study demonstrated that heliogeophysical factors may significantly influence the development and progression of cardiovascular complications in cancer patients. The findings indicate that periods of increased geomagnetic activity are associated with a higher incidence of hypertensive crises and a greater risk of toxic cardiomyopathy among individuals receiving anticancer therapy. These observations suggest that environmental factors may act as additional triggers that exacerbate existing cardiovascular vulnerability in oncology patients. The study confirmed that toxic cardiomyopathy remains one of the most important treatment-related complications affecting cardiac structure and function. At the same time, hypertensive crises were found to occur more frequently during periods of heightened heliogeophysical activity, indicating a possible relationship between geomagnetic disturbances and cardiovascular instability. The combined effects of anticancer therapy and environmental stressors may contribute to worsening cardiac outcomes and increased cardiovascular risk. The results emphasize the importance of comprehensive cardiovascular monitoring in cancer patients, particularly those undergoing potentially cardiotoxic treatment. Consideration of heliogeophysical conditions may improve risk assessment and support the development of preventive strategies aimed at reducing adverse cardiovascular events.

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