CHANGES IN HEMODYNAMIC PARAMETERS UNDER THE INFLUENCE OF PHYSICAL EXERCISES AT DIALYZED PATIENTS

MODIFICAREA PARAMETRILOR HEMODINAMICI SUB INFLUENŢA EXERCIŢIILOR FIZICE, LA PACIENŢII CU HEMODIALIZĂ

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Keywords: chronic hemodialysis, physical training, very high cardiovascular risk, pulse pressure

Abstract

The chronic kidney disease is a public issue of global concern that affects millions of people regardless of ethnicity or race. The coordinated exercise represents an important factor to improve vascular elasticity at some patients (patients with end-stage kidney chronic disease -hemodialysis patients) with very high risk of cardiovascular damage, a risk which is generated by the complexity of their pathology background.

Purpose. Improving the physical effort capacity in chronic hemodialysis patients, following the inclusion of physical training in their lifestyle.

Materials and methods. The study comprise 45 *chronic* hemodialysis patients, with average age of 59.1 years, that followed a physical training program coordinated over a period of three months. The following parameters were analyzed: the systolic blood pressure (SBP), the diastolic blood pressure (DBP), the mean arterial pressure (MAP), the pulse pressure (PP) and the aortic pulse wave velocity (PWVao). These indicators were measured for each patient at the initiation of the physical programme, during the programme, and on completion of three months of physical exercises. **Results:** I have obtained an average weight decrease with -1.9 kg; a significant reduction of PWVao with -0.7m/s; a significant decrese of SBP with -11.5mmHg; a significant decrese of DBP, with -7.3mmHg; a significant reduction of MAP with -8.8mmHg; ; and a significant decrese of PP with -4.5mmHg

Conclusions: The applied physical training program has proven effective in improving the physical effort capacity and reduction the cardiovascular risk for chronic hemodialysis patients.

Cuvinte cheie: hemodializă cronică, antrenament fizic, risc foarte înalt cardiovascular, presiunea pulsului

Rezumat

Boala cronică de rinichi este o problemă publică de interes mondial care afectează milioane de oamenii indiferent de etnie sau rasă. Exerciţiul fizic coordonat reprezintă un factor important de îmbunatatire a elasticităţii vasculare în cazul unor pacienţi (pacienţi cu boală cronică de rinichi în stadiul terminal –pacienţi hemodializaţi) cu risc foarte înalt de afectare cardio-vasculara, risc generat de complexitatea patologiei lor de fond.

Scop. Îmbunătăţirea capacităţii de efort la pacienţi aflaţi în program de hemodializă cronică, în urma includerii antrenamenului fizic în stilul lor de viaţă. **Material şi metodă.** În studiu au fost incluşi 45 de pacienţi aflati în program de hemodializa cronică, cu o vârstă medie de 59,1 ani, care au urmat un program de antrenament fizic coordonat pe o perioadă de 3 luni. S-au analizat următorii parametrii*:* tensiunea arterială: sistolică (TAS), diastolică (TAD), medie (TAM), frecvenţa cardiacă, presiunea pulsului (PP), viteza undei pulsatile aortice (PWVao). Acesti indicatori au fost masurati pentru fiecare pacient, la initierea programului de antrenament, pe parcursul acestuia şi la finalizarea celor 3 luni de exercitii fizice. **Rezultate.** Am obţinut o scădere a greutăţii medii a pacienţilor de -1.9 kg; o diminuare semnificativă a PWVao cu -0.7 m/s; o scădere semnificativă a tensiunii TAS cu -11.5mmHg; o reducere semnificativă a TAD cu -7.3mmHg; o diminuare seminificativă a TAM cu -8.8mmHg; şi o scădere semnificativă a PP cu -4.5mmHg..

Concluzii. Programul de antrenament fizic aplicat şi-a dovedit eficienţa în îmbunătăţirea capacităţii de efort si reducerea riscului cardio-vascular la pacienţii aflati in program de hemodializă cronică.

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Introduction

Hypertension is one of the most common cardiovascular diseases found in patients with chronic renal disease, being one of the leading causes of morbidity and mortality in patients with uremic syndrome.

The pulse pressure, a predictor of the major cardiovascular events that may occur in an individual's existence [1], represents an essential parameter for blood vessels' over time changes induced by tension, deposition of cholesterol and lipid areas of calcification and was assessed in this study with the other tension parameters. [2]

At hemodialysis patients, the increased arterial stiffness is a factor that influences mortality, much more important than in the general population, which was demonstrated by a number of international clinical trials; it seems that these studies speak of an increase of 1.5% in cardiovascular risk for each augmentation of 5 m/s of pulse wave velocity PWV. [3]

The arterial stiffness is assessed objectively by measuring several parameters, one of the most important being the pulse wave velocity (PWV).

Increased arterial stiffness at patients with end-stage chronic kidney disease represents a independent risk factor not only for the cardiovascular disease progression but also for the underlying disease and finally an independent predictive factor of mortality. [4]

The conclusions of the study were anticipated three decades ago in some dialysis centres throughout the world, where it has been attempted application of a temporary physical rehabilitation programmes and exercises for these patients. Despite the satisfactory results , these attempts have not been exploited in therapeutic motion programmes, by which the parameters to improve cardiovascular pathology associated with it and thereby implicitly improving their lifestyle. [5]

In dialysis centres, the specialized medical staff is established in order to encourage patients to improve their physical condition, but apparently these kind of individual exercises are only done in a sporadic way without any based programme that needs to be applied to all patients in dialysis centres. [6]

The innovation and the avant-garde elements of the study regarding the dialysis patients consists in adapting the exercise programme to a group of patients whose muscles show high degree of muscle atrophy, ligament and osteo-articular changes caused by the status of their disease; the muscular response variability and poor coordination, more or less, represented an extra challenge parameter in establishing the type of exercises and in the careful examination of the physical response of patients and their cooperation. [7]

This study tries to meet these requirements as a challenge and as an encouragement in the hope of implementing some generalized programmes in all the dialysis centres.

Purpose:

- *Improving the physical effort capacity in chronic hemodialysis patients, following the inclusion of physical training in their lifestyle.*
- *Tracking the influence of coordinated physical exercises on a patient echelon with a special feature of hemodynamic parameters with very high cardiovascular risk: patients with end-stage chronic kidney disease in chronic hemodialysis programme. In addition, the study was characterized by its unique exercises performed: during the hemodialysis sessions (while patients were connected to the hemodialysis machines).*

The evaluation of the hemodynamic parameters: the systolic blood pressure (SBP), the diastolic blood pressure (DBP), the mean arterial pressure (MAP), the pulse pressure (PP) and the aortic pulse wave velocity (PWVao) was made through a complex and individualized physical exercises programme to improve the cardiovascular status, lasting 3 months and assessed objectively through a suitable standardized machine that measures these parameters.

Material and method

Subjects

The study comprise 45 *chronic* hemodialysis patients, with average age of 59.1 years. Their selection was made according to the inclusion/exclusion criteria and self consent and were monitored by specialist nephrologists. The frequency of the programme was 3 sessions of 50 minutes per week, during conventional hemodialysis over a period of 3 months.

Inclusion criterias: Patients on chronic hemodialysis conventional program (3 sessions/ week) for more than 1 month. Patients who do not have major contraindications for performing a physical exercise for at least 3 times/week. Inclusion in the study was done only after the free consent of each participant in the study, while also respecting their individual rights.

Exclusion criterias: Patients with a physical inability to perform physical exercises. Patients who refused to participate in the study. Patients with co-morbidities associated with the baseline disease that would contraindicate physical effort.

It should be mentioned that 4 patients dropped out during the programme from various subjective and objective reasons (two were undergoing renal transplantation, one moved to another dialysis center and one patient gave up the exercise programme because he couldn't adapt to physical effort).

Means for kinetic intervention

The training programme consisted of a series of aerobic exercises combined with strength and power exercises carefully coordinated and supervised. At each meeting the main aim was to increase the pulse by 15 to 30 beats per minute as a sign of physical effort capacity improvement.

The physical training programme:

Objectives:

- improving physical effort capacity,
- decreasing the cardiovascular risk by changing the hemodynamic parameters,
- decreasing the frequency of intra and interdialytic cardiovascular complications,
- improving the quality of life.

The patients in the study group went through a physical training programme for 3 months during the hemodialysis sessions, as follows:

- physical effort preparation (5 minutes) – warming-up the locomotor system and performing breathing exercises,
- 2 sessions of 20 minutes of moderate exercise each (with 15 minute break between sessions),
- 5 minutes of physical exercise recovery, stretching exercises to reduce neuromuscular excitability at low intensity.
- the training programme consisted of a series of aerobic exercises combined with strength and power exercises carefully coordinated and supervised using small weights (isometric exercises),
- the dosing effort suffered changed regarding the intensity and complexity during the evolution of training, aiming specifically to increase heart rate by 15-30 beats/minute/training session,
- the training programme was conducted at the bedside of the patient using unique commands at all patients within a salon that simultaneously performed the same exercises with differences in the degree of physical effort (with or without the help of sand bags or dumbbells attached to their legs)
- the monitoring of exercise intensity was conducted using the monitors of the dialysis machines which were constantly providing data regarding heart rate and tension.

Assessment

*I*t was used the TensioMed *Arteriograph* device evaluated with a good performance in the assessment of the parameters for which it is realized. The Arteriograph gives us information about the arterial function through pulse wave analysis and measurement of the arterial stiffness. **[8]** All the patients were tested dressed in dorsal position, by applying the sleeve at about the same level as the arm of each study participant. The patients are not allowed to talk, gesticulate or sleep during the measurement. For the initial and final evaluations, the measurements were made at the same time of the day and in the same position. Before the evaluation, the patients needed to respect some standard measures related to relaxation, food, smoking, alcohol. [9]

The statistical analysis was performed using Microsoft Office Excel XP and SPSS v.17 programmes. For the numeric variables we calculated the central tendency and the dispersion indicators and presented them as histograms and line graphs; the differences between the independent variables were analyzed using the ANOVA test, followed by the parametric unpaired-t significance test. The differences between the variables originating from the same patients were analyzed using the paired-t test.

The haemodynamic parameters used in the study were: the systolic blood pressure (SBP), the diastolic blood pressure (DBP), the heart rate, the mean arterial pressure (MAP), the pulse pressure (PP), the aortic pulse wave velocity (PWVao).

The determinations were made following several steps:

- initial measurements were made to all the patients included in the physical programme of the study.
- current monitoring of pulse and blood pressure during training according to which the physical effort was graded.
- the initial measurements were repeated at the end of the 3 months study programme.

Results

Table 1.Weight

Variabile	Average	N	Std. Deviation	The average std. error	$p^{semnif.}$
Weight (kg) *initial*	77.2	45	16.51	2.36	**0.020**
Weight (kg) *final*	75.3	41	16.37	2.34	

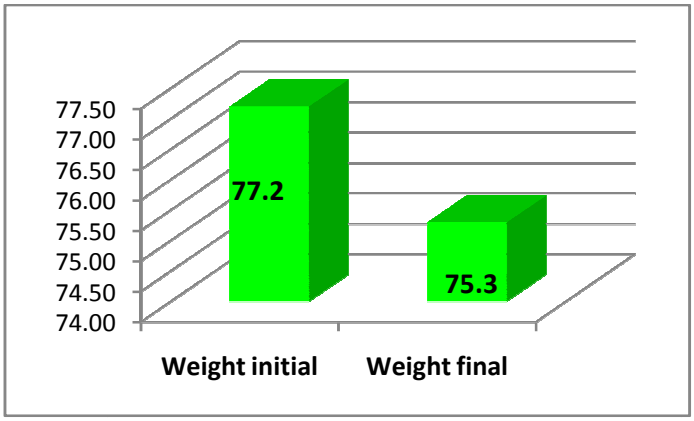

Chart 1. The Weight average value distribution at the initial moment and after 3 months

The Weight has significantly decrease after 3 months of physical training with - 1.9 kg ($p=0.02$, $\alpha=0.05$).

Table 2. The pulse wave velocity

Variabile	Average	N	Std. Deviation	The average std. Error	$p^{semnif.}$
The aortic pulse wave velocity **PWVao** (m/s) *Initial*	10.0	45	1.78	0.25	**<0.001**
The aortic pulse wave velocity **PWVao**(m/s) *Final*	9.3	41	1.61	0.23	

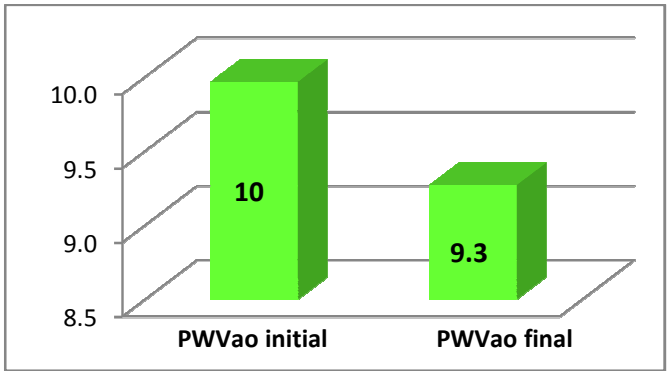

Chart 2. The PWVao average value distribution at the initial moment and after 3 months

The aortic pulse wave velocity (PWVao) has significantly decreases with -0.7 m/s after 3 months of physical training. ($p<0.001$, $\alpha=0.001$).

Table 3. The systolic arterial blood pressure

Variable	Average	N	Std. Deviation	The average std. error	$p^{semnif.}$
Systolic blood pressure **SBP** (mmHg) Initial	147.6	45	17.45	2.49	**<0.001**
Systolic blood pressure **SBP** (mmHg) *Final*	136.1	41	18.14	2.59	

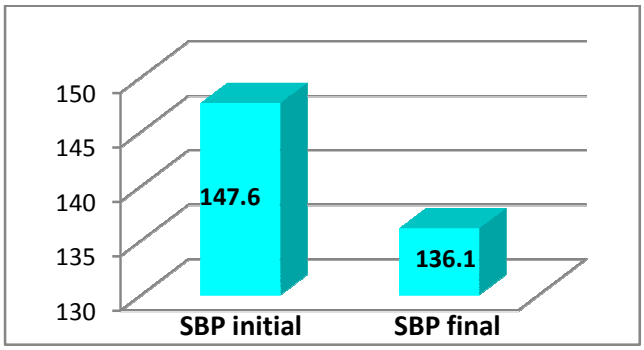

Chart 3. The SBP average value distribution at the initial moment and after 3 months

The systolic blood pressure (SBP) has significantly reduces after 3 months of physical training with -11.5 mmHg. ($p<0.001$, $\alpha=0.001$).

Table 4. The diastolic arterial blood pressure

Variable	Average	N	Std. Deviation	The average std. error	$p^{semnif.}$
Diastolic blood pressure (**DBP**)mmHg *Initial*	91.5	45	14.63	2.09	**<0.001**
Diastolic blood pressure (**DBP**)mmHg *Final*	84.2	41	11.79	1.68	

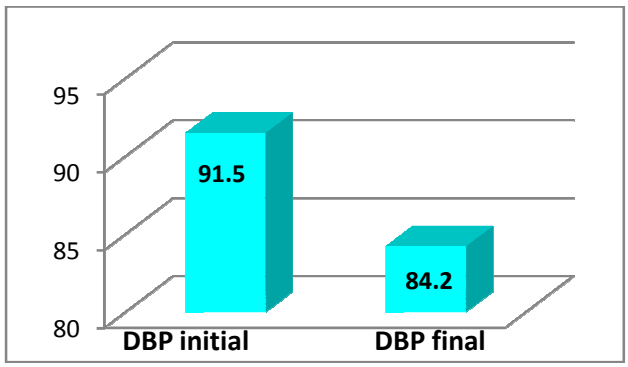

Chart.4 The DBP average value distribution at the initial moment and after 3 months

The diastolic blood pressure(DBP) has significantly *diminish* after 3 months of physical training with -7.3 mmHg. ($p<0.001$, $\alpha=0.001$).

Table 5. Mean arterial pressure

Variable	Average	N	Std. Deviation	The average std. error	$p^{semnif.}$
Mean Arterial Pressure **MAP** mmHg *Initial*	110.3	45	14.51	2.07	**<0.001**
Mean Arterial Pressure **MAP** mmHg *Final*	101.5	41	12.78	1.83	

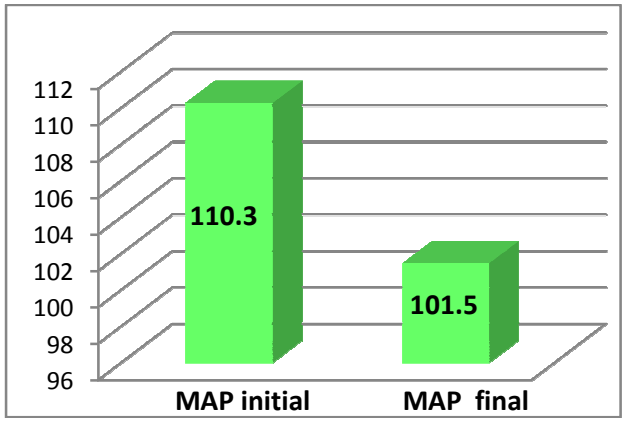

Chart.5 The MAP average value distribution at the initial moment and after 3 months

The *mean arterial pressure* (MAP) has significantly reduces after after 3 months of physical training with -8.8($p<0.001$, $\alpha=0.001$).

Table 6. The pulse pressure

Variable	Average	N	Std. Deviation	The average std. error	$p^{semnif.}$
The Pulse Pressure (**PP**) mmHg *Initial*	56.1	45	11.98	1.71	**0.013**
The Pulse Pressure (**PP**) mmHg *Final*	51.6	41	13.01	1.86	

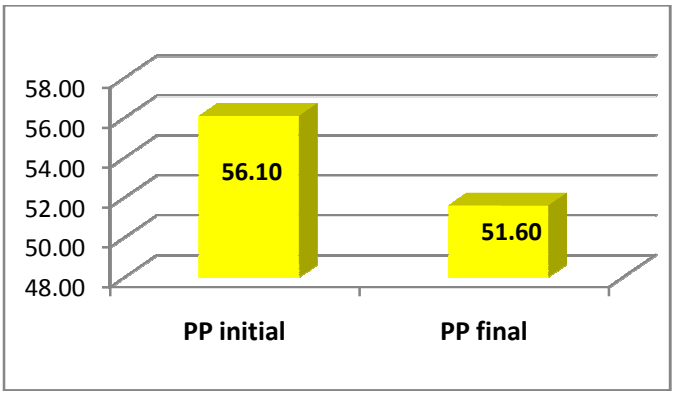

Chart 6. The PP average value distribution at the initial moment and after 3 months

The pulse pressure (PP) has significantly decreases with -4.5 mmHg (p=0.013, α=0.05) after 3 months of physical training.

Discussions

The decrease of the average weight of patients with -1.9 kg showed a lipid deposit combustion during the physical exercises performed, as patients are sedentary in general, due to the complex nature of their disease.

From the 3 tension parameters, SBP, DBP and MAP, the decreases in the absolute value show a SBP of -11.5 mmHg and a MAP of -8.8 mmHg; The DBP, although presenting a decrease of only -7.3 mmHg, represents a marked improvement in this parameter as a result of physical exercises. The DBP is a tension parameter whose decrease is obtained quite hard as it is influenced by a combination of hormonal and neurovegetative factors; The DBP and the PWV together with the PP are important predictors of vascular elasticity. In this context, the PWVao has significantly decreased with -0.7 m/s and the PP also significantly decreased with -4.5 mmHg. [10]

The lack of accidents during the training sessions show that they have been carefully standardized and organized in a complex manner and the response obtained was above expectations.

The exercises represented an emotional impact and also something new for this category of patients whose quality of life is quite low, bringing them not only a hemodynamic improvement, but also an improvement in their physical and emotional state. [11]

The individualized physical exercise programme can be recommended as a non-pharmaceutical therapeutic method in improving cardio-vascular diseases and some parameters specific to the kidney disease at dialyzed patients. [12,13,14]

The novelty of this programme raises a hope and a challenge for the remaining patients from other dialysis centres with the possibility and proposal of introducing in the functioning of these dialysis centres such programs under the supervision of specialist individuals. If dialysis centers would implement the physical exercise as a therapeutic measure, a new way for a uniform coordinated and evaluated programme in relation to the evolution of dialyzed patients might open.

Conclusions

The applied physical training program has proven effective in improving the physical effort capacity and reduction the cardiovascular risk for chronic hemodialysis patients.

The encouraging results of the tension parameters (SBP, DBP, MAP) and of the vascular elasticity predictors PWVao and PP at patients on dialysis (with a very high risk of cardiovascular disease) demonstrates the complex importance of physical exercises even if the hemodynamic parameters are profoundly altered for example at patients with end-stage chronic kidney disease.

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