Original Article

The Effect of Intradialysis Resistance Training on Quality of Life and Physical Activity of End-Stage Chronic Renal Failure Patients Hemodialysis

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ABSTRACT

Introduction: Patients with Chronic Kidney Failure have a decreased ability to excrete metabolic wastes. Metabolic wastes that accumulate in the musculoskeletal system are called uremic myopathy. Uremic myopathy is characterized by an increase in muscle protein catabolism which results in a decrease in contractility and muscle mass which causes the patient to tire easily and triggers sedentary behavior and reduces physical activity and quality of life.

Objective: The purpose of this study was to determine the effect of intradialysis resistance exercise on quality of life and level of physical activity in end-stage chronic kidney disease patients undergoing hemodialysis 2 times per week.

Methods: Thirty-nine subjects receive low-intensity resistance exercise for 2 sets of 15 repetitions. Progression of exercise is done by increasing the volume of exercise. Exercises are carried out twice a week for 24 training sessions under the supervision in the hospital. The examination was carried out before and after 24 training sessions including filling out the KDQOL (Kidney Disease and Quality of Life) and IPAQ (International Physical Activity Questionnaire) questionnaires. Statistical analysis using t-test and sign-test

Results: The results showed significant changes in all the variables studied, KDQOL score (p=0.00) and the level of physical activity (p=0.00). The average KDQOL scores before and after exercise were 166.67 and 243.16. Twenty-five research subjects has increased in physical activity level, and fourteen research subjects did not increase in physical activity level

Conclusion: Intradialysis resistance exercise improves quality of life and physical activity level of end-stage chronic kidney disease patients undergoing hemodialysis 2 times per week

Keywords: Chronic kidney disease, hemodialysis, physical activity, quality of life, resistance training

ABSTRAK

Pendahuluan: Pasien Gagal Ginjal Kronis mengalami penurunan kemampuan untuk mengeluarkan zat sisa metabolisme. Zat sisa metabolisme yang menumpuk pada sistem musculoskeletal dinamakan miopati uremikum. Miopati uremikum ditandai dengan adanya peningkatan katabolisme protein otot yang mengakibatkan penurunan kontraktilitas dan massa otot yang menyebabkan pasien mudah lelah dan memicu perilaku sedenter dan menurunkan aktivitas fisik serta kualitas hidup.

Tujuan: Tujuan penelitian ini untuk mengetahui pengaruh latihan resistensi intradialisis terhadap kualitas hidup dan tingkat aktivitas fisik pada pasien penyakit ginjal kronis tahap akhir yang menjalani hemodialisis 2 kali per minggu

Metode: Tiga puluh sembilan subjek dilakukan intervensi latihan resistensi intensitas rendah sebanyak 2 set 15 repetisi. Progresi latihan dilakukan dengan meningkatkan volume latihan. Latihan dilakukan dua kali seminggu sebanyak 24 sesi latihan dalam pengawasan tenaga ahli di Rumah Sakit. Pemeriksaan dilakukan sebelum dan setelah 24 sesi latihan meliputi pengisian kuisioner KDQOL (Kidney Disease and Quality of Life) dan IPAQ (International Physical Activity Questionnaire). Analisis statistic menggunakan t-test dan sign-test

Hasil: Hasil penelitian menunjukkan perubahan yang bermakna pada semua variabel yang diteliti yaitu skor KDQOL (p=0,00) dan tingkat aktivitas fisik (p=0,00). Rata-rata skor KDQOL sebelum dan setelah latihan yaitu 166.67 dan 243.16. Dua puluh lima subjek penelitian mengalami peningkatan aktivitas fisik, dan empat belas subjek penelitian tidak mengalami peningkatan aktivitas fisik.

Kesimpulan: Latihan resistensi intradialisis meningkatkan kualitas hidup dan level aktivitas fisik pasien penyakit ginjal kronis tahap akhir yang menjalani hemodialisis 2 kali per minggu.

Kata Kunci: Aktivitas Fisik, Hemodialisis, Kualitas Hidup, Latihan Resistensi, Penyakit gagal ginjal kronis

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INTRODUCTION

Physical activity in end-stage chronic renal failure patients on hemodialysis (CKD5D) is lower compared to healthy individuals.[1] The prevalence of sedentary behavior in the CKD patient population is almost twice that of the normal population.[2] Inactivity in CKD patients is caused by many symptoms that make patients uncomfortable, such as fatigue, pain, and depression. Sedentary behavior in CKD patients is associated with an increased risk of mortality.[3] Sedentary CKD5D patients undergoing hemodialysis have a 62% higher risk of death compared to non-sedentary patients.1 End-Stage Renal Disease (ESRD) is a global health problem with increasing prevalence and incidence. Based on RISKESDAS data, the prevalence of CKD5D in Indonesia increased from 0.2% in 2013 to 0.38% in

2018. West Java is the province with the highest number of CKD5D patients in Indonesia.[4,5]

CKD5D patients have a decreased ability to excrete metabolic waste. The accumulation of toxins and urea causes changes in mitochondrial function and morphology, resulting in increased production of reactive oxygen species (ROS) and inflammatory factors. This leads to uremic myopathy, which is characterized by increased muscle protein catabolism and decreased contractility and muscle mass. Uremic myopathy occurs in 75% of CKD5D patients undergoing hemodialysis. This causes the patient's muscles to fatigue easily, triggering sedentary behavior and decreasing the patient's daily physical activity level. Decreased physical activity is associated with an increased risk of mortality in CKD5D patients.[6]

Resistance training has been shown to increase mitochondrial number and function, reduce ROS, improve muscle perfusion, and change muscle fiber type. This can improve the patient's muscle endurance and physical performance. To optimize the effectiveness of resistance training, the principle of exercise specificity should be tailored to individual training goals. Resistance training to improve muscle endurance can be achieved with high-repetition exercises of 10-25 repetitions with minimal rest time between sets. The recommended rest time is 1-2 minutes for 15-20 repetitions, and 1 minute for 10-15 repetitions. The changes that occur as a result of resistance training include increased function and number of mitochondria and capillary blood vessels, as well as the transition of muscle fiber types.[7]

Resistance training in the CKD5D population can be performed intradialysis or interdialysis. Intradialysis exercise has a higher compliance and participation rate than interdialysis exercise. However, intradialysis resistance training currently lacks a standardized protocol. Most studies primarily involve the muscles of the lower extremities. Intradialysis resistance training specific to muscle endurance with a protocol involving the upper extremities has not been previously studied. The aim of this study was to determine the effect of intradialysis resistance training on quality of life and physical activity in CKD5D patients undergoing twice-weekly hemodialysis.

METHODS

This study employed a quasi-experimental design with a pre-test and post-test approach. The study population comprised End-Stage Chronic Kidney Disease (ESRD) patients undergoing hemodialysis at the Hemodialysis Unit of Hasan Sadikin Hospital, Bandung. The ethics committee of the participating research institution, Faculty of Medicine, Padjadjaran University, approved this study. The inclusion criteria for all patients are shown in Table 1, and a total of 39 patients who met the criteria were included in this study.

The intervention consisted of low-intensity intradialysis resistance training for 12 weeks. Exercises were performed twice a week, consisting of 2-3 sets with 15-20 repetitions per set. Exercise movements included hip flexor, hip extensor, hip abductor, hip external rotator, knee flexor, knee extensor, ankle plantar flexor, ankle dorsiflexor, shoulder flexor, shoulder extensor, elbow flexor, and elbow extensor. Measurement of the main variables was conducted before and after the 12-week intervention. Quality of life was measured using the Kidney Disease Quality of Life Short Form (KDQOL-SF) questionnaire, while physical activity was assessed using the International Physical Activity Questionnaire (IPAQ). Measurements were taken one hour after the hemodialysis procedure.

Data analysis utilized paired t-tests for normally distributed data and sign tests for non-normally distributed data. A probability level of $p < 0.05$ was considered statistically significant.

Table 1. Inclusion and exclusion criteria for study subjects

Inclusion criteria
• Age 18 - 59 years • Have a history of CKD5D undergoing HD 2 times per week. • Have been on HD for > 3 months • Capable of understanding verbal and written instructions (MMSE scoring ≥ 24) • Not having moderate and severe depressive disorder (Hamilton • Depression Rating Scale < 25) • Patients were cooperative, willing to participate in the study, and able to do the exercise by signing informed consent • Can walk in their community without assistive devices
Exclusion criteria
• Patients with contraindications to resistance training • Patients with a structured physical exercise program in the last 6 months • Patients with weekly physical activity IPAQ Score in the high category • Using HD access via catheter via femoral vein • Has a hemoglobin level < 8 g/dl in the past month • Have unstable/uncontrolled cardiovascular disease • Blood pressure ≥ 180/110 mmHg • Patients with a structured physical exercise program in the past 6 months • Have musculoskeletal disorders that prevent them from following the exercise procedures or measuring the study variables • Have neuromuscular disease • Patients with weekly physical activity IPAQ scores in the high category

RESULT

Out of 46 patients who met the inclusion criteria, 39 patients successfully completed the exercise program. Table 2 shows the demographic characteristics, with slightly more female patients (53.85%) than male patients (46.15%), and the majority of patients in the 36-45 year age group (46.15%). Medical characteristics revealed that most patients (74.36%) had hemoglobin levels between 8.0-9.9 g/dL, indicating mild to moderate anemia. The majority of patients (45.71%) had been on hemodialysis for 1-4 years, suggesting sufficient experience with long-term therapy. Notably, physical activity levels in the majority of patients (84.21%) were low, reflecting the challenges hemodialysis patients face in maintaining an active lifestyle. This profile provides important context for understanding the characteristics of the studied population and its implications for the management of chronic renal failure patients undergoing hemodialysis.

Table 2. Demographic and Medical Characteristics of the Sample Studies

Types of Characteristics	Description	Category	Frequency (n=39)	Presence
Demographics	Gender	Male	18	46.15%
		Female	21	53.85%
	Age	18 - 25	3	7.69%
		26 - 35	12	30.77%
		36 - 45	18	46.15%
		46 - 59	6	15.38%
Medical	Hb	8.0 - 9.9	29	74.36 %
		10.0 - 12	10	25.64 %
	Duration of hemodialysis	3 month - < 1 years	4	11.43 %
		1 - 4 years	16	45.71 %
		5 - 10 years	12	34.29 %
		>10 years	7	20%
	Physical activity level	Low	33	84.21%
		Moderate	6	15.79%

Table 3. Results of Comparison Effects in Intradialysis Resistance Training on Quality of Life Before and After Exercise for 12 weeks

Variable (n=39)	Pre Exercise	Post Exercise	Difference	P value
KDQOL Score	166.6786	243.1620	76.48344	0.000*

Description: t-test. * indicates statistically significant

Table 4. Comparative Results Effects of Intradialysis Resistance Exercise on Quality of Life Components (PCS, MCS, KDCS) Before and After Exercise

Variable (n=39)	Pre Exercise	Post Exercise	Difference	P value
PCS Score	49.6765	83.1571	33.47756	0.000*
MCS Score	54.7788	86.7479	31.96902	0.000*
KDCS Score	62.2203	73.2571	11.03686	0.000*

Description: t-test. * indicates statistically significant
PCS: Physical component score; MCS: Mental component score; KDCS: Kidney disease component score

Tables 3 and 4 demonstrate significant improvements in patients' quality of life after the 12-week intradialysis resistance exercise program. The total KDQOL score increased substantially from 166.6786 to 243.1620, with a mean difference of 76.48344 points ($p<0.000$). This improvement occurred across all measured quality of life components. The Physical Component Summary (PCS) score increased from 49.6765 to 83.1571 (difference 33.47756, $p<0.000$), indicating significant improvements in physical aspects of quality of life. The Mental Component Summary (MCS) also increased from 54.7788 to 86.7479 (difference 31.96902, $p<0.000$), suggesting an improvement in patients' mental well-being. The Kidney Disease Component Summary (KDCS) increased from 62.2203 to 73.2571 (difference 11.03686, $p<0.000$), indicating improvement in aspects specifically related to kidney disease. This consistent and statistically significant improvement across all components confirms the effectiveness of intradialysis resistance exercise in improving overall quality of life in chronic renal failure patients on hemodialysis.

Table 5. Effects of Intradialysis Resistance Training on Physical Activity Levels Before and After 12 Weeks of Exercise

Activity Condition	Pre Exercise	Post Exercise	Number of Patients	Total Patients	P value
Patients with no change in activity level	Low	Low	11	14	0.000*
	Moderate	Moderate	3		
Patients with increased activity levels	Low	Moderate	16	25	0.000*
	Low	High	6		
	Moderate	High	3		
Patients with decreased activity levels	High	Moderate	0	0	0.000*
	High	Low	0		
	Moderate	Low	0		

Description: t-test. * indicates statistically significant

(Table 5) indicates a significant positive change in patients' physical activity levels after the intradialysis resistance exercise program. Out of 39 patients, the majority (25 patients) experienced an increase in physical activity level. Among them, 16 patients improved from low to moderate activity level, 6 patients from low to high, and 3 patients from moderate to high. Meanwhile, 14 patients had no change in activity level, with 11 patients remaining at a low level and 3 patients at a moderate level. Importantly, no patient experienced a decrease in physical activity level. Statistical analysis using the sign test showed that these changes were statistically significant ($p<0.000$).

These findings indicate that the intradialysis resistance exercise program was effective in increasing physical activity levels in the majority of patients, which could have a positive impact on their overall health and quality of life.

DISCUSSION

The baseline characteristics of the study subjects demonstrate a fairly representative distribution of the hemodialysis patient population in Indonesia. 53.85% of the subjects were female, slightly higher than the data from the Indonesian Renal Registry in 2018, which reported 43% of hemodialysis patients as female. The largest age group was in the 36-45 year range (46.15%), which aligns with national data showing the 45-54 year age group as the most prevalent among hemodialysis patients.[5] The majority of subjects (74.36%) had hemoglobin levels <10 g/dL, consistent with the Indonesian Renal Registry report indicating that most hemodialysis patients have hemoglobin levels below 10 g/dL. This distribution suggests that the study sample adequately represents the target population, despite slight variations in gender proportions.[5]

Regarding physical activity, most subjects (84.21%) were in the low physical activity category before the intervention. This is consistent with previous research findings showing that hemodialysis patients tend to have lower physical activity levels compared to the general population. Interestingly, this study found no significant differences in physical activity levels based on gender, which is consistent with the findings of Kim et al. (2014).[8] However, there were discrepancies with previous literature regarding the influence of age on physical activity. While Kim et al. reported a decrease in physical activity with increasing age, Wong et al. found no significant relationship between age and physical activity levels in hemodialysis patients.[8,9]

This study demonstrates that a 12-week low-intensity intradialytic resistance training program significantly improves the quality of life and physical activity levels of patients with chronic kidney disease undergoing hemodialysis. Significant improvements were observed in the total KDQOL score and its components - Physical Component Score (PCS), Mental Component Score (MCS), and Kidney Disease Component Score (KDCS) - after the exercise intervention. These findings align with several previous studies that also reported enhanced quality of life following resistance training programs in hemodialysis patients. Research by Song et al. (2012) and Martins do Valle et al. (2020) showed similar results with significant increases in KDQOL scores after 12 weeks of intradialytic resistance training.[10,11]

The improvement in PCS indicates enhanced functional capacity in patients. This is crucial as PCS can be a predictor of survival in dialysis patients. DeOreo's (1997) study suggested that a 5-point increase in PCS correlates with a 10% increase in patient survival probability. In this study, the average PCS increase was 33.44 points, suggesting a potentially significant improvement in survival rates.[12]

The MCS component also showed significant improvement, reflecting enhancements in patients' emotional aspects, social function, energy levels, and fatigue. This is supported by Arazi et al.'s (2020) research, which found that resistance training can increase serotonin and dopamine levels, playing crucial roles in motivation and feelings of pleasure. Increased social interaction during training sessions may also contribute to MCS improvement.[13] A significant increase in patients' physical activity was also observed, with 25 out of 39 subjects experiencing increased physical activity levels based on the IPAQ questionnaire. This result is consistent with Chen et al.'s (2010) study, which also found increased physical activity following six months of intradialytic resistance training. The improvement in muscle strength due to resistance training likely enables patients to perform more daily physical activities without excessive fatigue.[14]

However, it should be noted that 14 (35.8%) subjects did not experience an increase in physical activity levels. This may be influenced by factors such as socioeconomic status, persistent fatigue or depression symptoms, and patients' understanding and adherence to recommendations for increasing physical activity outside training sessions. Further research is needed to identify factors influencing individual responses to the exercise program.[15]

The high safety profile and adherence rate in this study (39 out of 46 subjects completed the program) suggest that low-intensity intradialytic resistance training can be a viable intervention option for ESRD patients. This is supported by Bennett et al.'s (2020) study, which also found a high adherence rate (77%) in an intradialytic resistance training program.[16] While the results of this study are promising, there are several limitations, such as the absence of a control group, a wide age range of subjects, and a relatively short study period (3 months). Further research with randomized controlled trial designs, age stratification, and longer follow-up periods is necessary to strengthen these findings and assess the long-term effects of the intervention.

Overall, this study provides robust evidence for the benefits of low-intensity intradialytic resistance training in improving the quality of life and physical activity of hemodialysis patients. These findings have significant implications for clinical practice, suggesting that such exercise programs can be integrated as part of comprehensive care for chronic kidney disease patients undergoing hemodialysis.

CONCLUSION

Low-intensity intradialytic resistance training conducted over 12 weeks has proven effective in improving the quality of life and physical activity of end-stage renal disease (ESRD) patients undergoing hemodialysis twice a week. There were significant increases in the total KDQOL score and its components (PCS, MCS, and KDCS), indicating comprehensive improvements in physical, mental, and kidney disease-specific aspects. The majority of study subjects also demonstrated increased levels of physical activity after completing the exercise program. High adherence rates and the absence of serious side effects indicate that this intervention is safe and well-tolerated by hemodialysis patients.

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