



Original Article

# Effects of exercise therapy during dialysis for elderly patients undergoing maintenance dialysis

YUSUKE CHIGIRA, PT<sup>1</sup>\*, TAKAHIRO ODA, PT<sup>2</sup>), MASATAKA IZUMI, PT<sup>2</sup>), TUKASA YOSHIMURA, ME<sup>2</sup>)

<sup>1)</sup> Department of Physical Therapy, Faculty of Health Science, Takasaki University of Health and Welfare: 501 Nakaoorui, Takasakisi, Gunma 370-0033, Japan

<sup>2)</sup> Kanetsu Central Hospital, Japan

**Abstract.** [Purpose] Exercise therapy during dialysis is currently being recommended since it is easy for patients to follow and results in high participation rates. In this study, this therapy was performed for elderly patients undergoing maintenance dialysis, and its effects were examined. [Subjects and Methods] Seven elderly patients (age: 70.6 ± 4.4) with chronic renal failure, who were able to perform exercises during maintenance dialysis, received the exercise therapy 2 or 3 times weekly for 3 months. Lower-limb muscle strength as well as the standardized dialysis dose (Kt/V) was measured before and after intervention. The patients were also evaluated using the 30-sec chair stand test (CS-30), the World Health Organization QOL Assessment 26 (WHO-QOL26), and a questionnaire. [Results] The lower-limb muscle strength and circumference, CS-30 score, and Kt/V values improved after intervention, but the difference was not significant. Significant differences were observed only in the WHO-QOL26 score. [Conclusion] The outcome was particularly favorable in terms of the quality of life (QOL). Based on the results from the questionnaire, the higher QOL may be due to the patients' development of a positive attitude toward these activities. Although there were no significant differences, the values for the other criteria also improved, thereby supporting the effectiveness of exercise therapy to maintain or improve the patients' motor functions and activity daily living (ADL) ability.

**Key words:** Physical therapy, Maintenance dialysis, Exercise therapy during dialysis

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## INTRODUCTION

In recent years, advancements in dialysis technology have enabled dialysis patients to receive long-term treatment. Although the elderly population is increasing, the number of patients with chronic diseases is declining. However, the number of elderly patients undergoing maintenance dialysis as well as the number of patients who require assistance with activities of daily living (ADL) due to a decline in physical function is increasing. Therefore, renal rehabilitation has been proposed as a new method to address these issues<sup>1</sup>.

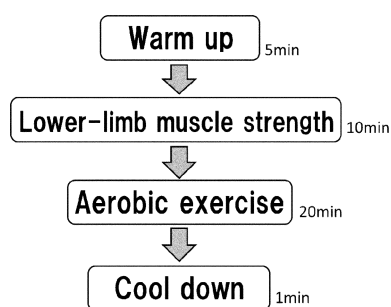
Renal rehabilitation aims to alleviate symptoms, maintain/promote physical fitness and health, reduce mental burdens, and improve the quality of life (QOL). This is implemented through exercise therapy, which has been shown to be effective in improving patient exercise tolerance and QOL<sup>2</sup>). The Clinical Practice Guidelines for Cardiovascular Disease in Dialysis Patients emphasizes that dialysis staff should make effort to increase the level of exercise for all patients<sup>3</sup>).

In this study, elderly patients undergoing maintenance dialysis, who had difficulty in developing exercise habits, received exercise therapy during dialysis for 3 months. Their muscle strength, motor functions, QOL as well as dialysis efficiency was evaluated before and after the intervention.

\*Corresponding author. Yusuke Chigira (E-mail: chigira@takasaki-u.ac.jp)

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**Fig. 1.** Protocol for exercise therapy during dialysis

## SUBJECTS AND METHODS

Seven elderly patients (age:  $70.6 \pm 4.4$ ) with chronic renal failure, who were able to perform exercise during maintenance dialysis, were given exercise therapy intervention 2 or 3 times weekly for 3 months. Those with severe cardiac failure or infections were excluded. The intervention consisted of lower-limb muscle strength training using the Thera Band and in-bed pedaling for aerobic exercise (Fig. 1).

Overall, the dialysis patients' vital signs stabilized within 30 minutes to 2 hours after the initiation of dialysis. To avoid hypotensive responses, it was necessary to limit the exercise period to the first half of each dialysis session<sup>4</sup>). The exercise therapy session was initiated 1 hour after the start of a dialysis session and was followed by the assessment of systemic conditions. The duration of the exercises during each session was approximately 40 minutes. It has been reported that, in the case of patients with renal failure, the target heart rate (HR) at the peak of exercise should be set at 75% of the estimated maximum HR for each age group or lower<sup>5</sup>). Therefore, the target pulse rate was calculated using the Karvonen method with the following formula:  $(\text{maximum HR} - \text{rest HR}) \times 0.6 + \text{rest HR}$ . Furthermore, the exercise intensity level based on the Borg Scale was set between 11 and 13 for management. During exercise, the activities were performed following this order: warm up exercises (ankle flexion/dorsiflexion and followed by 10 repetitions of stepping); lower-limb muscle strength training using the Thera Band (leg lifts, single leg raise, and hip abduction in bed for approximately 10 minutes); aerobic exercise (in-bed pedaling using the Room March device for 20 minutes); and cool down exercises (range-of-motion training, such as hip flexion, single leg raise, and ankle dorsiflexion for approximately 1 minute). Since guidelines on evidence-based exercise therapy for patients with renal impairment are not available, criteria for the discontinuation of intervention are usually based on those for patients with cardiac diseases<sup>6</sup>); these criteria were used to this study.

Lower-limb muscle strength, CS-30 test results, and WHO-QOL26 scores were examined. Dialysis efficiency was evaluated by measuring the standardized dialysis dose (Kt/V) before and after the intervention.

Lower-limb muscle strength was measured using a hand-held dynamometer (Mobie MT-100, SAKAI Medical Co., Ltd.). The patients adopted a sitting position with a knee flexion angle of 90 degrees and then extended their knees on the dominant side to measure their muscle strength during isometric contraction. Measurements were performed twice, and the maximum value was chosen and divided by the weight (N/kg) to determine the quadriceps maximal voluntary contraction force (QMVC)<sup>7</sup>).

The CS-30 test is used to measure the standing frequency from a chair within a 30-second period. Based on the method by Nakatani et al.<sup>8</sup>), the patients were instructed to stand from a 40-cm-high armless platform with their arms crossed in front of their bodies to prevent reaction forces.

The WHO-QOL26 was used to assess the patients' QOL. This scale, in which higher scores indicate improvements in the QOL, consists of 26 questions from 5 domains: physical health, psychological, social relationships, environment, and overall. The total score is divided by the number of questions to calculate the mean QOL score. This scale was used to compare values between patients and healthy individuals, and is standardized by the data of the latter, which represents the general public<sup>9</sup>).

Values for Kt/V, which were evaluated during the initial dialysis session and 3 months after the intervention, are a measure of clearance per dialysis session factored by the patient's body size. A Kt/V value of 1.4 or higher is desirable, with 1.2 as the minimum value. A Kt/V value of 2 indicates that the total blood volume has been dialyzed. The higher the Kt/V value, the lower the mortality rate<sup>10</sup>).

The Wilcoxon's signed-rank sum test was used to examine changes in values after intervention. The significance level was set at 5%. For statistical analysis, SPSS for Windows (Statistics 22.0, IBM, USA) was used. The study was conducted in accordance with the Helsinki Declaration. The ethics committee at Kanetsu Central Hospital approved all study protocols (approval no. 201548), and written informed consent was obtained from all subjects.

**Table 1.** Effect of exercise therapy during dialysis

Patients, n (male/female)	7 (5/2)		
Age (years)	70.6 ± 4.4		
Body mass index	19.7 ± 2.2		
Dialysis history (years)	9.1 ± 6.5		
	Before	After	Effect size ( $\Delta$ )
QMVC (N/kg)	2.8 ± 0.9	3.2 ± 0.9	0.4
CS-30	12.3 ± 4.1	14.3 ± 6.2	0.5
Kt/V	1.5 ± 0.3	1.6 ± 0.4	0.1
WHO-QOL26			
Physical health	2.6 ± 0.4	3.2 ± 0.5 *	1.6
Psychological	2.8 ± 0.5	3.1 ± 0.6	0.5
Social relationships	2.9 ± 0.8	3.2 ± 0.5	0.5
Environment	2.9 ± 0.5	3.2 ± 0.4 *	0.7
Overall	2.4 ± 0.4	2.5 ± 0.4	0.4
Average QOL	2.6 ± 0.3	3.0 ± 0.3 *	1.2

Data are presented as mean ± SD unless otherwise indicated.

\*p<0.05.

QMVC: Quadriceps maximal voluntary contraction force; CS-30: 30-sec chair stand, Kt/V: standardized dialysis dose; WHO-QOL26: The World Health Organization QOL Assessment 26

## RESULTS

Significant differences were not observed in the lower-limb muscle strength, CS-30, or Kt/V values. However, the outcome was favorable based on the values indicating maintained or improved conditions, and the WHO-QOL26 scores markedly varied between before and after intervention (p<0.05; Table 1). Furthermore, based on the responses from the questionnaires, there were positive results with exercise therapy with patients being able to increase their frequency of excursions.

## DISCUSSION

Currently, the number of elderly patients undergoing maintenance dialysis is increasing, and issues involving the maintenance of motor functions, ADL ability, and QOL need to be addressed. This study examined the potential of exercise therapy during maintenance dialysis, which was performed by physical therapists.

In a previous study, the motor functions and lower-limb muscle strength for dialysis patients improved through exercise<sup>11</sup>. However, in this study, there were no significant differences in motor abilities or muscle strength, which was possibly due to age-related delays in the effect of exercise therapy as elderly patients were involved. In contrast, the CS-30 test results and the values for QMVC improved. These results may have clinical significance since it has been reported that patients with higher motor abilities show more beneficial outcomes<sup>12</sup>.

The QOL has been reported to improve through intervention<sup>13</sup>. In this study, the QOL markedly varied between before and after intervention, indicating a favorable outcome. The values for the WHO-QOL26 domains of physical health, environment, and average QOL were significantly higher after intervention. These improvements may have been the result of patients developing a positive attitude toward physical activities. Furthermore, since the “environment” domain contained a question regarding the quality of the follow-up for the disease at the hospital, the implementation of exercise therapy may also account for the higher QOL. The values for the other domains were also high; all of which may have contributed to the difference in the “average QOL” after exercise therapy.

It is important to note that dialysis patients who perform daily physical activities have a lower death risk compared with those who rarely exercise<sup>14</sup>. The Kt/V values have also been reported to improve through exercise during dialysis<sup>10</sup>. Although the Kt/V values did not significantly change after intervention in this study, these measurements further supported the effectiveness of the therapy to maintain or improve patient conditions. Further studies regarding the Kt/V values may be necessary using a larger patient sample size.

In previous studies, exercises for patients with renal diseases or those requiring dialysis improved their exercise tolerance without negatively influencing their renal function, thereby enhancing dialysis efficiency<sup>2</sup>. Furthermore, the prognosis is more favorable for dialysis patients who habitually perform exercises compared with those who do not<sup>13</sup>. Based on these findings, dialysis patients are now being encouraged to actively exercise.

However, as the number of dialysis patients who actively exercise is relatively few, it may be necessary for patients to

develop exercise habits through outpatient rehabilitation or other measures. In such cases, ensuring that sufficient time is given for exercise along with supporting patients to continue these activities may be challenging.

Although training is limited to the lower limbs, exercise therapy during dialysis enables patients to continue to safely perform exercises while receiving treatment 3 times weekly. This exercise therapy intervention was conducted for the elderly, and a favorable outcome was achieved without any patients withdrawing from this study.

While the rate of continued exercise therapy is highest when performed during dialysis, training on non-dialysis days under supervision has been reported to be the most effective for dialysis patients<sup>15</sup>). Therefore, in the future, it may be necessary to develop programs to perform exercise therapy only on such days. In addition, as the elderly are subject to marked decline in antigravity muscle strength due to their prolonged bedridden condition, the incorporation of muscle strength training in a standing position should also be considered.

### *Conflict of interest*

The authors declare no conflict of interest.

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