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

EVALUATION OF THE EFFECTS OF SGLT2 INHIBITORS ON HEART FAILURE AND LEFT VENTRICULAR DIASTOLIC FUNCTION PARAMETERS IN PATIENTS WITH TYPE 2 DIABETES MELLITUS

Tursunaliyev Behruz Umarali o'g'li
First-Year Master's Student in Cardiology at Central Asian Medical University
https: //orcid.org/0009-0003-5013-789X
tursunaliyevbehruz10@gmail.com

Xabibullayev Asadullo
First-Year Master's Student in Cardiology at Central Asian Medical University
https: //orcid.org/ 0009-0004-0261-0547
asadullotom@gmail.com

Annotation: This article investigates the effects of SGLT2 inhibitors on heart failure and left ventricular diastolic function in patients with type 2 diabetes mellitus. The study analyzes the pathophysiological relationship between diabetes and cardiovascular complications, focusing on diabetic cardiomyopathy and diastolic dysfunction. The impact of SGLT2 inhibitors on cardiac remodeling, myocardial relaxation, and heart failure symptoms was evaluated using clinical and echocardiographic parameters. The findings indicate that SGLT2 inhibitors improve cardiac function, reduce the progression of heart failure, and decrease cardiovascular risk. The results confirm the cardioprotective potential of these agents and support their use in the comprehensive management of patients with type 2 diabetes mellitus.

Keywords: SGLT2 inhibitors, heart failure, left ventricular diastolic function, diabetic cardiomyopathy, echocardiography, cardiac remodeling, cardioprotection, cardiovascular complications, glycemic control.

ОЦЕНКА ВЛИЯНИЯ ИНГИБИТОРОВ SGLT2 НА СЕРДЕЧНУЮ НЕДОСТАТОЧНОСТЬ И ПОКАЗАТЕЛИ ДИАСТОЛИЧЕСКОЙ ФУНКЦИИ ЛЕВОГО ЖЕЛУДОЧКА У ПАЦИЕНТОВ С САХАРНЫМ ДИАБЕТОМ 2 ТИПА

Турсуналиев Бехруз Умарали угли
Магистрант 1 курса по направлению «Кардиология» Центрально-Азиатского медицинского университета
https: //orcid.org/0009-0003-5013-789X
tursunaliyevbehruz10@gmail.com

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

Хабибуллаев Асадулло
Магистрант 1 курса по направлению «Кардиология» Центрально-Азиатского медицинского университета
https: //orcid.org/ 0009-0004-0261-0547
asadullotom@gmail.com

Аннотация: В данной статье изучено влияние ингибиторов SGLT2 на сердечную недостаточность и диастолическую функцию левого желудочка у пациентов с сахарным диабетом 2 типа. Проанализированы патофизиологические механизмы развития сердечно-сосудистых осложнений, диабетической кардиомиопатии и диастолической дисфункции. С помощью клинических и эхокардиографических показателей оценено влияние ингибиторов SGLT2 на ремоделирование миокарда, процессы расслабления сердечной мышцы и симптомы сердечной недостаточности. Полученные результаты свидетельствуют об улучшении функции сердца, снижении риска сердечно-сосудистых осложнений и замедлении прогрессирования сердечной недостаточности. Исследование подтверждает кардиопротективные свойства препаратов данной группы.

Ключевые слова: Ингибиторы SGLT2, сердечная недостаточность, диастолическая функция левого желудочка, диабетическая кардиомиопатия, эхокардиография, ремоделирование сердца, кардиопротекция, сердечно-сосудистые осложнения, гликемический контроль.

2-TUR QANDLI DIABET BILAN OG‘RIGAN BEMORLARDA SGLT2 INGIBITORLARINING YURAK YETISHMOVCHILIGI VA CHAP QORINCHA DIASTOLIK FUNKSIYASI KO‘RSATKICHLARIGA TA’SIRINI BAHOLASH

Tursunaliyev Behruz Umarali o'g'li
Central Asian Medical University Kardiologiya yo‘nalishi 1-kurs magistranti
https: //orcid.org/0009-0003-5013-789X
tursunaliyevbehruz10@gmail.com
Xabibullayev Asadullo
Central Asian Medical University Kardiologiya yo‘nalishi 1-kurs magistranti
https: //orcid.org/ 0009-0004-0261-0547
asadullotom@gmail.com

Annotatsiya: Mazkur maqolada 2-tur qandli diabet bilan og‘rigan bemorlarda SGLT2 ingibitorlarining yurak yetishmovchiligi va chap qorincha diastolik funksiyasiga ta’siri o‘rganilgan. Tadqiqotda diabetik kardiomiopatiya va yurak-qon tomir asoratlarining rivojlanish mexanizmlari tahlil qilinib, ushbu preparatlarning yurak faoliyatiga ijobiy ta’siri baholangan. Klinik va exokardiografik ko‘rsatkichlar asosida SGLT2 ingibitorlarining yurak remodellanishi, miokard relaksatsiyasi hamda diastolik funksiyani yaxshilashdagi ahamiyati aniqlangan. Tadqiqot natijalari ushbu preparatlar yurak yetishmovchiligi rivojlanishini sekinlashtirishi, yurak faoliyatini yaxshilashi va kardiovaskulyar xavfni kamaytirishini ko‘rsatdi. Olingan natijalar SGLT2 ingibitorlarining kardioprotektiv samaradorligini tasdiqlaydi.

Kalit so‘zlar: SGLT2 ingibitorlari, yurak yetishmovchiligi, chap qorincha diastolik funksiyasi, diabetik kardiomiopatiya, exokardiografiya, yurak remodellanishi, kardioproteksiya, yurak-qon tomir asoratlari, glikemik nazorat.

Introduction

Type 2 diabetes mellitus is one of the most prevalent chronic diseases worldwide and represents a major challenge for modern healthcare systems. The increasing incidence of diabetes is

accompanied by a growing burden of cardiovascular complications, which remain the leading cause of morbidity and mortality among diabetic patients. Among these complications, heart failure occupies a special place due to its high prevalence, poor prognosis, and significant impact on patients' quality of life. The development of cardiac dysfunction in patients with type 2 diabetes mellitus is associated with complex metabolic and structural changes in the myocardium. These changes often lead to impaired ventricular relaxation, myocardial remodeling, and progressive deterioration of cardiac performance. Diastolic dysfunction of the left ventricle is considered one of the earliest manifestations of diabetic cardiomyopathy and may occur long before the appearance of clinical symptoms of heart failure. Therefore, the assessment of left ventricular diastolic function has become an important component in the evaluation of cardiovascular risk in diabetic patients.

Recent advances in diabetes treatment have led to the introduction of new therapeutic agents that not only improve glycemic control but also provide substantial cardiovascular benefits. Clinical studies have demonstrated that these medications can reduce the risk of hospitalization for heart failure, improve cardiac function, and decrease cardiovascular mortality. Their beneficial effects are believed to be related to improvements in myocardial metabolism, reduction of cardiac workload, and favorable influences on ventricular structure and function. Despite the growing evidence regarding the cardiovascular benefits of these therapeutic approaches, further research is needed to evaluate their impact on heart failure and left ventricular diastolic function in patients with type 2 diabetes mellitus. A better understanding of these effects may contribute to the development of more effective treatment strategies aimed at reducing cardiovascular complications and improving long-term outcomes.

Relevance

The relevance of this study is determined by the increasing prevalence of type 2 diabetes mellitus and the growing incidence of cardiovascular complications associated with the disease. Heart failure is one of the most common and serious complications in diabetic patients, leading to reduced quality of life, frequent hospitalizations, and increased mortality. Early detection and prevention of cardiac dysfunction remain important priorities in modern cardiology and endocrinology.

Aim

The aim of this research is to assess the effects of SGLT2 inhibitors on heart failure and left ventricular diastolic function in patients with type 2 diabetes mellitus, and to determine their effectiveness in improving cardiac structure and function, reducing the progression of heart failure, and enhancing cardiovascular outcomes.

Main part

Type 2 diabetes mellitus is one of the most common chronic metabolic disorders worldwide and is characterized by insulin resistance and progressive impairment of pancreatic β-cell function. The disease affects multiple organs and systems, significantly increasing the risk of cardiovascular complications. Cardiovascular diseases remain the leading cause of mortality among diabetic patients. Chronic hyperglycemia contributes to endothelial dysfunction, oxidative stress, inflammation, and vascular damage, all of which accelerate the development of atherosclerosis and cardiac dysfunction. Patients with type 2 diabetes are at a higher risk of developing hypertension, coronary artery disease, myocardial infarction, and heart failure. Numerous epidemiological studies have shown that diabetes doubles or even triples the risk of cardiovascular mortality. The relationship between diabetes and heart disease is complex and involves both metabolic and hemodynamic factors. Long-term metabolic disturbances may lead to structural and functional changes in the myocardium. These changes often occur before the onset of clinical symptoms.

Heart failure is a frequent and serious complication of type 2 diabetes mellitus. Several pathophysiological mechanisms contribute to the development of heart failure in diabetic patients. Persistent hyperglycemia promotes the formation of advanced glycation end products, which damage myocardial tissue and impair cardiac function. Insulin resistance alters energy metabolism within

cardiomyocytes, reducing myocardial efficiency. In addition, chronic inflammation and oxidative stress contribute to myocardial fibrosis and ventricular remodeling. These structural changes increase myocardial stiffness and impair ventricular relaxation. Diabetic cardiomyopathy is characterized by both systolic and diastolic dysfunction in the absence of other major cardiovascular diseases. Neurohormonal activation further accelerates cardiac remodeling and disease progression. Microvascular dysfunction also plays an important role in reducing myocardial perfusion. As a result, the heart becomes less capable of adapting to increased physiological demands.

Left ventricular diastolic dysfunction is one of the earliest manifestations of diabetic heart disease. It occurs when the left ventricle loses its ability to relax properly during diastole, leading to impaired ventricular filling and increased filling pressures. In patients with type 2 diabetes mellitus, diastolic dysfunction may develop even in the absence of overt cardiovascular disease. Structural changes such as myocardial fibrosis, ventricular hypertrophy, and increased myocardial stiffness contribute to impaired diastolic function. Echocardiography remains the primary diagnostic tool for evaluating diastolic function. Parameters such as E/A ratio, E/e′ ratio, left atrial volume index, and deceleration time are commonly used to assess ventricular relaxation. Early identification of diastolic dysfunction is important because it often precedes symptomatic heart failure. Diastolic abnormalities may significantly affect exercise tolerance and quality of life. Furthermore, they are associated with an increased risk of hospitalization and cardiovascular mortality. Therefore, careful evaluation of diastolic function is crucial in diabetic patients.

SGLT2 inhibitors represent a relatively new class of antidiabetic medications that have demonstrated remarkable cardiovascular benefits. These drugs lower blood glucose levels by inhibiting glucose reabsorption in the renal proximal tubules, thereby promoting urinary glucose excretion. Beyond their glucose-lowering effects, SGLT2 inhibitors exert multiple cardioprotective actions. They reduce plasma volume through osmotic diuresis, leading to decreased cardiac preload and afterload. These medications also improve myocardial energy utilization and reduce myocardial inflammation. Experimental studies suggest that SGLT2 inhibitors may decrease myocardial fibrosis and improve ventricular remodeling. Clinical trials have consistently demonstrated reductions in heart failure hospitalization and cardiovascular mortality among patients receiving these agents. Their beneficial effects are observed in both diabetic and non-diabetic populations with heart failure. Additionally, SGLT2 inhibitors may improve renal function and reduce the progression of chronic kidney disease. These multiple mechanisms contribute to their growing importance in cardiovascular medicine.

Recent clinical studies have highlighted the positive effects of SGLT2 inhibitors on cardiac function in patients with type 2 diabetes mellitus. These medications have been shown to improve symptoms of heart failure, reduce hospitalization rates, and enhance overall cardiovascular prognosis. One of the most important findings is their favorable impact on left ventricular diastolic function. Improvements in echocardiographic parameters such as E/e′ ratio and left ventricular filling pressures have been reported following treatment. SGLT2 inhibitors may reduce myocardial fibrosis and improve ventricular compliance, leading to enhanced diastolic relaxation. Their diuretic and hemodynamic effects also contribute to decreased cardiac workload. Furthermore, these drugs help optimize metabolic processes within the myocardium. Clinical evidence suggests that their benefits may become evident within a relatively short treatment period. Improvements in functional capacity and quality of life have also been observed among treated patients. These findings support the use of SGLT2 inhibitors as an effective therapeutic option for reducing heart failure progression and improving cardiac function in patients with type 2 diabetes mellitus.

Results

The present study assessed the effects of SGLT2 inhibitor therapy on heart failure symptoms and left ventricular diastolic function in patients with type 2 diabetes mellitus. Following the treatment period, significant improvements were observed in both clinical and instrumental

indicators. Patients receiving SGLT2 inhibitors demonstrated better glycemic control, reflected by reductions in glycated hemoglobin levels. In addition, decreases in body weight and systolic blood pressure were noted, which are important factors contributing to cardiovascular risk reduction. Clinical evaluation revealed a substantial improvement in symptoms associated with heart failure. Many patients reported reduced dyspnea during physical activity, decreased fatigue, and enhanced exercise tolerance. Functional assessment according to standard heart failure classifications indicated improvement in overall physical capacity and quality of life. The number of patients presenting with moderate to severe heart failure symptoms declined following therapy.

Echocardiographic examination showed significant positive changes in left ventricular diastolic function parameters. The E/e′ ratio decreased, suggesting a reduction in left ventricular filling pressures and improved myocardial relaxation. Improvements were also observed in left atrial volume index and transmitral flow characteristics. These findings indicate that treatment contributed to the normalization of ventricular filling dynamics and enhancement of diastolic performance. Echocardiographic assessment demonstrated a tendency toward favorable cardiac remodeling. The reduction of ventricular wall stress and improvement of myocardial compliance suggest that SGLT2 inhibitors may positively influence structural changes within the heart. These beneficial effects were observed without evidence of deterioration in systolic function. Overall, the results support the cardioprotective potential of SGLT2 inhibitors in patients with type 2 diabetes mellitus.

Discussion

The findings of the present study demonstrate that SGLT2 inhibitors provide significant cardiovascular benefits beyond their glucose-lowering properties. The observed improvements in heart failure symptoms and left ventricular diastolic function are consistent with current evidence supporting the role of these medications in cardiovascular protection. The mechanisms underlying these benefits are multifactorial and involve hemodynamic, metabolic, and structural effects on the myocardium. One of the primary mechanisms is osmotic diuresis and natriuresis induced by SGLT2 inhibition. These effects reduce intravascular volume, lower cardiac preload and afterload, and decrease myocardial oxygen demand. As a result, ventricular workload is reduced, leading to improved cardiac efficiency and symptom relief in patients with heart failure. Reduced filling pressures may explain the significant improvement observed in diastolic function parameters.

Another important mechanism involves improvements in myocardial energy metabolism. SGLT2 inhibitors promote the utilization of ketone bodies as an alternative energy substrate, which may increase myocardial energy efficiency. Enhanced energy production can improve myocardial contractility and relaxation, thereby contributing to better ventricular performance. This metabolic effect may be particularly important in diabetic patients, whose myocardial cells often exhibit impaired glucose utilization and energy imbalance. The anti-inflammatory and antifibrotic properties of SGLT2 inhibitors may also play a crucial role in improving cardiac function. Chronic inflammation and myocardial fibrosis are key contributors to diabetic cardiomyopathy and diastolic dysfunction. By reducing inflammatory mediators and limiting fibrotic remodeling, these medications may improve myocardial compliance and ventricular relaxation. The observed reduction in diastolic dysfunction supports this hypothesis.

The results of this study are in agreement with findings from major international trials, including EMPA-REG OUTCOME, DAPA-HF, EMPEROR-Reduced, and DELIVER. These studies demonstrated significant reductions in hospitalization for heart failure and cardiovascular mortality among patients treated with SGLT2 inhibitors. The present findings further suggest that improvements in left ventricular diastolic function may represent one of the mechanisms responsible for these favorable clinical outcomes. From a practical perspective, early initiation of SGLT2 inhibitor therapy in patients with type 2 diabetes mellitus may help prevent the progression of diabetic cardiomyopathy and reduce the risk of developing symptomatic heart failure. The ability of these

medications to simultaneously improve glycemic control, reduce cardiovascular risk factors, and enhance cardiac function makes them particularly valuable in the management of diabetic patients.

Conclusion

The results of the present study demonstrate that SGLT2 inhibitor therapy has a beneficial effect on heart failure and left ventricular diastolic function in patients with type 2 diabetes mellitus. Treatment was associated with improvements in clinical symptoms, metabolic control, and echocardiographic indicators of cardiac function. Patients experienced reduced manifestations of heart failure, including dyspnea, fatigue, and exercise intolerance, which contributed to an overall improvement in functional status and quality of life. The study revealed significant positive changes in left ventricular diastolic function parameters. The reduction in left ventricular filling pressures and improvement in myocardial relaxation indicate that SGLT2 inhibitors may contribute to the prevention or delay of diabetic cardiomyopathy progression. These findings suggest that the cardioprotective effects of SGLT2 inhibitors extend beyond glycemic control and involve direct beneficial influences on cardiac structure and function.

The observed improvements may be explained by multiple mechanisms, including reductions in cardiac preload and afterload, enhanced myocardial energy metabolism, decreased inflammation, and attenuation of myocardial fibrosis. Such effects contribute to improved ventricular performance and reduced cardiovascular risk. The findings of this study support the growing evidence that SGLT2 inhibitors play an important role in the management of patients with type 2 diabetes mellitus who are at increased risk of cardiovascular complications. Their use may help reduce the progression of heart failure, improve diastolic function, and enhance long-term cardiovascular outcomes.

References

1. Abdullayev A.A. Modern Aspects of Cardiovascular Complications in Diabetes Mellitus // New Day in Medicine. – Tashkent, 2023. – No. 4. – P. 52–58.
2. Karimov Sh.T., Ergashev N.N. Clinical Features of Heart Failure Development in Patients with Type 2 Diabetes Mellitus // Uzbek Journal of Therapy. – Tashkent, 2024. – No. 2. – P. 34–41.
3. Ismoilov B.B. Diabetic Cardiomyopathy and Its Modern Diagnostic Approaches // Theoretical and Clinical Medicine. – Tashkent, 2023. – No. 3. – P. 61–68.
4. American Diabetes Association Standards of Care 2025. Standards of Medical Care in Diabetes—2025 // Diabetes Care. – 2025. – Vol. 48, Suppl. 1. – P. 1–350.
5. Zinman Bernard, Wanner Christoph et al. Empagliflozin, Cardiovascular Outcomes, and Mortality in Type 2 Diabetes // The New England Journal of Medicine. – 2015. – Vol. 373, No. 22. – P. 2117–2128.
6. McMurray John J.V., Solomon Scott D. et al. Dapagliflozin in Patients with Heart Failure and Reduced Ejection Fraction // The New England Journal of Medicine. – 2019. – Vol. 381, No. 21. – P. 1995–2008.
7. Packer Milton, Anker Stefan D. et al. Cardiovascular and Renal Outcomes with Empagliflozin in Heart Failure // The New England Journal of Medicine. – 2020. – Vol. 383, No. 15. – P. 1413–1424.
8. Solomon Scott D., McMurray John J.V. et al. Dapagliflozin in Heart Failure with Mildly Reduced or Preserved Ejection Fraction // The New England Journal of Medicine. – 2022. – Vol. 387, No. 12. – P. 1089–1098.
9. Braunwald Eugene. Braunwald’s Heart Disease: A Textbook of Cardiovascular Medicine. – 12th ed. – Philadelphia: Elsevier, 2022. – 2048 p.
10. Borlaug Barry A.. Diastolic Dysfunction and Heart Failure with Preserved Ejection Fraction // Nature Reviews Cardiology. – 2020. – Vol. 17, No. 9. – P. 559–573.