

Dynamics of Myocardial Markers During Intradialysis Physical Load in Patients with Chronic Kidney Disease

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Abstract **Aim of the study:** to study the effect of intradialytic physical activity on myocardial markers in patients with chronic kidney disease. **Material and research methods.** The study included 103 patients with CKD5d aged 18 to 65 years. In all patients, natriuretic peptide (NUP), myocardial fraction of creatine phosphokinase (CPK-MB), myocardial fraction of troponin (troponin T) were determined in the blood of all patients before the hemodialysis (HD) procedure, at 60-90 minutes of HD and after cessation of HD. The physical activity used was bicycle ergometry (BE) for 30 minutes during the first hour of HD. **Results:** During the HD procedure, by the 60-90th minute of the procedure, there was a significant increase in the concentration of NUP - by 18.04%, CPK-MB - by 172.78%, and troponin T - by 263.01% Intradialytic physical exercise (PhE) contributes to a significant decrease in the rate of increase in the concentration of myocardial markers (for NUP: +7.66% versus +18.04%, for CPK-MB: 87.2% versus +172.8% and for troponin T: +66.09% versus +263%, $p < 0.001$ for all three indicators). **Conclusion.** During the HD procedure, a significant increase in the concentration of markers of myocardial “suffering” is noted. Intradialytic physical exercise helps to reduce these markers of myocardial damage in the blood compared to standard HD and may have a preventive effect on cardiomyocytes.

Keywords Chronic kidney disease, Hemodialysis, Natriuretic peptide, Creatine phosphokinase, Troponin T, Intradialytic bicycle ergometry

1. Introduction

Hemodialysis (HD) is critical for the survival of patients with CKD. However, each HD session is accompanied by significant sharp hemodynamic and metabolic changes. The circulating blood volume (CBV) decreases significantly, which causes impaired perfusion of organs and tissues, including the myocardium [1,2]. A decrease in blood volume has two main negative effects on the myocardium: a decrease in pressure in the coronary vascular system leads to the development of intradialytic myocardial ischemia, and a decrease in preload is associated with non-ischemic myocardial dysfunction [3,4]. A decrease in systolic blood pressure and ultrafiltration are associated with the development of local myocardial dyskinesia, indicating myocardial stunning [5,6].

Dynamic physical activity can help strengthen the body's adaptive abilities and normalize reflex regulatory pathways. The literature provides evidence of the positive effect of intradialytic exercise on quality of life and intradialytic hypotension [7,8].

Purpose of the study: to study the effect of intradialytic physical activity on myocardial markers in patients with chronic kidney disease.

2. Material and Research Methods

The study included 103 patients with CKD5d aged 18 to 65 years. The average HD experience is 8.45 ± 0.57 months. When included in the study, natriuretic peptide (NUP), myocardial fraction of creatine phosphokinase (CPK-MB), myocardial fraction of troponin (troponin T) were determined in the blood of all patients before the hemodialysis procedure, at 60-90 minutes of HD and after cessation of HD. The control group consisted of 20 healthy individuals of the appropriate age.

The load used was bicycle ergometry (BE) on an exercise bike, which allows BE to be carried out in foot and hand modes. A low-intensity load was used - without resistance, for 30 minutes during the first hour of HD with the patient lying down or semi-sitting.

3. Research Results and Discussion

During the HD procedure, by the 60-90th minute of the procedure, a significant increase in the concentration of myocardial markers “suffering” was noted: thus, the concentration of NUP increased by 18.04%, CPK-MB – by 172.78%, and troponin T – by 263.01% (Table 1). An increase in the concentration of NUP is probably associated with a change in loading conditions - a decrease in BCC during HD, a decrease in preload on the myocardium, while

an increase in the concentration of both markers of necrosis indicates cell damage, which can be caused by metabolic turbulence and mitochondrial energy deficiency with damage to integrity membranes, and myocardial ischemia due to a decrease in coronary blood flow with a decrease in blood volume and stimulation of coronary vasospasm [11,12]. By the end of the HD procedure, the NUP concentration remained at the level of the middle of the HD (with initial dynamics data of +19.84%), reflecting the persistence of hemodynamic shifts. The concentration of CPK-MB decreased relative to the values achieved during HD, but did not reach the initial values (the dynamics with the initial data was 137.10%), and the concentration of troponin T continued to increase to 867.78% of the initial value. Such multidirectional changes reflect patterns characteristic of markers: CPK-MB is the “fastest” marker, the concentration of which increases from the first minutes of ischemia and also quickly decreases, while the concentration of troponin T increases somewhat delayed and the peak concentration occurs later. Thus, intradialytic dynamics of markers of myocardial condition reflects changes in hemodynamic load and necrosis of cardiomyocytes during the procedure.

According to the conditions of the study, HD with physical activity was carried out after standard HD. At the same time, predialysis data did not differ during both stages of the study, which means that all intradialytic changes in the myocardium observed during the first stage were leveled out by the next HD procedure. Intradialytic physical activity significantly reduced the degree of increase in myocardial markers during HD (Table 2). Moreover, the concentration of NUP and the activity of CPK-MB, increasing by 60-90

minutes of HD (reliably less than against the background of standard HD), at the end of HD with PhE decreased slightly, while against the background of standard HD, the concentration of NUP continued to increase, and the activity of CPK-MB decreased slightly ($p < 0.001$ significance of the difference in the relative dynamics of both indicators between HD and HD with PhE). The concentration of troponin T progressively increased throughout HD with PhE, but the degree of increase was significantly less than during HD ($p < 0.001$ significance of the difference in the relative dynamics of troponin T concentration at both time points against the background of both variants of HD).

The study showed that intradialytic physical activity contributes to a significant reduction in the amplitude of the increase in the concentration of markers of myocardial necrosis and NUP compared with standard HD by the 60-90th minute of HD (+7.66% versus +18.04% for NUP, 87.2% versus +172.8% for CPK-MB and +66.09% versus +263% for troponin T, $p < 0.001$ significance of comparison between HD regimens for all three markers). Also by the end of HD against the background of HD with PhE, there was a decrease in the concentration of NUP and CPK-MB, in contrast to the dynamics with standard HD (+4.17% versus 19.84% and +28.9% versus 137.1%, respectively, $p < 0.001$ significance of the difference between HD modes for both markers). The concentration of troponin T at the end of HD with ES progressively increased, but the relative dynamics were significantly lower than during standard HD (+719.3% versus +867.8%, $p < 0.001$). Our results support the results of the PEDAL RCT study, which suggests widespread introduction of intradialytic loading into the routine HD program [9,10].

Table 1. Intradialytic dynamics of markers of the structural and functional state of the myocardium (in the numerator - absolute values, in the denominator - dynamics relative to the initial data)

Markers	Pre-PH (n=103)	60-90 min PH (n=103)	Post-PH (n=103)
	Absolute values	<u>Absolute values</u> Relative dynamics from the original data, %	<u>Absolute values</u> Relative dynamics from the original data, %
NUP, pg/ml	564,41±31,15	<u>759,85±22,76^{^^^}</u> 18,04±1,07	<u>769,54±22,64^{^^^}</u> 19,84±1,17
CPK-MB, units/l	34,73±1,52	<u>96,87±2,07^{^^^}</u> 172,78±7,20	<u>84,89±2,56^{^^^}</u> 137,10±7,28
Troponin-T, ng/ml	0,28±0,01	<u>0,87±0,01^{^^^}</u> 263,01±15,94	<u>2,25±0,03^{^^^}</u> 867,78±46,79

Note: ^ - reliability of the difference with the original data. Three signs – $p < 0.001$.

Table 2. Intradialytic dynamics of markers of the structural and functional state of the myocardium in patients with CKD5d during HD with PhE

Markers	Pre-PH (n=103)	60-90 min PH (n=103)	Post-PH (n=103)
	Absolute values	Absolute values	
NUP, pg/ml	654,54±23,80	<u>694,15±23,01^{^^^###}</u> 7,65±0,53###	<u>673,03±22,59^{^^^###}</u> 4,17±0,50###
CPK-MB, units/l	39,60±1,50	<u>67,47±1,72^{^^^###}</u> 87,20±6,43###	<u>45,61±2,22^{^^^###}</u> 28,90±7,38###
Troponin-T, ng/ml	0,28±0,01	<u>0,43±0,01^{^^^###}</u> 66,09±3,40###	<u>1,89±0,02^{^^^###}</u> 719,32±39,49###

Note: ^ - reliability of the difference with pre-dialysis data, # - reliability of the difference with the data during standard HD. One sign - $p < 0.05$, two signs - $p < 0.01$, three signs - $p < 0.001$.

4. Conclusions

In conclusion, during the HD procedure, a significant increase in the concentration of markers of myocardial “suffering” is observed. Intradialytic physical exercise helps to reduce markers of myocardial damage in the blood compared to standard HD and may have a preventive effect on cardiomyocytes.

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