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Tidal Automated Peritoneal Dialysis Preserves Residual Renal Function Better Than Non Tidal Automated Peritoneal Dialysis

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*Residual renal function (RRF) is a key element for good maintenance of patients on peritoneal dialysis (PD). Several reports have been published comparing RRF preservation between continuous ambulatory PD and automated PD (APD); however, no comparisons have yet been made between tidal and non tidal APD. We therefore retrospectively analyzed RRF in patients on tidal (*n = *10) and non tidal (*n = *19) APD and tried to elucidate factors that differed between them.*

We observed no statistical differences in background, body mass index, RRF, urinary volume, peritoneal clearance, ultrafiltration (UF) volume, daily infusion volume, creatinine generation rate (CGR), or urea generation rate between the two groups at that start of PD. However, after 3 years, renal creatinine clearance (CCr) and urinary output in the tidal group were statistically higher than those in the non tidal group. Conversely, UF and peritoneal CCr were lower. Although the CGR in the tidal group increased, it decreased in the non tidal group, leading to a statistically significant difference after 3 years. The dialysate-to-plasma creatinine and total CCr showed no statistical difference between the two groups. These results indicate that RRF is better preserved in tidal than in non tidal APD.

Key words
Tidal APD, residual renal function, creatinine generation rate

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Introduction

Preservation of residual renal function (RRF) is a key element in maintaining patients on peritoneal dialysis (PD), and previous reports have studied factors that potentially affect RRF. Moist *et al.* revealed that use of an angiotensin converting-enzyme inhibitor or a calcium channel blocker and higher serum calcium are factors that lead to better preservation of RRF, but that female sex, diabetes, congestive heart failure, non white ethnicity, and hemodialysis accelerate RRF decline (1). Debate has also surrounded the issue of how continuous ambulatory PD and automated PD (APD) affect RRF (2–4). However, no study has ever aimed to compare RRF preservation in tidal and non tidal APD. The purpose of the present study was therefore to compare changes of RRF in incident patients treated with tidal or non tidal APD for 3 years.

Patients and methods

Our retrospective analysis used these inclusion criteria:

- Patients had to have started APD at less than 15mL/min renal creatinine clearance (CCr) at the Kobe Central Hospital of Social Insurance.
- Peritoneal equilibration test and RRF data had to be available for 3 years.
- The APD prescriptions had to have been fixed for either tidal or non tidal APD for the entire 3-year period.

A total of 29 patients fulfilled these criteria (10 on tidal and 19 on non tidal APD). Patients who complained of nocturnal drainage pain or discomfort from the alarm system on the APD machine were counseled to use tidal mode. All patients used Baxter APD systems, and the drainage volume for the tidal

prescription was 50% – 70% at each cycle. In most cases, 4 cycles per night were used.

We compared body mass index, peritoneal creatinine clearance (CCr) and urea clearance, renal CCr and urea clearance, daily total infusion volume, daily urinary volume, creatinine generation rate (CGR), urea generation rate (UGR), and peritoneal permeability expressed as dialysate-to-plasma (D/P) creatinine at years 1, 2, and 3 between the tidal and non tidal groups. Because ultrafiltration (UF) volume at dialysis start was negative in some cases, changes in volume for the following 3 years were calculated by subtracting the initial value.

The statistical analysis used the unpaired *t*-test or chi-square test to compare the two groups, and the paired *t*-test for intergroup comparisons. A p value less than 0.05 was considered statistically significant.

Results

Table I shows values for the various study parameters at year 0 and year 3 (UF expressed as change in volume). Renal CCr and urinary output in the tidal group was better preserved than that in the non tidal group, with statistical significance in all 3 years (also see Figure 1). Conversely, UF volume and peritoneal CCr were significantly lower in the tidal group after 3 years. Although CGR increased in the tidal group, it decreased in the non tidal group, with the difference reaching statistical significance at year 3. Of D/P creatinine, total infusion volume, body mass index, UGR, and total CCr, no parameter showed a statistical difference over time. To minimize the effect of the differences between the two groups at year 0, we recalculated percentage values at year 3 as compared with year 0 for each parameter. As shown Figure 2, only renal CCr and CGR were statistically significantly different between the two groups.

Discussion

We showed for the first time that RRF is better preserved in patients on tidal APD than in those on non tidal APD. Although our data did not make clear the reasons for better RRF preservation, one possible explanation might be that, over time, patients on tidal APD receive a lesser dialysis dose, as indicated by significantly lower values for both UF volume and peritoneal CCr after 3 years. However, that finding seems less of a cause than a consequence of lower RRF in the non tidal patients, because prescriptions for an increased dialysate volume or dextrose concentration are given only after insufficient UF occurs as a result of decreased RRF. Indeed, the total infusion volume in tidal patients was not statistically different from that in the

TABLE I Comparison between the tidal and non tidal automated peritoneal dialysis groups at the start of dialysis and after 3 years

Parameter	*Tidal (*n *patients)*	*Non tidal (*n *patients)*	p *Value*
Start			
Weekly renal CCr (L)	62.6±55.2 (10)	41.1±24.7 (19)	0.156
Weekly peritoneal CCr (L)	22.1±5.4 (10)	28.8±10.4 (19)	0.067
Weekly total CCr (L)	84.7±52.0 (10)	70.0±22.1 (19)	0.290
D/P creatinine	0.69±0.10 (7)	0.64±0.13 (18)	0.324
Urinary volume (mL/24h)	976±355 (10)	1143±587 (19)	0.418
Ultrafiltration (mL/24h)	308±322 (10)	457±582 (19)	0.459
Total infusion volume (mL/24h)	7225±1905 (10)	8200±1424 (19)	0.130
BMI	20.7±2.9 (10)	21.8±3.0 (19)	0.335
After 3 years			
Weekly renal CCr (L)	41.6±42.9 (9)	11.2±11.7 (16)	0.013
Weekly peritoneal CCr (L)	30.8±10.8 (10)	44.7±12.3 (19)	0.005
Weekly total CCr (L)	68.2±35.4 (10)	54.1±10.0 (19)	0.112
D/P creatinine	0.67±0.11 (10)	0.68±0.07 (19)	0.892
Urinary volume (mL/24h)	849±576 (9)	437±399 (16)	0.046
Ultrafiltration (mL/24h)	461±392 (10)	1045±644 (19)	0.015
Total infusion volume (mL/24h)	9176±3105 (10)	10255±2098 (19)	0.275
BMI	21.9±3.2 (10)	23.1±3.0 (19)	0.305

CCr = creatinine clearance; D/P = dialysate-to-plasma; BMI = body mass index.

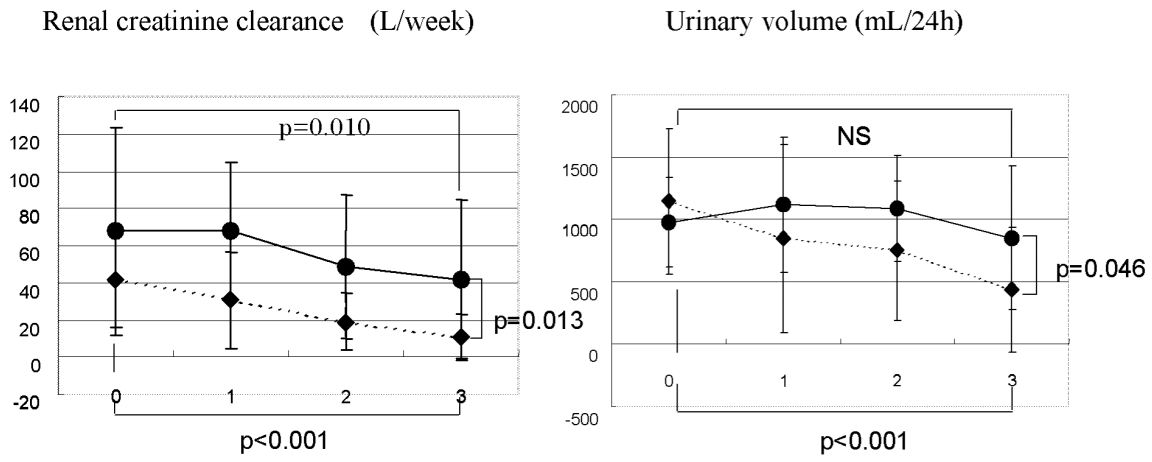

FIGURE 1 Renal creatinine clearance and urinary output in the tidal (filled circles) and non tidal (filled diamonds) automated peritoneal dialysis groups over 3 years.

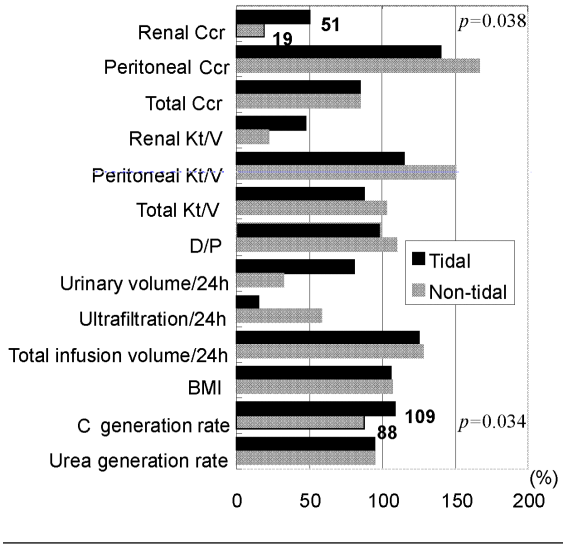

FIGURE 2 Changes in various parameters at 3 years between the tidal and non tidal automated peritoneal dialysis groups. All values expressed as a percentage of the value at dialysis start. CCr = creatinine clearance; D/P = dialysate-to-plasma creatinine; BMI = body mass index; C = creatinine.

non tidal group throughout the study period, although it tended to be lower. Therefore, the lesser UF and peritoneal CCr found in the tidal group seem unlikely to be the reason for the difference.

Another possible explanation is based on the fact that CGR in the tidal group increased, but that it decreased in the non tidal group. In dialysis patients, CGR is an indicator of nutrition status (5), although it should be normalized to age, sex, body weight, and muscular volume. To remove those confounding factors, we recalculated the rate of change in the CGR by dividing the value at year 3 by that at year 0. The average change over the 3 years in the tidal group was 108%. In the non tidal group, it was 88% – a statistically significant difference (p =0.034).

Some reports show that PD patients with better RRF can maintain better nutrition status (6,7); however, no report has ever tried to show whether better nutrition status in PD patients contributes to better preservation of RRF. Therefore, the enhanced CGR in the tidal group may again be a consequence of their better-preserved RRF.

Another interesting finding is that peritoneal permeability in patients treated with the tidal mode of APD did not differ from that in patients treated with the non tidal mode. Davies *et al.* reported that higher concentrations of dextrose are a risk factor for increased peritoneal permeability (8). In tidal mode, the average glucose concentration in the peritoneum could theoretically be higher than that reached in the non tidal mode; however, the peak concentration of glucose immediately after infusion could be lower because of the dilution effect created

by the tidal dialysate volume. Thus, we believe that, even though the average concentration of glucose is higher, tidal APD does not subject the peritoneal membrane to harmful effects beyond those exerted by non tidal APD.

Future prospective controlled studies are warranted to prove the hypothesis found in this report, and a comparison of RRF between tidal APD and CAPD would be another attractive research topic.

Conclusions

Tidal APD preserves RRF better than non tidal APD does.

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