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Nutrition and hydration status improve with exercise training using stationary cycling during hemodialysis (HD) in patients with end-stage renal disease (ESRD)

Patients with end-stage renal disease (ESRD) undergoing hemodialysis and peritioneal dialysis are functionally limited as a consequence of their physical, emotional, and social problems (2, 3, 4). Many factors contribute to functional limitation in ESRD patients. These are: anemia, uremic toxicity, calcium-phosphate inbalance, muscle dysfunction, and many others. On the other hand, the main reason of deconditioning status is the problem of inactivity (6, 7). Some rehabilitation programs such as Renal Exercise Demonstration Projects reported that exercise training improved both physical performance measures and self-reported physical functioning (10). As has been reported in several studies exercise training is possible "on dialysis", and gives benefits similar to training "off dialysis" (1, 9, 11).

The present study describes the effect of cycling exercises in 10 HD patients during 6-month period (including each of dialysis session) on nutrition, dialysis adequacy, and fluid parameters as measured by biochemical, and bioimpedance parameters.

MATERIAL AND METHODS

Patients and exercise setup. 10 patients pedalled for about 30 min. during the first hour of each hemodialysis treatment during 6-month period. Standard bicarbonate dialysis was delivered by dialysis machines with volumetric control. All treatments were performed using polysulfone capillary dialyzers (F5, F6 Fresenius Medical Care, Germany) with surface area of 1.2 to 1.4 m^2. Medications were not adjusted during these studies. All patients had given informed consent to participate in the study.

B i o i m p e d a n c e. Whole body bioimpedance was measured for a spectrum of frequencies ranging from 5 to 500 kHz (Hydra 4200 Analyzer, supplied by Xitron Technologies Inc., San Diego, CA). Electrodes were placed on the wrist and on the ankle on the contra-lateral access side of the patient for the whole body bioimpedance measurement as described elsewhere (12). Data were collected at the pre-dialysis time, and at the end of each dialysis session. The software supplied with the device was used to fit the impedance data to an electrical model to obtain the value of total body water (TBW) and extracellular water (ECW) volumes.

B i o c h e m i c a l p a r a m e t e r s. Routine serum biochemical parameters such as hemoglobin, C-reactive protein, total protein and albumin concentration have been measured in comparison to urea kinetic modelling parameters of dialysis adequacy including Kt/V, and normalized protein catabolic rates (nPCR) at the time: before and after 6 months of regular cycling exercise during hemodialysis.

S t a t i s t i c a l a n a l y s i s. Data are presented as mean±standard deviation (SD). Differences between groups were estimated by means of Pearson's product-moment correlations and probability (P) <0.05 was assumed to reject the null hypothesis. The Statistical analysis was performed using SPSS\PC for Windows, version 9.0.

RESULTS

Patients (N=10) and treatment (before study versus time 6 months following the start of the exercise) characteristics are summarized in Table 1. The results of biochemical serum parameters in comparison to urea kinetic modelling data, and TBW and ECW as measured by BIS analysis data are presented in Table 2.

Table 1. Patients and treatment characteristics at the time; before, and after 6 months of the regular cycling exercise. The mean value ± SD and P value

Unit	Pre exercise period	After 6 months of exercise	P value
Treatment time (hr)	4.05±0.2	4.1±0.3	NS
UFV [L]	3.1±0.3	3.2±0.4	NS
Weight pre HD (kg)	63.41±13.2	62.40±12.6	0.046
Δ Weight (pre-post HD)	2.79±0.77	2.94±0.77	NS
Body mass index	23.90±4.41	23.57±4.26	NS

Table 2. Serum biochemical and bioimpedance (BIS) data at the time; before, and after 6 months of the regular cycling exercise. TBW – total body water, ECW – extracelullar compartment water. The mean value ± SD and P value

Unit	Pre exercise period	After 6 months of exercise	P value
pre HD Hb [g/dL]	4.05±0.2	4.1±0.3	NS
pre HD Albumin [g/dL]	3.88±0.29	4.06±0.3	0.024
pre HD CRP [mg/dL]	4.37±1.04	3.65±1.08	0.046
nPCR [g/kg/day]	0.98±0.16	1.03±0.16	0.001
Kt/V	1.03±0.27	1.20±0.28	0.026
Δ TBW (pre-post HD) [L]	2.98±1.80	2.74±2.06	NS
Δ ECV (pre-post HD) [L]	2.46±1.24	2.64±1.03	0.025
Δ ECV/TBW (pre-post HD)	0.98±0.45	1.30±0.63	0.047

We observed a significant increase of serum albumin concentration, higher Kt/V, and nPCR after 6 months of regular stationary cycling during hemodialysis. It is very interesting that serum level of C-reactive protein decreased after 6 months of study and this correlation has been also noted as statistically significant (p=0.046, Table 2).

Relative changes (pre-post HD) in extracellular water compartment and ECW/TBW ratio as measured before study have significantly increased in comparison to values after 6 months of observation period.

DISCUSSION

The basic finding of the present study is that a regular, long-term exercise such as stationary cycling during hemodialysis makes potential improve in nutrition and dialysis adequacy in hemodialyzed patients population. Many previous studies showed that exercise training improves exercise capacity, blood pressure, and mood for some patients with end-stage renal disease (2, 4, 6, 10, 11). The Renal Exercise Demonstration Project reported that exercise counselling increased participation in physical activity and improved both physical performance measures and also self-reported physical functioning. Moore et el. investigated cardiovascular response to submaximal stationary cycling during hemodialysis. They concluded that the cardiovascular exercise response is superimposed on hemodynamic effects of dialysis and is adequately stable during the first 2 hours of treatment (5). We performed our exercise during the first hour of each hemodialysis session to eliminate potential cardiovascular decompensation. We noted based on bioimpedance analysis of body watèr compartment such as changes in extracellular compartment and in total body water compartment that patients after 6 months of regular cycling exercise on stationary ergometer are less hydrated.

Conclusion: we support the recommendation of regular exercise training using stationary cycling during hemodialysis session which should be done during the first hour of treatment.

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SUMMARY

Patients with end-stage renal disease (ESRD) undergoing hemodialysis and peritoneal dialysis are functionally limited as a consequence of their physical, emotional, and social problems. Exercise intolerance is a major problem in chronic renal failure. Stationary cycle training during hemodialysis is recommended as safe, effective, and practical in ESRD patients treated on hemodialysis. The aim of the present study was to evaluate the effect of cycling exercises in 10 HD patients during 6-month period (including each of dialysis sessions) on nutrition, dialysis adequacy, and fluid parameters as measured by biochemical, and bioimpedance parameters. A significant increase in serum albumin concentration, Kt/V, and nPCR, and decrease in serum CRP have been observed after 6 months of regular stationary cycling during hemodialysis. Relative changes (pre-post HD) in extracellular water compartment and ECW/TBW ratio have significantly increased after 6 months of observation period.

Wpływ regularnych ćwiczeń na rowerze stacjonarnym w czasie dializy na poprawę stanu odżywienia oraz nawodnienia pacjentów leczonych hemodializami z powodu schyłkowej niewydolności nerek

Prawidłowe funkcjonowanie pacjentów ze schyłkową niewydolnością nerek, leczonych za pomocą hemodializ oraz dializy otrzewnowej, jest ograniczone poprzez problemy związane z aktywnością fizyczną, a także problemy emocjonalne oraz socjalne. Ograniczenie tolerancji wysiłku jest istotnym problemem w niewydolności nerek. Zastosowanie ćwiczeń na rowerze stacjonarnym w czasie dializy jest polecane jako łatwy, efektywny oraz praktyczny sposób ćwiczeń fizycznych. Celem naszego badania było określenie wpływu 6-miesięcznego cyklu regularnych ćwiczeń na ergometrze rowerowym w czasie dializy na parametry stanu odżywienia, adekwatności dializy oraz wielkości przestrzeni wodnych mierzonych przy użyciu wskaźników biochemicznych oraz techniki bioimpedancji elektrycznej. Stwierdzono istotny statystycznie wzrost poziomu albumin w osoczu, wskaźników adekwatności dializy Kt/V oraz nPCR, natomiast obniżenie stężenia w osoczu CRP po 6 miesiącach regularnych ćwiczeń na ergometrze rowerowym. Mierzone za pomocą bioimpedancji elektrycznej zmiany wielkości przestrzeni pozakomórkowej (ECW) oraz wskaźnika ECW/TBW istotnie wzrosły po 6 miesiącach regularnych ćwiczeń.