Renal Replacement Therapy

CASE REPORT

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Effectiveness of physical therapy on physical activity and employment status in kidney transplant recipients in their sixties: a case report with literature review

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Abstract

Background Few reports have been published on preoperative and long-term postoperative rehabilitation after kidney transplantation. Poor physical function after kidney transplantation is associated with adverse events; hence, physical function should be improved postoperatively. We report a case in which physical therapy was provided just before the operation and 12 months postoperatively to improve physical performance.

Case presentation A 64-year-old man, working as a janitor and maintenance worker at a driving school, received a living-donor kidney transplant from his wife. The just before the operation assessment revealed a decline in his physical function, indicating he had become frail. Accordingly, physical therapy was initiated prior to kidney transplantation. Subsequently, his Short Physical Performance Battery score improved from 10 to 12, and his knee extension muscle strength improved from 0.38 to 0.43 kgf/kg, enabling him to resume work. The work functioning impairment scale improved from 13 to 7.

Conclusions This case reveals that just before the operation and long-term rehabilitation is crucial in enhancing physical activity in kidney transplantation patients. Although this focused rehabilitation approach holds promise, evaluating its efficacy requires the examination of a larger cohort of cases.

Keywords Employment status, Kidney transplantation, Physical activity, Physical therapy intervention

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Background

Kidney transplantation has a higher return-to-work rate than other kidney replacement therapies. However, complications associated with kidney transplantation include perioperative disuse syndrome, weight changes, and susceptibility to infection because of steroid and immunosuppressive medication. These complications reduce physical activity, function, and exercise tolerance and increase the risk of frailty [1, 2], which may preclude return to the workplace and community. Therefore, medical treatment to preserve transplanted kidney function and post-transplant care is required to improve physical activity and function for returning to the community and employment.

Renal rehabilitation guidelines recommend exercise therapy in patients who undergo kidney transplantation (2C) [3]. In Japan, the overall decline in the available workforce has necessitated the critical inclusion of older people to maintain essential labor pools. Moreover, employment is vital in sustaining health, physical fitness, and cognitive function. Therefore, evaluating work status along with physical function and activity is pivotal for older renal transplant patients. However, previous reports have focused on younger patients aged 40–50 years and have not adequately demonstrated long-term preoperative to postoperative follow-up in older patients or included a comprehensive physical function, activity, and employment assessment. We encountered a case of a patient undergoing hemodialysis and admitted for kidney transplantation who underwent continuous physical therapy just before the operation for up to 12 months postoperatively. This study aimed to evaluate the influence of physical therapy, particularly on the level of activity performed, in a patient undergoing hemodialysis and admitted for kidney transplantation. The physical therapy intervention commenced before surgery and continued for 12 months post-surgery.

Case presentation

Patient profile

The patient was a 64-year-old man on hemodialysis for 4.2 years for end-stage kidney failure due to diabetic kidney disease. He had a medical history of hypertension, paroxysmal atrial fibrillation, and angina pectoris and had undergone surgery for a calcified amorphous tumor of the left ventricular 1 year before transplantation. Before admission, the patient lived with his spouse, was self-caring, and could transport himself to outpatient dialysis. He was fully independent and worked part-time as a janitor and maintenance worker at a driving school for 3 h, 3 days a week.

Assessment of physical function in rehabilitation

Table 1 presents the data obtained on *X*−3 days.

The preoperative evaluation (*X*–4 days) in rehabilitation encompassed the assessment of muscle strength, walking ability, physical performance, cognitive function, muscle mass, frailty, exercise motivation, and employment status (Table 2).

Knee extension muscle strength was assessed using a dynamometer (μTas F-1 handheld dynamometer; Anima, Tokyo, Japan) on three occasions, and the maximum values were used. The ratio of knee extension muscle power to body weight was calculated as representative values for lower extremity muscle strength. Grip strength was measured using a Smedley digital hand dynamometer (101A HATS; Tokyo, Japan), and the highest value from the two measurements was considered. Walking ability was assessed by measuring the 10-m walking speed. Physical performance was assessed using the Short Physical Performance Battery, cognitive function was assessed using the Mini-Mental State Examination, muscle mass was determined by calculating the skeletal muscle index, and frailty was evaluated using the Japanese version of the Cardiovascular Health Study criteria. The patient met three Japanese frailty criteria: grip strength, exercise habits, and fatigue. Exercise motivation was assessed through measurements of exercise self-efficacy (SE). He had no exercise routine—his exercise SE was 14/20. Work functioning impairment scale (WFun) score was 13/35. WFun is composed of seven simple questions, each scored between 1 and 5 points, allowing for a total score ranging from 7 to 35 points. In this scale, a lower score is indicative of better work functioning or a better condition.

Table 1 Patient characteristics

	X−3 days
Dry weight (kg)	64.4
Height (m)	1.65
BMI (kg/m^2)	23.7
Albumin level (g/dL)	3.8
Hemoglobin (g/dL)	13.0
Blood urea nitrogen level (mg/dL)	67.5
Creatinine level (mg/dL)	12.17

BMI body mass index

Table 2 Results of the physical function assessment

	X−4 days	6 months	12 months
KEMS (kgf/kg)	0.38/0.36	0.40/0.34	0.43/0.36
Grip strength (kg)	25.5/20.5	25.2/18.5	25.6/19.8
10-m walking speed (m/s)	1.07	1.01	1.10
SPPB (points)	10	12	12
SMI (kg/m^2)	7.0	8.7	8.0
J-CHS	frailty (3)	pre-frailty (2)	pre-frailty (1)
SE (points)	14	16	18
WFun (points)	13	16	7

KEMS knee extension muscle strength, *SPPB* short physical performance battery, *SMI* skeletal muscle index, *J-CHS* the Japanese version of the Cardiovascular Health Study criteria, *SE* exercise self-efficacy, *WFun* work functioning impairment scale

Methodology of rehabilitation intervention

The patient's physical therapy goal was to return to the same job and to travel further distances. His rehabilitation started 4 days before surgery. The just before the operation rehabilitation program included an orientation toward early postoperative rehabilitation interventions, assessment of physical function, and self-training instructions using informational brochures. Postoperatively, we followed a rehabilitation program based on previous studies [4] to reduce disuse syndrome as much as possible. Specifically, orthostatic and gait training was started on day 4, and aerobic exercise using a bicycle ergometer was started on day 10. Additional exercises, such as squats, wall push-ups, and one-leg standing, were gradually introduced to improve strength and balance. Following renal rehabilitation guidelines, we prescribed five 40-min exercise therapy sessions daily, five times per week [3].

Outpatient intervention

The patient visited the outpatient clinic every 2–4 weeks for medication management, nutritional counseling, and rehabilitation. We used a self-monitoring sheet to record daily physical changes, independent training activities, number of steps, weight, blood sugar, frequent urination, and amount of water consumed. He maintained a diabetes diary before hospitalization. After his discharge, it was integrated into a self-monitoring sheet, which allowed him to continue the ongoing documentation personally. For outpatient rehabilitation, the target number of steps set was based on his continuous step count recorded during hospitalization and was gradually increased. At each visit, the number of steps was recorded, the target was readjusted accordingly, and visual feedback was provided. The number of steps taken was noted using a graph to visually show the degree of goal attainment; the graph was printed on paper and was distributed each time for visual feedback. We assessed his physical condition using a self-recorded sheet by a physical therapist at each visit.

Postoperative treatment and progress

An ABO non-identical living donor kidney transplant was performed with his spouse as the donor. The left donor kidney was then transplanted into the right pelvic cavity. Immunosuppressive therapies included basiliximab, methylprednisolone, tacrolimus, and mycophenolate mofetil. After kidney transplantation, two additional hemodialysis sessions were required because of delayed graft function. A physical activity tracker device (Lifecorder, Kenz, Suzuken Co., Ltd., Nagoya, Aichi, Japan) was given to the patient after surgery and catheter removal, and he was instructed to incrementally increase the step count by 5000 steps per day during hospitalization and by 5% every month after discharge [4, 5]. The patient was discharged on day $X+36$. The estimated glomerular filtration rate (eGFR) at discharge was 16 mL/min/1.73 m^2. His weight during the 12 months post-surgery is shown in Fig. 1. No adverse events associated with kidney function occurred because of the exercise intervention. Physical function during the 12 months post-surgery is shown in Table 2. At 6 months, the patient resumed work, and the number of workdays increased from three to five. A total of 12 months later, working hours increased from 3 h to 4.5 h. Furthermore, he was able to travel for one week without worrying about his dialysis appointments.

Literature review

To our knowledge, there have been three previous studies evaluating physical activity levels (step counts) in renal transplant patients using activity monitors (Table 3). In the study conducted by Yamamoto et al. [4], the effectiveness of early postoperative rehabilitation was compared between a control group receiving usual care and an intervention group undergoing rehabilitation. The intervention group commenced rehabilitation on the sixth day post-surgery and received guidance on physical activity levels for two months post-surgery. While there was no significant difference in step counts between the two groups two months post-surgery, knee extensor strength was substantially higher in the intervention group compared with that of the control group. Furthermore, no adverse events related to exercise intervention on renal function were observed, and estimated glomerular filtration rate (eGFR) exhibited a similar trajectory to that of the control group. In the research by Serper et al. [6], a randomized controlled trial (RCT) focused on physical activity levels was conducted for three months among renal and liver transplant patients within the first 12 months postoperatively. The intervention group received guidance with a target step count set at 15% above their average step count every two weeks. At the final assessment, there was no considerable difference in actual step counts between the intervention and control groups. However, the odds ratio for achieving the target step count was 2.23, demonstrating the effectiveness of physical activity guidance through monitoring. A study by O'Brien et al. [7], implemented a 12-month RCT targeting individuals aged 60 and above, and at least 3 months or longer post-transplantation. The intervention group set a target step count by adding 5% to the average step count of the previous month. As a result, there was no discernible difference in step counts between the two groups over the course of 12 months. From these findings, a consensus on the efficacy of improving physical activity levels has not been reached. Moreover, studies focusing on elderly renal transplant patients are limited, and the impact of intervening in physical activity levels from pre- to post-surgery over an extended period on physical and labor functions remains unclear (Table 3).

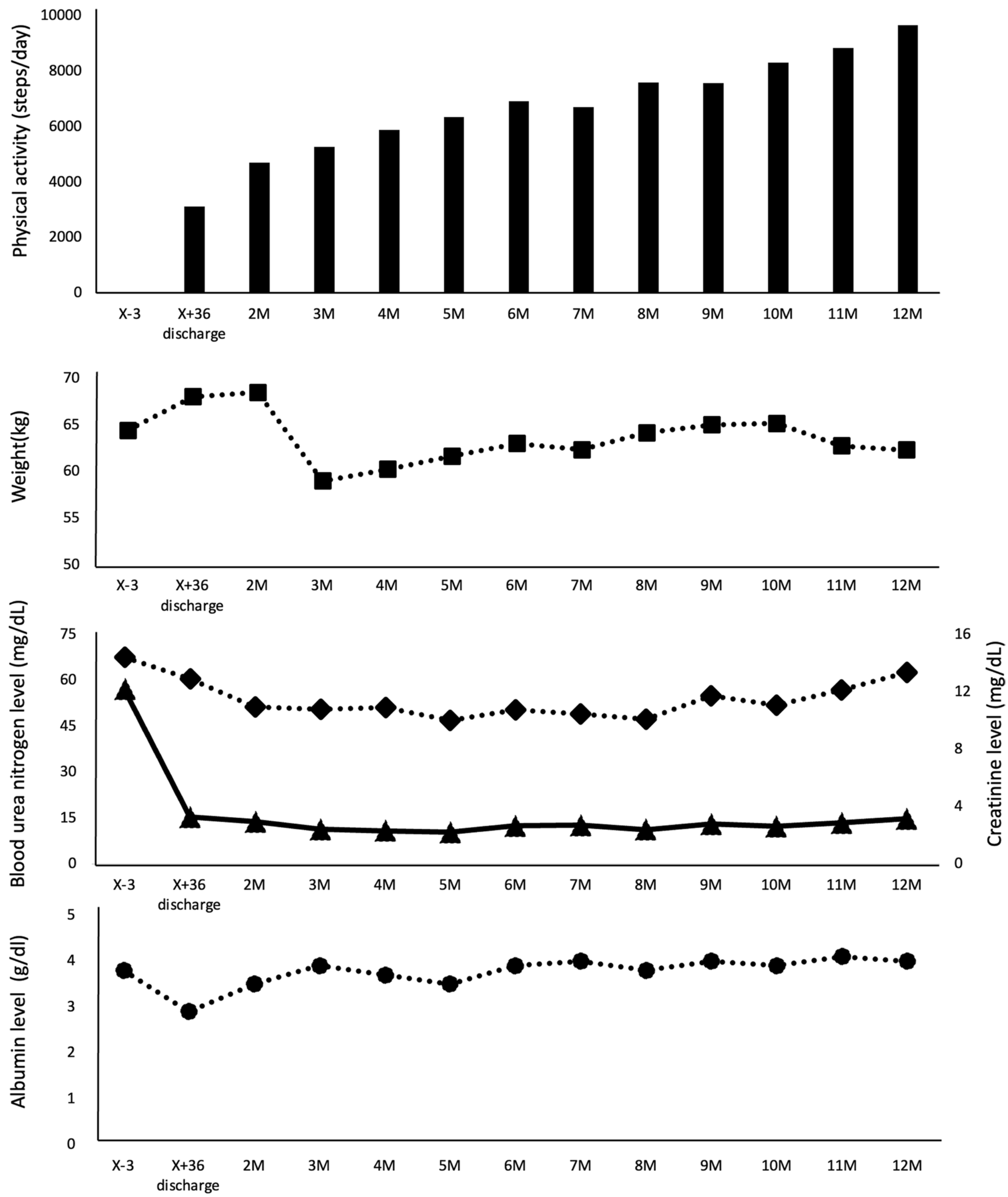

Fig. 1 Progress during rehabilitation (physical activity and weight). ◆, Blood urea nitrogen level; ▲, Creatinine level; ●, Albumin level

Discussion and conclusions

Following kidney transplantation, physical function declines and frailty is prevalent due to disuse syndrome, complications, and adverse drug reactions associated with surgery and hospitalization [3]. A previous study has reported that the level of frailty at the time of kidney transplantation surgery is significantly higher, at 20%, compared with 6.9% in the general older population aged ≥ 65 years [5]. Frailty and poor physical function in patients who undergo kidney transplantation contribute to adverse events, such as prolonged hospital stay, graft dysfunction, and mortality [1, 2]. Preventing frailty and physical functional decline in

Table 3 Previous studies on postoperative physical activity in kidney transplant patients

Study	Subject	Measures of physical activity	Outcome	Main results
Yamamoto et al. [4]	Candidates living donor KTRs	Triaxial accelerometer	Physical activity (number of steps) KEMS	There were no significant mean differences neither within nor between groups in number of steps KEMS at two months postoperatively was significantly higher in the exercise group
Serper et al. [6]	KTRs and LTRs within 2–24 months post-transplantation	Wearable accelerometer	Adherence to step targets	Intervention group was associated attainment number of steps led to an odds ratio of 2.23 for the goal attainment number of steps
O'Brien et al. [7]	KTRs, at least 3 months or longer post-transplantation	Fitbit Charge 2™	Physical activity (number of steps)	There was no difference in the mean difference in daily steps from baseline to 12 months between the two groups

KTRs kidney transplant recipients, *KEMS* knee extension muscle strength, *LTRs* liver transplant recipients

patients who undergo kidney transplantation is crucial for improving postoperative prognosis.

Further, rehabilitation is a critical intervention for patients who undergo kidney transplantation after surgery, preventing frailty and physical function decline. Exercise therapy has been reported to enhance physical function in middle-aged kidney transplant patients. However, most previous studies have focused on short-term interventions in middle-aged patients ≥ 6 months postoperatively, with limited research on the effects of exercise therapy during the early or long-term postoperative periods. The patient in the current case was older and exhibited more preoperative weakness and impaired physical function compared with the patients described in the referenced studies [4, 6]. However, the patient's physical function improved with ongoing long-term interventions initiated in the early postoperative period. These interventions could potentially facilitate long-term kidney rehabilitation and commitment to physical activity from the early postoperative stages, even for relatively older patients.

A previous study has shown that an intervention targeting exercise therapy and physical activity improved exercise tolerance and walking ability without adverse effects on kidney function compared with a non-exercise intervention [4]. Another RCT conducted among middle-aged patients who underwent kidney transplantation during the stable postoperative phase (2–24 months) has reported that the provision and monitoring of a target number of steps led to an odds ratio of 2.23 for the goal attainment number of steps in the intervention group, compared with that of the control group [6]. In the present case, the absence of exercise habits before surgery and low SE, which served as an index of motivation to exercise, were evident. Long-term rehabilitation and visual feedback on physical activity using self-monitoring sheets may improve frailty and physical function by enhancing SE, establishing exercise habits, and increasing physical activity. Providing home exercise instructions and self-monitoring, general exercise therapy during hospitalization, and continuation therapy after discharge were influential in our case.

After kidney transplantation, whereas some individuals reintegrate into society due to the improvement of uremia, others face restrictions in employment or working hours due to the complications and side effects of kidney transplantation and medications. Within the framework of Standardized Outcomes in Nephrology—Transplantation, life participation has been identified as a crucial core outcome for patients who underwent kidney transplantation, along with considerations of mortality and infection, followed by the capacity to engage in work [8]. A previous study has revealed that working patients showed superior subjective health status post-kidney transplantation compared with that of non-working patients, indicating that enhanced physical function is essential for employment [9]. A 12-month rehabilitation program for patients who underwent kidney transplantation contributed to improved physical and mental quality of life, higher employment rates, and enhanced participation in social activities [10]. In the present case, the patient worked 3 days per week on non-dialysis days before undergoing kidney transplantation. A total of 6 months after the surgery, he was successfully reemployed, with the frequency of work increasing from 3 to 5 days per week and working hours from 3 h to 4.5 h per day for 12 months, and an improvement in labor function was observed. Consequently, long-term rehabilitation can improve physical function, activity, and frailty, proving effective in physically demanding occupations.

In this case, the limited duration of just before the operation rehabilitation precluded evaluating the patient's physical activity level before admission. Therefore, it is not easy to refer to preoperative rehabilitation. However, the patient underwent physical therapy evaluation, risk stratification, and intervention during the just before the operation and 12-month postoperative periods. This improved physical function, enhanced physical activity, reduced frailty and allowed him to resume vocational activities. Physical therapists' active involvement in caring for patients who underwent kidney transplantation helps reintegrate patients with kidney failure into society.

In conclusion, we suggest that the long-term rehabilitation of frail patients who undergo kidney transplantation in their 60 s yields favorable physical function, physical activity, and employment outcomes.

Abbreviations

KEMS	Knee extension muscle strength
SPPB	Short physical performance battery
RCT	Randomized controlled trial
SMI	Skeletal muscle index
SE	Self-efficacy
WFun	Work functioning impairment scale

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Author contributions
T.Y. investigated physical activity, physical function, and employment status in kidney transplant recipients in their 60s. T.Y., H.Y., and T.S. were major contributors in writing the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials
All data in this case are available upon request.

Declarations

Ethics approval and consent to participate
All procedures performed in studies involving human participants were in accordance with the ethical standards of the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Written informed consent was obtained from the patient.

Consent for publication
Written consent was obtained from the patient for publication of this case report.

Competing interests
The authors declare no competing interests.

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