A Case in Which Renal Function and Peritoneal Function Were Maintained for Ten Years by Proactive Combination Therapy with Peritoneal Dialysis and Hemodialysis

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To avoid loss of residual renal function (RRF) and to enhance solute clearance, we sometimes, from the initiation of peritoneal dialysis (PD) therapy, combine PD with hemodialysis (HD) that removes little or no fluid. In one typical valuable case, a 51-year-old woman with diabetic nephropathy who selected combined PD and HD therapy as her first dialysis method has continued on that therapy for 10 years. Her dialysis schedule consists of 5 PD days and 1 HD day without fluid removal weekly. Because this combination therapy was proactively started at dialysis initiation, good fluid control could be kept with urinary excretion and PD ultrafiltration. Stable peritoneal equilibration test data indicate that peritoneal resting might be expected to be beneficial for the preservation of peritoneal function. This case demonstrates that proactive combination therapy can be extremely useful for preserving both RRF and peritoneal function, indicating a good prognosis.

Key words
Residual renal function, peritoneal function, proactive combination therapy

Introduction

In peritoneal dialysis (PD) therapy, ultrafiltration failure and uremic symptoms caused by loss of residual renal function (RRF) can lead to withdrawal from PD. When PD fluid removal and solute clearance become insufficient, the addition of hemodialysis (HD) is considered an alternative therapy that compensates for the limitations of PD therapy (1–8), thus supporting PD continuation while trying to achieve adequate dialysis in patients with loss of RRF (9–11). However, PD patients with well-preserved RRF have not been tried on this combination therapy. Rapid fluid removal during the short time of a HD session accelerates the loss of RRF, which is an important factor for mortality and quality of life in patients receiving PD therapy (12). To avoid RRF loss and enhance solute clearance from the initiation of PD therapy, we therefore combined PD with HD that removes little or no fluid. Here, we report the case of a patient who maintained stable RRF, peritoneal function, and nutrition status for 10 years after initiation of this proactive combination therapy.

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Case description

A 51-year-old woman with diabetic nephropathy who had been treated with insulin injections since the age of 17 first visited our hospital in 2002 because of chronic renal failure. Her serum creatinine was 5.7 mg/dL at her first medical examination. When the level increased to 9.3 mg/dL, she consented to start dialysis therapy (her estimated glomerular filtration rate was 7.1 mL/min/1.73 m^2).

In May 2003, therapy with PD plus HD that removes little or no fluid was selected as this patient's first dialysis method. The dialysis schedule consisted of PD 5 days per week (1.5 L of 1.5% glucose dialysate 4 times daily) and HD 1 day per week without fluid removal (session duration: 3 hours; dialyzer: polymethyl

methacrylate membrane; blood flow: 1.0 m^2, 150 mL/min; ultrafiltration: 0 mL). To evaluate RRF, 24-hour urine volume and renal Kt/V were measured every 6 months. The urea clearances by kidney, PD, and HD were evaluated based on the renal equivalent urea clearance proposed by Casino and Lopez (13). A peritoneal equilibration test was performed every 6 months to assess peritoneal function as the dialysate-to-plasma ratio of creatinine (D/P Cr). The patient also received regular nutrition guidance to control her nutrition status and diabetes. Sodium intake was restricted to 6 – 8 g daily, protein intake was limited to 0.8 – 1.0 g/kg daily, and energy intake was kept within approximately 25 – 27.5 Kcal/kg daily. Blood pressure was recorded every day at home and carefully controlled with antihypertensive drugs. Her blood glucose was checked 3 times daily, and insulin was administered 4 times daily.

Table I shows the patient's laboratory findings before dialysis start in 2003, after dialysis start in 2003, and in 2013. No significant changes from 2003 to 2013 were found for urine volume, blood urea nitrogen, or serum creatinine. However, creatinine clearance was slightly decreased. Values for total protein, albumin, and C-reactive protein were within the normal range, and no significant changes were observed during follow-up. In addition, the patient's anemia obviously improved, and her blood glucose was well controlled.

Figure 1 illustrates changes in the patient's urea clearance during 10 years of combined PD and HD therapy (renal equivalent urea clearance from RRF and the HD and PD clearances). At the start of combination therapy, clearances by HD, PD, and RRF were 0.81, 1.29, and 0.52 respectively, for a total renal equivalent urea clearance of 2.62. Interestingly, RRF clearance increased from 0.53 at dialysis initiation to 1.29 at 6 months, and it then remained absolutely stable for 8 years, declining to 0.57 at 9 years and 0.44 at 10 years. The mean clearances by RRF, PD, and HD during the observation period were 0.85 ± 0.32, 1.32 ± 0.07, and 0.83 ± 0.08 respectively. The average total clearance was 3.00 ± 0.31.

Figure 2 shows time-dependent changes in 24-hour peritoneal ultrafiltration volume and 24-hour urine volume during the observation period. The 24-hour urine volume at the beginning of combination therapy was 667 mL; it fluctuated thereafter, but stayed above 500 mL throughout the 10 years of observation. The patient's mean 24-hour urine volume and 24-hour peritoneal fluid removal were 942.5 mL ± 258.1 mL and 732.9 mL ± 258.1 mL respectively during the observation period.

Figure 3 shows time-dependent changes in peritoneal permeability. Peritoneal permeability as assessed by D/P Cr was 0.48 at the start of the combination therapy, increasing transiently to 0.68 at 1.5 years, tending to decline after 2 years, and reaching 0.45 at 10 years. The patient's mean D/P Cr ratio was 0.513

TABLE I Laboratory findings at the start of dialysis and 10 years later

	2003		*2013*
	Dialysis start		
Variable	*Before*	*After*	*Study end*
Urine volume (mL/day)	700	800	800
Creatinine clearance (mL/min)	5.5	7.6	2.4
Total protein (g/dL)	6.9	6.3	6.2
Albumin (g/dL)	3.7	3.5	3.1
Blood urea nitrogen (mg/dL)	108	73	67
Creatinine (mg/dL)	9.3	8.4	9.3
Ca (mg/dL)	8.2	7.4	8.4
iPTH (mg/dL)	6.7	6.9	6.1
Total cholesterol (mg/dL)	258	280	182
Triglycerides (mg/dL)	103	68	70
C-Reactive protein (mg/dL)	0.01	0.02	0.01
Hemoglobin (g/dL)	6.5	9.8	11.7
HbA1c (%)	5.5	6.5	6.9

iPTH = intact parathyroid hormone.

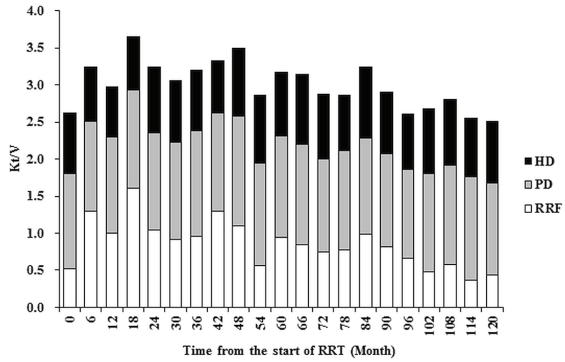

FIGURE 1 Changes in renal Kt/V, peritoneal Kt/V, and hemodialysis Kt/V calculated as renal equivalent urea clearance over 120 months. HD = hemodialysis; PD = peritoneal dialysis; RRF = residual renal function; RRT = renal replacement therapy.

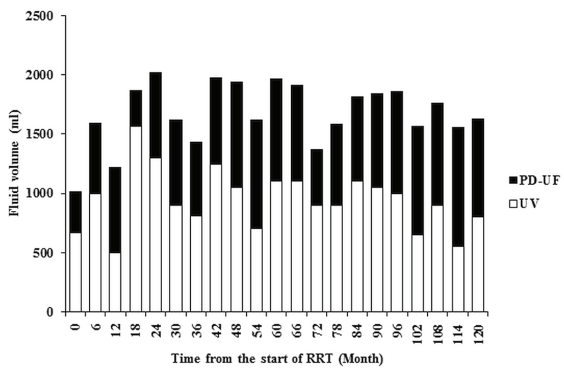

FIGURE 2 Changes in 24-hour peritoneal dialysis ultrafiltration (PD-UF) volume and urine volume (UV) over 120 months. RRT = renal replacement therapy.

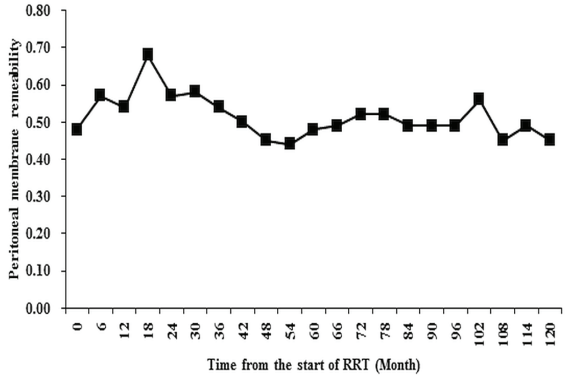

FIGURE 3 Changes in peritoneal membrane permeability during long-term combination therapy with peritoneal dialysis and hemodialysis for 120 months. RRT = renal replacement therapy.

± 0.057. Peritoneal permeability did not increase over her time on PD.

Body weight recorded at HD sessions remained stable, and fluid removal during the HD sessions was therefore not required during the 10-year period. The patient developed peritonitis in July 2004 and June 2008, and blood-access stenosis in July 2007. Nevertheless, the patient showed good compliance during the entire observation period. Neither uremic symptoms nor edema were ever observed.

Discussion

It has been reported that, compared with PD therapy alone, combination therapy with PD and HD improves not only a patient's overhydration and solute status, but also their nutrition status and anemia (2,9–11,14). Combination therapy has previously been attempted only for patients with loss of RRF, because the HD sessions compensate for the reduced solute and fluid removal. However, HD therapy can lead to lower RRF because of rapid fluid removal and frequent exposure to dialysis membranes that might trigger an inflammatory response. Previous reports implied that urine volume declines significantly 1 year after the start of combined therapy (2,9,14), and that decline is one of the few adverse effects, although it is a critical issue because of its direct effect on prognosis (15–18).

We thought that the use of combination therapy in pre-dialysis patients with end-stage renal disease, who have usually some urine volume, should begin proactively at the start of renal replacement therapy to preserve RRF. We paid attention to the patient's dietary intake and fluid balance. Sodium intake was severely restricted by providing frequent nutritional guidance. Fluid was to be removed both by RRF and by 5 days of PD ultrafiltration weekly, and thus the patient's body weight remained stable. Surprisingly, there was then no need for excessive fluid removal during a HD session for 10 years. Although the patient's recent creatinine clearance value was noted to have declined slightly, urine volume was continuously maintained. Moreover, the patient's blood pressure and serum glucose were well controlled. Those factors are possibly the reason that RRF was preserved during this patient's 10 years of dialysis.

Several reports have demonstrated that peritoneal resting decreases the occurrence of peritoneal hyperpermeability and ultrafiltration failure (19–21). Matsuo *et al.* (14) indicated the same result and other beneficial effects for patients whose modality was switched from PD only to combination therapy with PD and HD. The stable peritoneal equilibration test data during our patient's 10 years of dialysis show that peritoneal resting for 2 days each week from the beginning of renal replacement therapy might be more beneficial for the preservation of peritoneal function.

The proactive use of combination therapy with PD and HD from the start, without fluid removal during HD sessions, might therefore be more effective than initiating conventional combination therapy after the loss of RRF. In addition, supplemental solute removal by HD might help to prevent deterioration in the

patient's nutrition status. Davies *et al.* (22) reported that, in patients with higher peritoneal transport, RRF declined by half within 3 years, and even in patients with stable peritoneal function, it declined within approximately 4 years. We therefore assume that preservation of RRF for as long as 10 years is attributable to the enhanced solute removal without fluid removal during HD sessions.

Suzuki *et al.* (23) mentioned that an early start of combination therapy was associated with good maintenance of creatinine clearance despite gradually diminishing RRF. That observation could support the principle of our therapy. The present case report demonstrates that proactive combination therapy was extremely useful for the preservation of both RRF and peritoneal function, indicating that it might be associated with a good prognosis. We suggest that proactive combination therapy could be a new renal replacement therapy of choice. However, prospective clinical studies with a larger number of patients are needed to confirm the efficacy of this approach to combination therapy.

Disclosures

We understand that *Advances in Peritoneal Dialysis* requires disclosure of any conflicts of interest, and we declare that we have no conflicts to disclose.

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