International Journal of Modern Medicine
VOLUME05 ISSUE05
PUBLISHED DATE: - 06-05-2026
DOI: https://doi.org/10.55640/ijmm-05-05-04
Page 19-23
eISSN: 2156-5198 pISSN: 2156-518X

RESEARCH ARTICLE

Endothelial Function Dynamics in Patients with Chronic Heart Failure During Antioxidant Treatment

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Abstract: The aim of the study was to evaluate the effectiveness of the use of natural antioxidants on the state of endothelial function in patients with IHD and chronic heart failure (CHF). Sixty patients with IHD were examined. Stable exertional angina of FC II-III, complicated CHF, middle-aged from 45-60 years. It was found that the inclusion of tivortine in the complex therapy of patients with CHF can reduce the manifestations of vascular endothelial dysfunction, which indicates the promise of using the drug for the purpose of secondary prevention of coronary heart disease and CHF.

Key words: Chronic heart failure, endothelial function, antioxidants, ischemic heart disease.

INTRODUCTION

Currently, a considerable body of evidence has been accumulated confirming changes in the structural organization of membranes and the functional state of cells during the aging process. A decrease in the content of natural antioxidants increases the damaging effect of free radicals, resulting in changes in the functional characteristics of membranes. These and other similar data contributed to the development of the peroxide theory of cell division and aging of the organism. All of this may indicate the important pathogenetic role of these processes in the course of ischemic heart disease and other diseases [2, 4, 8].Experimental and clinical studies conducted in recent years in this field have demonstrated the important role of the vascular endothelium in the development and progression of atherosclerotic lesions of the arterial bed [1, 2, 6, 8]. Impairment of vascular endothelial function not only accelerates the development of the atherosclerotic process in the vascular wall but also reduces the effectiveness of antianginal and antihypertensive agents, since their vasoregulatory pharmacological activity is ultimately mediated through the NO system [4, 6]. In this regard, the use in clinical practice of drugs capable of influencing the main pathogenetic mechanisms of endothelial dysfunction is of particular interest, as this may become one of the fundamental factors in the primary and secondary prevention of atherosclerosis and ischemic heart disease [5, 8].

Purpose of the research

Aim of the study is to evaluate the effectiveness of the antioxidant Tivortin on endothelial function in patients with ischemic heart disease and chronic heart failure.

METHODS

A total of 60 patients with ischemic heart disease were examined. The patients had stable exertional angina of functional class II–III complicated by chronic heart failure and were

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aged 45–60 years. The examination of patients was carried out at the clinic of the Republican Specialized Scientific and Practical Medical Center of Therapy and Medical Rehabilitation of the Republic of Uzbekistan. Depending on the therapy administered, the examined patients were divided into two study groups: Group 1 received standard therapy for ischemic heart disease and chronic heart failure (n=30), while Group 2 received standard therapy with the additional use of the antioxidant Tivortin (n=30).Patients in both groups had received conventional basic therapy for at least two months before the start of the study and throughout the entire observation period. This therapy included a selective β-adrenoblocker, bisoprolol 5–10 mg/day; acetylsalicylic acid 100–125 mg/day; statins, atorvastatin 10–20 mg/day; ACE inhibitors, enalapril 5–10 mg/day. In some patients with functional class III angina, when the antianginal efficacy of β-blockers was insufficient, treatment was supplemented with long-acting nitrates, namely isosorbide-5-mononitrate 40–60 mg/day.Patients in Group 2, in addition to basic therapy, received Tivortin at a daily dose of 20 mg/day. The degree of endothelial dysfunction (ED) was determined using the method described in [3, 7], based on pulsed-wave Doppler ultrasound examination of the brachial artery with the use of an Ultramark 9 ultrasound scanner equipped with a linear transducer operating at a frequency of 7 MHz. Endothelium-dependent vasodilation of the brachial artery was assessed during the cuff test, with calculation of changes in the brachial artery diameter (Δd) and the coefficient of endothelial sensitivity to shear stress (K).Statistical processing of the obtained results was performed using the Statistica 6.0 software package, including the use of the χ^2 test.

RESULTS AND DISCUSSION

When assessing the baseline state of endothelium-dependent vasodilatory capacity of the brachial artery in the patients included in the study, varying degrees of vascular endothelial dysfunction were identified. In this regard, the patients were distributed according to the severity of endothelial dysfunction, as shown in Table 1. The severity was assessed based on the degree of brachial artery dilation during the cuff test [3, 7].

The majority of patients had grade II and grade III endothelial dysfunction, while a smaller proportion had grade I and grade IV endothelial dysfunction.

Table 1.

Distribution of patients with chronic heart failure according to the severity of endothelial dysfunction based on the results of the cuff test before the start of treatment.

Severity of ED	Degree of brachial artery dilation in the cuff test	Number of patients: Group 1	Number of patients: Group 2
0	≥9%	0	0
I	9%–7.5%	6	7
II	7.5%–3.0%	12	11
III	3.0%–2.0%	8	9
IV	<2.0% or constriction	4	3

For the convenience of statistical processing and due to differences in the severity of endothelial dysfunction, the patients included in the study in Groups 1 and 2 were divided into two subgroups. The first subgroup included patients with grade I and II ED (n1=18 and n2=18 in the main and control groups, respectively), while the second subgroup included patients with grade III and IV ED (n1=12 and n2=12). Analysis of changes in the parameters of vascular endothelial dysfunction (Table 2) showed that, against the background of Tivortin therapy, by the end of the first month of treatment, patients with grade I–II endothelial dysfunction demonstrated a significant increase in the brachial artery

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diameter (ΔD) in the reactive hyperemia test. This increase amounted to 18.4% compared with the baseline level and was significantly higher ($p<0.05$ according to the χ^2 test) than in Group 1 patients who received standard therapy, where the ΔD value changed only slightly, increasing by 6.8% from baseline. In the subgroup of patients with pronounced baseline endothelial dysfunction, namely grade III–IV ED, the increase in ΔD was less significant and amounted to 8.3% by the end of the first month of Tivortin treatment (Table 2). In Group 1 patients with initially pronounced endothelial dysfunction, no significant changes in ΔD were observed.

Table 2

Changes in endothelial function parameters in the reactive hyperemia test in patients with chronic heart failure during Tivortin therapy (M±SD)

Group	Subgroup	Parameters	Baseline	4 weeks	12 weeks
Group 1, standard therapy	1, grade I–II ED	**ΔV2, (%)**	95.8±12.1	87.8±8.3	98.1±13.3
		ΔD2, (%)	7.4±0.31	7.9±0.22	8.2±0.15
		τ0, (dyn/cm²)	357.6±54.2	370.8±50.2	356.2±53.1
		τ2, (dyn/cm²)	593.8±42.9	571.8±55.0	594.7±42.1
		K, (conventional units)	0.11±0.015	0.14±0.025	0.11±0.014
Group 1, standard therapy	2, grade III–IV ED	**ΔV2, (%)**	141.5±17.3	139.5±17.2	140.1±17.2
		ΔD2, (%)	2.2±0.25	2.3±0.3	2.38±0.15
		τ0, (dyn/cm²)	380.2±69.4	383.1±71.6	385.2±73.3
		τ2, (dyn/cm²)	684.5±63.4	679.9±59.1	687.2±68.7
		K, (conventional units)	0.027±0.01	0.029±0.005	0.027±0.006
Group 2, Tivortin therapy	1, grade I–II ED	**ΔV2, (%)**	90.3±11.4	76.6±9.5	67.5±7.8*
		ΔD2, (%)	7.6±0.25	9.0±0.31*	10.1±0.3*
		τ0, (dyn/cm²)	354.5±55.4	341.4±45.6	342.5±47.1
		τ2, (dyn/cm²)	597.6±43.1	541.4±37.8	506.8±29.6*
		K, (conventional units)	0.11±0.024	0.15±0.014*	0.21±0.026*
Group 2, Tivortin therapy	2, grade III–IV ED	**ΔV2, (%)**	133.1±18.6	122.3±17.7	107.9±13.4
		ΔD2, (%)	2.4±0.22	2.6±0.15	3.09±0.09*
		τ0, (dyn/cm²)	378.5±69.7	367.1±58.7	365.2±57.5
		τ2, (dyn/cm²)	673.4±62.1	641.7±51.3	628.9±41.5
		K, (conventional units)	0.03±0.005	0.035±0.006	0.041±0.007*

Note: $p<0.05$ compared with the baseline level.

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By the end of three months of therapy, in the subgroup of patients with grade I–II endothelial dysfunction who received Tivortin, the increase in ΔD in the reactive hyperemia test amounted to 32.9% compared with baseline. This was significantly higher ($p<0.05$ according to the χ^2 test) than in patients in the control group, where ΔD increased by 10.8%. In the subgroup of patients with initially pronounced endothelial dysfunction, namely grade III–IV ED, the increase in ΔD by the end of the third month of Tivortin therapy was 28.7% ($p<0.05$ according to the χ^2 test), whereas in Group 1 patients who received only basic therapy, ΔD increased by 8.2% ($p<0.05$). When assessing changes in blood flow velocity in the brachial artery and the magnitude of shear stress acting on the endothelium, it was found that the change in ΔV occurred mainly due to a decrease in the linear blood flow velocity in the brachial artery during the reactive hyperemia test. The blood flow changes recorded before the cuff test did not differ significantly from baseline values throughout the entire observation period. By the end of the third month of therapy, a decrease in ΔV was observed only with the use of Tivortin; at the same time, the severity of these changes depended on the initial degree of ED. Thus, in the subgroup with mild to moderate ED, grade I–II, the decrease in ΔV in the brachial artery was 25.2% ($p<0.05$), while in patients with severe ED, grade III–IV, ΔV decreased by 18.8%. The differences between the subgroups were statistically significant according to the χ^2 test ($p<0.05$). The coefficient of brachial artery sensitivity to shear stress (K) is one of the integral indicators characterizing endothelial dysfunction. By the end of the first month of therapy, in the subgroup of patients with mild and moderate endothelial dysfunction who received Tivortin, the sensitivity coefficient significantly increased by 38.6% ($p<0.05$), and by the end of the course of therapy, the K value was 90.0% higher than baseline ($p<0.05$). In Group 1, this parameter did not differ from baseline values throughout the observation period. In the subgroups of patients with severe endothelial dysfunction, less pronounced changes in the coefficient of endothelial sensitivity to shear stress (K) were observed. As a result of the course of therapy, a significant increase in the coefficient of endothelial sensitivity to shear stress was observed only in the subgroup of patients receiving Tivortin; it increased by 38.9% according to the χ^2 test ($p<0.05$). In Group 1, the K value did not change. A decrease in blood peroxide levels reduces the intensity of peroxide degradation of the NO molecule, thereby increasing its lifespan [3, 8] and contributing to improved bioavailability. Another mechanism underlying the endothelium-protective effect of Tivortin may be the improvement of intracellular energy metabolism in the vascular endothelium through stimulation of ATP production in endothelial cells. This leads to increased NO generation, enhanced NO synthase expression, and increased sensitivity of endothelial NO receptors [4, 5].Thus, the inclusion of Tivortin in the complex therapy of patients with stable angina complicated by chronic heart failure reduces the manifestations of vascular endothelial dysfunction, indicating the potential usefulness of this drug for the secondary prevention of ischemic heart disease and chronic heart failure.

CONCLUSIONS

1. The use of the antioxidant Tivortin at a dose of 20 mg/day as part of complex therapy in patients with ischemic heart disease, stable exertional angina of functional class II–III complicated by chronic heart failure, leads to an increase in brachial artery diameter and endothelial sensitivity to shear stress, as well as a decrease in linear blood flow velocity in the brachial artery during the reactive hyperemia test.

2. The effectiveness of the endothelium-protective effect of Tivortin in patients with ischemic heart disease and chronic heart failure depends on the initial severity of endothelial dysfunction.

REFERENCES

1. Atakhodjaeva G., Mizaeva B., Aripova J., Abdulatipov A., Valiev A. The effectiveness of the treatment of heart failure metabolic syndrome on the parameters of post infarct remodeling and functional state of the left ventricle in patients with metabolic

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syndrome. Chin J Ind Hyg Occup Dis, 2021, Vol. 39, No. 13, pp. 382–392. https://doi.org/10.5281/zenodo.5593953

2. Bardymova T.P., Potasov K.V., Tsyretova S.S., Donirova O.S. Type 2 diabetes mellitus and ischemic heart disease. Bulletin of the East Siberian Scientific Center of the Siberian Branch of the Russian Academy of Medical Sciences. 2017; Vol. 2, No. 1(113): 100–108.
3. Dushina A.G., Lopina E.A., Libis R.A. Features of chronic heart failure depending on left ventricular ejection fraction. Russian Journal of Cardiology. 2019; (2): 7–11. https://doi.org/10.15829/1560-4071-2019-2-7-11
4. Dushina A.G., Lopina E.A., Libis R.A. Features of chronic heart failure depending on left ventricular ejection fraction. Russian Journal of Cardiology. 2019; (2): 7–11. https://doi.org/10.15829/1560-4071-2019-2-7-11
5. ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure 2016. The Task Force for the Diagnosis and Treatment of Acute and Chronic Heart Failure 2016 of the European Society of Cardiology. Developed with the special contribution of the Heart Failure Association (HFA) of the ESC. Eur Heart J. 2016; Vol. 10: 1093–1128.
6. Fomin I.V. Chronic heart failure in the Russian Federation: what do we know and what should we do? Russian Journal of Cardiology. 2016; 8: 7–13. doi:10.15829/1560-4071-2016-8-7-13.
7. Galyavich A.S., Mingalimova I.M., Galeeva Z.M., Baleeva L.V. Assessment of the risk of long-term fatal outcome in hospitalized patients with post-infarction chronic heart failure. Russian Journal of Cardiology. 2020; 25(1): 3671. https://doi.org/10.15829/1560-4071-2020-1-3671
8. Gheorghiade M., Vaduganathan M., Fonarow G. et al. Rehospitalization for heart failure: problems and perspectives. J Am Coll Cardiol. 2013; 61(4): 391–403.
9. Habal M.V., Liu P.P., Austin P.C. et al. Association of heart rate at hospital discharge with mortality and hospitalizations in patients with heart failure. Circ Heart Fail. 2014; 7: 12–20.
10. Kamilova U., Abdullaeva Ch., Atakhodjaeva G., Beknazarova S., Masharipova D., Ikramova F. Disorders of kidney function in chronic heart failure. Indian Journal of Forensic Medicine and Toxicology. 2021; 15(4): 1547–1552.
11. Clinical Guidelines 2020. Russian Society of Cardiology. Chronic heart failure. Russian Journal of Cardiology. 2020; 25(11). doi:10.15829/1560-4071-2020-4083.
12. Kurlykina N.V., Seredenina E.M., Orlova Ya.A. Use of loop diuretics in heart failure: current aspects. Terapevticheskiy Arkhiv. 2017; 89(9): 115–119. doi:10.17116/terarkh2017899115-119.
13. Mareev V., Fomin I., Ageev F. et al. Russian Heart Failure Society, Russian Society of Cardiology. Russian Scientific Medical Society of Internal Medicine Guidelines for heart failure: chronic heart failure and acute decompensated heart failure. Diagnosis, prevention and treatment. Kardiologiia. 2018; 58(6S): 8–158. doi:10.18087/cardio.2475.
14. Mareev V.Yu., Fomin I.V., Ageev F.T. et al. Clinical guidelines. Chronic heart failure. Russian Heart Failure Journal. 2017; 18(1): 3–40. doi:10.18087/rhfj.2017.1.2346.
15. Tereshchenko S.N., Zhirov I.V. Chronic heart failure: new challenges and new perspectives. Terapevticheskiy Arkhiv. 2017; 9: 4–9. doi:10.17116/terarkh20178994-9.