Analiza učinkovitosti zdravljenja, obravnave slabokrvnosti, vnetja, mineralne kostne bolezni in pogostosti peritonitisov dializnega centra – Primerjava kontinuirane ambulantne peritonealne dialize (capd) in avtomatizirane peritonealne dialize (adp)

Single peritoneal dialysis centre observations of treatment adequacy, anemia treatment, inflammation, mineral bone disease, and peritonitis rate – In patients undergoing continuous ambulatory peritoneal dialysis versus automated peritoneal dialysis

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Izvleček

Namen: *Peritonealno dializo smo v našem centru začeli izvajati leta 1998. Cilj naše retrospektivne analize je bil ugotoviti razliko v učinkovitosti zdravljenja, potrebi po eritropoetinu, nivoju hemoglobina, C–reaktivnem proteinu (CRP), intaktnemu parathormonu (i–PTH) in pojavnosti peritonitisa pri bolnikih, ki so prešli s kontinuirane ambulantne peritonealne dialize (CAPD) na avtomatizirano peritonealno dializo (ADP).*

V prispevku avtorji predstavijo peritonealno dializo kot metodo nadomestnega zdravljenja ledvične odpovedi ter njihove izsledke retrospektivne analize.

Metode: *Pregledali smo dokumentacijo 12–ih bolnikov, devetih moških in treh žensk, starih v povprečju 52,8 ± 11,7 let, ki so v obdobju od maja 1998 do decembra 2013 prešli iz CAPD na APD. Na podlagi rezulta-*

Abstract

Purpose: *Peritoneal dialysis was introduced to our centre in 1998. The aim of our retrospective analysis was to evaluate the difference in treatment adequacy, erythropoietin requirements, serum haemoglobin, serum C–reactive protein (CRP) and serum intact parathyroid hormone (i–PTH) levels, and episodes of peritonitis in patients switching from continuous ambulatory peritoneal dialysis (CAPD) to automated peritoneal dialysis (APD). We introduce peritoneal dialysis as a method of treatment for end–stage renal disease and the results of a retros-pective analysis.*

Methods: *From May 1998 to December 2013, we retrospectively reviewed 12 patients (9 males and 3 females; mean age, 52.8±11.7 years) who switched from CAPD to APD. According to the peritoneal equilibration test, 75% of the patients were high transporters. We compared the*

ta peritonealnega ekvilibracijskega testa (PET) je bilo 75 % bolnikov spoznanih za hitre izmenjevalce. Obe obliki peritonealne dialize smo primerjali glede na učinkovitost zdravljenja (Kt/V), porabo eritropoetina, nivo hemoglobina, CRP in i–PTH. Analizirali smo epizode peritonitisa v CAPD in APD obdobju.

Rezultati: *Povprečen čas na CAPD je bil 747,1,1 ± 1028,2 dni; povprečen čas na APD je bil 1300,0 ± 1042,0 dni. Za CAPD obdobje je bila srednja vrednost Kt/V 2,13 ± 0,43, srednja vrednost hemoglobina 117,8 ± 6,2 g/l, srednja vrednost porabe eritropoetina 5290,1 ± 4641,4 IE/teden, srednja vrednost CRP 8,7 ± 9,3 mg/l in srednja vrednost i–PTH 580,2 ± 445,9 pg/ml. Za APD obdobje je bila srednja vrednost Kt/V 2,24 ± 0,35, srednja vrednost hemoglobina 117,1 ± 8,6 g/l, srednja vrednost porabe eritropoetina 4829,9 ± 4976,6 IE/teden, srednja vrednost CRP 9,1 ± 8,3 mg/l in srednja vrednost i–PTH 550,5 ± 400,0 pg/ml. S primerjavo rezultatov obeh oblik peritonealne dialize (parni t–test) statistično pomembnih razlik v času zdravljenja (p = 0,273), učinkovitosti (Kt/V) (p = 0,159), nivoju hemoglobina (p = 0,804), porabi eritropoetina (p = 0,303), nivoju CRP (p = 0,886) in i–PTH (p = 0,802) nismo ugotovili. Prav tako nismo opazovali razlike v pojavnosti peritonitisa v obeh obdobjih zdravljenja.*

Zaključek: *Med oblikama peritonealne dialize nismo ugotovili pomembne razlike v učinkovitosti zdravljenja, porabi eritropoetina, nivoju hemoglobina, CRP, i–PTH in pojavnosti peritonitisa.*

two periods regarding peritoneal treatment adequacy number (Kt/V), erythropoietin requirements, serum haemoglobin, and CRP and i–PTH levels. We analysed the episodes of peritonitis during the CAPD and APD periods.

Results: *The average time spent on CAPD was 747.1±1028.2 days, and the average time spent on APD was 1300.0±1042.0 days. For the CAPD period, the mean Kt/V was 2.13±0.43, the mean haemoglobin value was 117.8±6.2 g/l, the mean erythropoietin requirement was 5290.1±4641.4 IU/week, the mean CRP value was 8.7±9.3 mg/l, and the mean i–PTH value was 580.2±445.9 pg/ml. For the APD period, the mean Kt/V was 2.24±0.35, the mean haemoglobin value was 117.1±8.6 g/l, the mean erythropoietin requirement was 4829.9±4976.6 IU/week, the mean CRP value was 9.1±8.3 mg/l, and the mean i–PTH value was 550.5±400.0 pg/ml. When comparing the two treatment modalities with a paired samples test, we found no significant differences regarding time spent (p=0.273), Kt/V (p=0.159), haemoglobin concentration (p=0.804), erythropoietin requirements (p=0.303), and CRP (p=0.886) and i–PTH levels (p=0.802). Further, no difference in the rate of peritonitis episodes between both modalities was found.*

Conclusion: *Both peritoneal dialysis modalities are equal with respect to treatment adequacy, erythropoietin requirements, serum haemoglobin concentration, CRP and i–PTH levels, and peritonitis episodes.*

INTRODUCTION

Peritoneal dialysis (PD) is a method of renal replacement therapy. PD involves the transport of solutes and water across the PD membrane, which separates two fluid–containing compartments (the blood in the peritoneal capillaries, which in renal failure contains an excess of urea, creatinine, and other solutes, and the dialysis solution in the peritoneal cavity, which contains sodium, chloride, lactate or bicarbonate, and glucose [acting as an osmotic agent]). During the course of a PD dwell, three transport processes occur simultaneously (diffusion, ultrafiltration, and absorption). The amount of dialysis achieved and the extent of fluid removal depends on the volume of dialysis solution infused (the dwell), how often this solution is exchanged, and the concentration of the osmotic agent (1).

The peritoneal barrier is composed of three layers (the peritoneal mesothelium, interstitium, and the capillary endothelium). According to the three–pore model of solute transport, the capillary endothelium contains three different–sized pores, which are size selective in restricting solute transport (2, 3). Aquaporin–1 is the smallest sized pore and is responsible

for approximately 40% of free water transport across the peritoneal membrane (4). The transcapillary ultrafiltration rate is determined by the net pressure gradient, as well as peritoneal membrane characteristics, and is determined by Starling's law. Both crystalloids and/or colloid–based dialysis solutions may be used to provide the required osmotic or oncotic gradients across the peritoneal membrane (5, 6). PD solutions primarily consist of water, osmotic agents, electrolytes, and minerals (7). Osmotic agents allow net water removal by altering the osmotic pressure gradient between the PD solution and plasma water. Glucose is the most commonly used osmotic agent. Available glucose concentrations include 1.5%, 2.5%, and 4.25% solutions. Amino acids may be used as an alternative to glucose to improve nutritional status in PD patients. Another useable colloid osmotic agent is icodextrin (8–10).

To perform PD, the patients need a PD catheter, the main function of which is to permit consistent bidirectional flow of the dialysate (11). Most catheters are flexible tubes with multiple ports in the distal (intra–abdominal) segment, which is ideally positioned freely in the intra–abdominal pelvic area. The mid–portion of the catheter is normally implanted within the wall of the abdomen via one to two Dacron velour cuffs. With double–cuffed catheters, the deep cuff is imbedded in the abdominal rectus muscle, and the superficial cuff is placed subcutaneously approximately 2 cm from the catheter exit site on the abdominal wall. With different insertion techniques, the catheter is usually placed in a paramedian or lateral abdominal location under general or local anaesthesia (11–13).

Peritonitis is a common complication of PD. Peritonitis may be PD–related or secondary (enteric). PD–related peritonitis is due to touch contamination with pathogenic skin bacteria or to a PD catheter–related infection. Secondary peritonitis is less common and is caused by underlying pathology of the gastrointestinal tract. The most common signs and symptoms of peritonitis among PD patients are abdominal pain and cloudy peritoneal effluent. Other signs and symptoms include fever, nausea, diarrhea, and abdominal tenderness. Patients with secondary peritonitis are more likely to have systemic manifestations of sepsis (14–17, 18).

Ultrafiltration failure may be a result of alterations in the vascular surface area (larger vascular surface area makes more pores available for transport), which leads to the rapid dissipation of the glucose gradient across the membrane and fluid retention. Selective loss of aquaporin–1 function and other factors can also lead to ultrafiltration failure (19–21).

PD can be performed manually, as with continuous ambulatory PD (CAPD), in which the patient performs manual exchanges of fluid several times per day, or with the use of a machine (a cycler), which is referred to as automated PD [APD] (22–24). APD with multiple automated short dwell times over 8–10 hours is often followed by daytime (diurnal) dwells, and is largely reserved for patients who are rapid or high transporters and considered inappropriate for slow or low transporters. If one individualizes the therapy by adjusting diurnal dwell times, osmotic agents, and/or glucose concentration, however, APD appears to work for patients of all transport types (22, 23).

An important question is whether or not there are unique clinical advantages among the two modalities. Although there is a paucity of data, CAPD and APD appear to yield similar mortality rates (25–28). The relative effects of CAPD and APD on residual renal function, peritonitis, volume control, and technique survival are controversial. A clinically relevant difference between modalities on residual kidney function has not been proven (23). Similarly, there appear to be no differences between modalities in other outcomes (peritonitis, volume management, and technique survival) (23, 29).

PD is considered adequate in most patients if the weekly total Kt/V for urea is at least 1.7 and, if considering creatinine clearance, the weekly creatinine clearance is at least 50–60 L/week/1.73m2 body surface area (with some variation based upon transporter status). The Kt/V is calculated from the daily perito-

neal urea clearance (Kt), and the volume of distribution of urea (V). The daily Kt is the product of the total 24–hour peritoneal drain volume and the ratio of the urea concentration in the pooled drained dialysate to that in the plasma (30–32).

Once stable on PD, to optimize a PD prescription, a test to characterize PD membrane transport (peritoneal equilibration test – PET) is recommended (33). The PET is usually performed after approximately 1 month on PD to minimize the early effects PD fluids may have on membrane transport (33). PET is used to test the transport function of the peritoneal membrane of each patient, in which the solutes (creatinine, sodium, urea, and glucose) transport rates are assessed by the rate of the equilibration between the dialysate and the peritoneal capillaries. The PET value will divide patients into four categories: high transporters, who achieve rapid equilibration of the solutes; low transporters, who achieve slower equilibration of the solutes; and high and low average, who have intermediate values of equilibration of the solutes (34–38).

Rapid transporters achieve almost total equilibration between plasma and dialysate for urea and creatinine in a few hours. Rapid transporters are also rapid absorbers of dialysate glucose, thereby removing the osmotic stimulus to ultrafiltration. The net effect is that rapid transporters often begin to absorb dialysate after 2–3 hours, resulting in reductions in ultrafiltration volume and net solute clearance (as the solutes that have diffused into the dialysate are also absorbed back into the systemic circulation). In this setting, standard CAPD, which utilizes prolonged dwell times, might not produce sufficient fluid or solute removal. This would necessitate the more frequent use of hypertonic dialysate (2.5% or 4.25% glucose), potentially inducing hyperglycemia, hypertriglyceridemia, and/or weight gain from the increase in glucose absorption or icodextrin use (39).

Slow transporters need long dwell times to adequately remove small solutes. Ultrafiltration is not an issue in this setting because glucose is also slowly absorbed (39). CAPD is the usual mode of treatment chosen for patients at the beginning of PD (40, 41). Selection of the ideal type of dialysis to achieve optimal dialysis clearance is usually based on the patient's body weight, residual renal function, and the PET. The current recommendation is to perform the PET and Kt/V during the first 4–6 weeks of starting the PD. Patients classified as high transporters are thought to do better with APD, in which a shorter dwell time is used, leading to a better dialysis clearance and fluid removal. Thereafter, high transporters are usually switched from CAPD to APD to achieve the best total dialysis clearance (Kt/V) and fluid removal (34–38).

Patients typically have some residual renal function when they are started on PD. Among patients who have significant renal function, the solute clearance provided by kidney function is added to the Kt/V provided by PD for total solute clearance. Significant renal function is defined as a urine volume >100 mL/day (42). The patient should also be monitored over time for the loss of residual renal function. The associated fall in solute clearance can usually be reversed by increasing the dialysis prescription via an increase in the dwell volume or the number of exchanges per day (42).

At our dialysis centre both APD and CAPD are utilized, but we start all the patients on CAPD and later switch patients to APD based on patient preference and PET results. The reason for starting all the patients on CAPD is to persuade patients to learn the technique at the initiation of the technique. Moreover, the patients often feel abdominal pain when initiating PD, which is less common with CAPD. The patient is potentially switched to APD after the first PET is performed.

MATERIAL AND METHODS

In this retrospective study, we included 12 patients who started treatment of end–stage kidney disease with PD in our centre between 2001 and 2013. The patients included 9 males and 3 females with a mean age of 52.8±11.7 years. The patients were started on CAPD and subsequently made the transition to APD. One–half of the patients (6 of 12) made the transi-

tion by choice, 5 patients transitioned because of inadequate solute clearance on CAPD, and 1 patient transitioned to APD for both reasons. During our observation period of 12 years, 3 of the patients died, 4 patients transferred to HD because of PD technique failure, 3 patients underwent transplantation, and 2 patients were still doing APD at the end of the observation period.

We compared the two periods of different treatment modalities regarding total peritoneal treatment adequacy number (Kt/V), erythropoietin requirements, serum haemoglobin, and CRP and i–PTH levels. Total Kt/V values were obtained with standard PET, which was performed in patients once every 6 months while undergoing CAPD and APD. Serum haemoglobin and CRP and i–PTH levels were obtained during CAPD and APD every 6 weeks at the time of routine follow–up evaluations. Erythropoietin requirements were also assessed every 6 weeks for all patients during both CAPD and APD. We expressed erythropoietin requirements in units of epoetin alfa per week (units/week). For patients who were treated with other epoetins, we used the equimolar conversion ratios (1 unit of epoetin alfa = 1 unit of epoetin zeta = 1 unit of epoetin beta; 200 units of epoetin alfa = 1 mcg of darbepoetin alfa). Conversion of methoxy polyethylene glycol–epoetin beta dosage was based on the ratio between the recommended starting dose given every 2 weeks (Q2W dose) for dialysis patients compared to the recommended starting Q2W dose of darbepoetin alfa for dialysis patients (0.6 mcg/kg for methoxy polyethylene glycol–epoetin beta and 0.75 mcg/kg for darbepoetin alfa), thus 200 units of epoetin alfa = 1 mcg of darbepoetin alfa = 0.8 mcg of methoxy polyethylene glycol–epoetin beta.

We also compared both periods for occurrences of peritonitis, which was expressed as 1 episode of peritonitis in number of patients–months.

Statistical analysis

The values for Kt/V, haemoglobin, CRP and i–PTH levels, and erythropoietin requirements were calculated for CAPD and APD separately and presented as continuous variables with the mean ± standard deviation (SD). We presented the time patients spent on each of two PD modalities as the mean ± SD for both treatment periods. When comparing the above–mentioned variables between the CAPD and APD periods, a paired samples t–test was used. For peritonitis rates, we calculated overall patient–months for all patients and separately for the CAPD an APD periods, and divided the number by total peritonitis episodes and separately for the CAPD and APD periods. For evaluation of differences between PD modalities regarding peritonitis episodes a paired samples t–test was used. SPSS 19.0 software was used for statistical analysis.

RESULTS

Data for all observed variables in both treatment periods, including age of patients and time spent on CAPD and APD, are shown in Table 1.

When comparing the two treatment modalities with a paired samples test, we found no statistically significant differences regarding time spent (p=0.273), Kt/V (p=0.159), haemoglobin (p=0.804), erythropoietin requirements (p=0.303), and CRP (p=0.886) and i–PTH levels (p=0.802).

Peritonitis rates

The total duration of PD of all study patients in the observation period was 805.4 patients–months (293.9 CAPD patient–months and 511.5 APD patient–months). There were a total of 9 episodes of peritonitis (3 episodes in the CAPD period and 6 episodes in the APD period). Five of 12 patients did not develop peritonitis and 5 patients had 1 episode of peritonitis (2 patients in the CAPD period, and 3 patients in the APD period). The remaining 2 patients had 2 episodes of peritonitis during the observation period (1 patient had both episodes in the APD period and 1 patient had 1 episode each in the CAPD and APD periods; Table 2). The overall peritonitis rate was 1 peritonitis episode per 89.5 patient–months. The peritonitis rate for the CAPD and APD periods was 1 episode per 98 and 85.3

Table 1. *Minimum, maximum, mean and SD values for the observed parameters, age, and the days spent on CAPD and APD treatment modalities*

		N	Minimum	Maximum	Mean	Std. Deviation
CAPD	Age	12	37	77	52.8	11.7
	Days	12	45	3472	747.1	1028.2
	Haemoglobin (mg/L)	12	107	128	117.8	6.2
	Epoetin (units/week)	12	0	17937	5290.1	4641.4
	CRP (mg/L)	12	0.7	26.1	8.7	9.3
	i–PTH (pg/ml)	12	100	1535	580.3	445.9
	Kt/V	12	1.7	3.0	2.1	0.4
APD	Age	12	37	77	52.8	11.7
	Days	12	199	3721	1300.0	1041.9
	Haemoglobin (mg/L)	12	100	131	117.1	8.5
	Epoetin (units/week)	12	80	18060	4829.9	4976.6
	CRP (mg/L)	12	1.7	25.8	9.1	8.3
	i–PTH (pg/ml)	12	23.9	1188.0	550.5	400.0
	Kt/V	12	1.9	3.0	2.2	0.4

patient–months, respectively. No statistically significant differences regarding the rate of peritonitis episodes per patients–months between PD modalities existed (p=0.273).

DISCUSSION

In our retrospective analysis, we compared the two PD methods (CAPD and APD) with respect to the differences in treatment adequacy, erythropoietin requirements, haemoglobin, and C–reactive protein (CRP) and intact parathyroid hormone (i–PTH) levels in patients switching from CAPD to APD.

Dialysis treatment adequacy

We found no differences in Kt/V between APD and CAPD; however, the results must be taken with knowledge that most of the patients were high transporters (75%). Therefore, we can only speculate that our results could be different if the group of patients was more heterogeneous concerning the type of membrane transporter. Unfortunately, we did not collect the data about residual renal function (RRF); however, there are only a few studies available that address the problem of decreased RRF while on PD (22, 23). Based on different studies (mainly observational and single–centre studies) there can be no final conclusion that APD leads to a more rapid decline in residual kidney function than CAPD (22, 23).

Serum CRP level

A high serum CRP level, an acute phase reactant, is widely considered as an indicator of an underlying inflammatory disease or a high oxidative stress condition, and a long–term prognostic predictor for patients undergoing dialysis (24, 43–45). CRP has been shown to predict the clinical outcome of various cardiovascular diseases, such as myocardial infarction and stroke, in the general population and in patients with chronic kidney disease (CKD) and those under-

Table 2. *Number of peritonitis episodes during the CAPD and APD periods, days spent on each treatment modality, reason for switching modalities, and status of the 12 patients at the end of PD treatment or end of the observation period*

Patient	Number of peritonitis episodes		Days on PD treatment		Reason for switch from CAPD to APD	Status at the end of PD treatment / observation period
	CAPD	APD	CAPD	APD		
1	0	0	644	525	inadequate CAPD	kidney transplantation
2	0	0	196	199	patient preference	switch to HD – technique failure
3	0	1	483	876	inadequate CAPD	death
4	1	1	798	1131	inadequate CAPD	switch to HD – technique failure
5	1	0	3472	395	inadequate CAPD	kidney transplantation
6	1	0	2121	1555	inadequate CAPD	still on APD
7	0	0	45	3721	patient preference	death
8	0	0	119	2626	patient preference	still on APD
9	0	2	182	1810	patient preference	switch to HD – technique failure
10	0	1	214	749	inadequate CAPD and patient preference	switch to HD – technique failure
11	0	1	586	1590	patient preference	death
12	0	0	105	423	patient preference	kidney transplantation

going dialysis (24, 46). During the past decade, the serum CRP level has emerged as a powerful predictor of mortality in dialysis patients (24, 47–50). It has been reported that 30%–50% of PD patients have increased serum CRP levels (24, 45, 51). It has also been reported that the characteristics of membrane transporter status and RRF in PD patients affect the serum CRP level (24, 52–53).

Some studies have reported that a reduction in RRF and Kt/V leads to an elevated serum CRP level, whereas other studies have not found this correlation (24, 51–58). Controversy exists, however, whether or not the serum CRP high–sensitivity level predicts the clinical outcome of PD patients independent of RRF and Kt/V (24). Shou–Hsuan Liu et al. demonstrated that Kt/V is decreased across the three tertiles (lower, middle, and upper) according to the serum hs–CRP level, whereas there was no significant difference in the RRF across the three tertiles (24). The study showed the importance of hs–CRP in the prediction of 2–year mortality and technique survival in PD patients, independent of age, diabetes, hypoalbuminemia, and the occurrence of cardiovascular events (24).

In the current study, only the serum CRP level, but not the serum hs–CRP level, was compared, and we found no differences between APD and CAPD. Thus, a comparison with other studies is not possible.

Serum haemoglobin level and erythropoietin requirements

The major causes of serum haemoglobin variability in dialysis patients, based on the results from the studies on CKD and haemodialysis patients, are iron deficiency or iron supplementation, angiotensin converting enzyme inhibitor or angiotensin receptor blocker therapy, infection and inflammation, blood loss and transfusion, dialysis inadequacy, acute and chronic comorbid illness, and

secondary hyperparathyroidism (59–61). Different pharmacokinetics (long– vs. short–acting) among erythropoietins can also affect haemoglobin variability (59). A study with PD patients showed that patients with RRF have better metabolic status and nutrition and lower erythropoietin resistance and anemia (59, 62). There are a limited number of studies investigating haemoglobin variation in PD patients (59, 63–65). The multicentre Slovenian study included 51 PD patients and found no correlation between the epoetin resistance index and RRF. The results showed that systemic inflammation, secondary hyperparathyroidism, and angiotensin system antagonist treatment are the most important modifiable parameters affecting epoetin requirements in stable PD patients (66).

In this study, we found no differences in haemoglobin level and erythropoietin requirements between APD and CAPD. This was expected because we did not find any differences in Kt/V and serum CRP and iPTH levels between both PD modalities in our patients. Moreover, closer inspection of our data showed that the PD patients had high dialysis treatment adequacy on average (Kt/V 2.1 for CAPD and 2.2 for APD) and also had a low average level of serum CRP (8.7 mg/L for CAPD and 9.1 mg/L for APD). We did not analyse the impact of angiotensin system antagonist treatment on erythropoietin requirements in our patients; however, the average erythropoietin requirements in our patients were comparable with erythropoietin requirements in previously published studies involving PD patients (66–68).

Serum i–PTH level

Possible links between anaemia and i–PTH include reduced erythropoiesis due to calcitrol deficiency, and direct or indirect effects of i–PTH on erythropoietin release, red blood cell production, survival, and loss (69). The relative role of secondary hyperparathyroidism may be modest compared with more important factors in the pathogenesis of the anaemia in CKD, such as recombinant human erythropoietin deficiency, unavailable iron stores, and chronic inflammation (69). As reported by Suwan (70), 29.8% of 173 CAPD patients had secondary hyperparathyroidism. The duration of CAPD and hypocalcaemia are independent risk factors in the development of secondary hyperparathyroidism (70). Based on the data of the available studies comparing phosphate clearance between APD and CAPD, it is difficult to assess whether or not choice of modality actually affects phosphate clearance (71,72). The available studies are limited by small sample size, design, and lack of adjustments for confounders. Assessing phosphate removal in CAPD compared with APD is challenging because of a substantial bias by indication attributable to differences in RRF, transport status, and required dialysis dose. Loss of RRF could be counterbalanced by APD and an increased dialysis dose. The efficiency of increasing phosphate removal is low and comes with the burden of significantly increased costs. Higher transport status, dialysis dose, and ultrafiltration are associated with higher phosphate removal regardless of modality. Weighing the foregoing evidence and giving special consideration to the confounders in each study, CAPD seems to be slightly favoured over APD with respect to peritoneal phosphate clearance, especially in low transporters (71, 72).

In our patients, the treatment of secondary hyperparathyroidism has been changing over time based on currently accepted guidelines. Unfortunately, we did not compare the serum phosphate and calcium levels between the two modalities. We also did not compare secondary hyperparathyroidism therapy between the two modalities. Our analysis showed no differences in i–PTH levels between APD and CAPD, which is consistent with no differences in haemoglobin levels and erythropoietin requirements. These results were expected because we also did not detect any differences in haemoglobin level, erythropoietin requirements, and serum CRP level.

Peritonitis rate

Peritonitis remains the most important infectious complication in PD and the cause of technique failure and mortality in 15% and 2%–3% of PD patients, respectively. Because of less frequent connections in

APD, the risk of patients making mistakes during connections and disconnections was lessened, and there was new hope for a reduction in the peritonitis rate; however, previously published studies reported conflicting results about the impact of different PD modalities on the frequency of peritonitis episodes (73). Despite the conclusions of some studies that APD might be a better PD modality for reduction of the peritonitis rate, an important limitation of these studies (small number of patients and short follow–up period) should be considered (73). Some recently published studies, including a Cochrane review, stressed that peritonitis occurrences are comparable between both PD modalities (27, 29, 73). In addition, in our small sample, single centre study, no statistically significant differences regarding the rate of peritonitis episodes per patients–months between PD modalities was demonstrated.

Limitations of our analysis

The major drawback to our analysis was the retrospective observational design. Second, there were a small number of patients included. Moreover, it should be noted that the patients switched from CAPD to APD very fast, consequently the observational time for the two modalities was very different (i.e., APD was almost twice as long as CAPD).

CONCLUSION

Based on our results, we conclude that both peritoneal dialysis modalities (CAPD and APD) appear to be equal regarding treatment adequacy, erythropoietin requirements, serum haemoglobin, CRP and i–PTH levels, and peritonitis occurrence.

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