Kidney International, Vol. 63 (2003), pp. 1491–1498

Nutrition in hemodialysis patients previously on a supplemented very low protein diet

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Nutrition in hemodialysis patients previously on a supplemented very low protein diet.

Background. Nutritional safety of protein-restricted diets in patients with chronic renal failure is controversial. In the present study, we have assessed the evolution of nutritional status after initiation of hemodialysis in patients previously treated by a supplemented very low protein diet (SVLPD).

Methods. Nutritional data were prospectively collected during the first year of hemodialysis from 15 consecutive patients treated with a SVLPD (0.3 g protein/kg/day supplemented with essential amino acids, calcium, iron, and vitamins) and compared to 15 age- and gender-matched end-stage renal disease (ESRD) patients previously on a less-restricted diet (0.90 ± 0.21 g protein/kg/day) who started hemodialysis during the same period. Dual-energy x-ray absorptiometry (DEXA) was used to assess body composition at 0, 6, and 12 months. Hemodialysis prescriptions, biologic data and 3-day food records were collected every 3 months.

Results. Protein intake was higher than 1.2 g/kg/day in both groups as soon as 3 months after the start of hemodialysis. Albumin and prealbumin increased significantly during the first 6 months in all patients. Body mass index (BMI) increased in all patients (+0.97 ± 1.31 kg/m^2; $P < 0.001$) reflecting a gain in fat mass in the overall population (+2.36 ± 2.94 kg/m^2; $P < 0.001$) while lean body mass remained stable overall.

Conclusion. Once on hemodialysis, SVLPD patients rapidly increased protein intake. Nutritional status improved in all patients, with a gain in fat mass in all, and a gain in lean body mass in SVLPD men only. These data indicate that treatment with a SVLPD prior to hemodialysis initiation is nutritionally safe.

Nutritional status of patients at the time of initiation of dialysis is a strong predictor of their short-term [1] and long-term outcome [2] and the relative risk of death is conversely correlated with serum albumin levels observed at that time [3, 4]. Prevalence of protein-energy malnutrition among patients starting dialysis therapy varies from 20% to 80%, depending on the choice of nutritional markers and the population studied [3, 5, 6]. At initiation of dialysis, hypoalbuminemia was present in 60% of patients beginning dialysis between the years 1995 and 1997 in the United States and mean and median serum albumin were 32 g/L and 33 g/L, respectively [7]. In prevalent patients treated by dialysis, malnutrition is common [2, 8–10], and nutritional factors are strongly predictive of the risk of death [9, 11–14]. Patients with impaired renal function who have not received dietary advice spontaneously reduce their dietary intake of protein [15], but hardly half of new dialysis patients have been seen by a dietitian and only one third have been seen by a dietitian on two or more occasions before reaching the end stage [16]. Prescription of low protein diet has been put forward among the different factors susceptible to contribute to the high prevalence of malnutrition that is observed at the initiation of dialysis [17–20], although the few studies dealing with the prognosis on dialysis of patients previously on a low protein diet have not shown any deleterious effect on the outcome of these patients [21]. We have previously reported that a good nutritional status could have been maintained until start of dialysis treatment in a study concerning 239 patients treated with a supplemented very low protein diet (SVLPD) [22]. Nevertheless, several authors wondered whether such dietary prescription during a long predialysis period could be responsible for a subsequent poor nutritional status on dialysis with negative consequences on morbidity and mortality [19]. It has also been claimed that these diets delayed the adaptation to a higher protein intake because, once these patients were on dialysis treatment, they were unable to alter their predialysis dietary habits during the first months of dialysis [23].

To address these different concerns, we prospectively followed, during the first year of their dialysis treatment, the eating behavior, nutritional indices, and body composition of patients who were on a SVLPD prior to dialysis. Their results were compared to those of age and gender-matched patients who had only received general dietary counseling.

Key words: body composition, nutritional status, diet, protein-restricted, densitometry, x-ray, renal dialysis.

Received for publication January 9, 2002
and in revised form May 13, 2002, August 27, 2002, and October 16, 2002
Accepted for publication November 25, 2002

METHODS

Patients

From December 1985 to January 1998, a SVLPD (0.3 g protein/kg/day) was proposed to adult patients with advanced chronic renal failure [glomerular filtration rate (GFR) <25 mL/min/1.73 m^2) who were followed in the Service de Néphrologie, Hôpital Pellegrin, Bordeaux, France and were willing to follow such a diet. As previously reported [22, 24, 25], patients who required immediate initiation of dialysis, had excessively severe comorbid conditions, or were obviously unable to adapt to the dietary prescription or to its close monitoring were not given SVLPD. In this period of time, it can be estimated that 30% to 40% of patients presenting with advanced chronic renal failure (CRF) were administered a SVLPD in our department. Between September 1995 and December 1999, 17 consecutive patients who had previously chosen to eat a SVLPD started hemodialysis treatment and were all prospectively studied during the first year of dialysis. Some of these patients were included in the previously reported 239 patient cohort [22]. They were compared to 20 age- and gender-matched uremic patients, followed up for at least 6 months before the initiation of hemodialysis treatment and who were advised to eat a diet providing no more than 1 g protein/kg/day during the predialysis period (control group). Biologic nutritional status and dietary intakes were evaluated at the start of the study, then every 3 months for 1 year. Body composition assessment by dual-energy x-ray absorptiometry (DEXA) was performed at 0, 6, and 12 months. All patients were alive at 12 months and completed the 1-year evaluation but seven patients (two SVLPD and five control) did not complete the intermediary evaluation (dietary recall and DEXA) because they were referred to other distant centers. These seven patients did not differ significantly in either age, gender, body mass index (BMI), or increase in weight gain from those who completed the evaluation (data not shown). All data reported in the present study concern the 30 patients (15 in each group) in whom complete results were available.

Clinical care of the patients

Hemodialysis prescriptions. After the initiation of hemodialysis, patients were treated in different units according to their residence. Dialysis prescriptions (modality and dose of dialysis), epoietin prescriptions, and biologic results (urea, creatinine, plasma bicarbonate) before and after a midweek session were recorded every 3 months. Standard prescription was a single-pool urea Kt/V higher than 1.2 and a dialysis duration of 4 hours three times a week, as is commonly practiced in France [10, 13]. Epoietin prescription was close to the Dialysis Outcome Quality Initiative (DOQI) recommendations (i.e., the common hemoglobin target was 11 g/dL). Iron status was evaluated every month and epoietin and iron prescriptions were adapted at least monthly.

Predialysis diets.

SVLPD group. All patients were prescribed a diet providing daily 0.3 g protein of vegetable origin and 5 to 7 mg inorganic phosphorus per kilogram of body weight [22, 25]. The energy supplied (35 kcal/kg/day) was furnished mainly by carbohydrates (67%). Lipids accounted for 30% of the energy intake and protein for only 3%. For each 5 kg body weight, the diet was supplemented with one tablet of a mixture of essential amino acids and ketoanalogs (Ketosteril®, Fresenius, Germany). Patients who had proteinuria of more than 2 g/day were supplemented with animal proteins of high biologic value calculated on the basis of 1.25 g for 1 g protein in the urine. They also received antihypertensive medications and diuretics as needed according to standard clinical criteria. Patients received calcium carbonate, iron, and vitamin D supplementation according to their biologic status. Patients were evaluated every month as outpatients. After physical examination, a joint dietetic visit with a physician and a dietitian allowed for a readjustment of the prescription when necessary.

Control group. The main standard prescription in patients with advanced CRF was a diet not exceeding 1 g protein/kg/day with calorie intake between 30 and 35 kcal/kg/day. Patients received an initial dietetic counseling, then dietetic reevaluation was performed when needed.

Dietary prescriptions at start of dialysis

After initiation of dialysis therapy, all patients received a standard regimen close to the DOQI recommendations [26]: 1.2 g protein/kg/day and 30 to 35 kcal/kg/day. After a 3-day dietary record, patients received counseling and an adapted written regimen with example.

Dietary evaluation

Daily total energy and protein intakes were assessed by means of 3-day food record every 3 months. Patients were asked to complete a diet diary to assess their protein and energy intake during 2 weekdays and 1 weekend day, including food portion sizes, which was followed by an interview with a skilled dietitian to ensure accurate reporting. Calculation was completed with a computerized nutrient analysis program.

Biologic parameters

Common laboratory blood investigations (urea, creatinine, glucose, total bicarbonates) were performed using standard laboratory techniques every 3 months before and after a midweek dialysis session. Serum albumin, prealbumin, and transferrin were measured by nephelometry in a single laboratory the day between 2 dialysis sessions. Normal values were the following: albumin, 36

Table 1. Baseline characteristics of patients

	SVLPD	Control	*P* value
Number of patients	15	15	
Gender *M/F*	9/6	10/5	NS
Age *years*	57.6 ± 12.6	59.5 ± 12.4	NS
Initial nephropathy			
Glomerulonephritis	5	3	
Diabetes	0	3	
Chronic interstitial nephritis	1	0	
Nephroangiosclerosis	2	2	
Autosomal-dominant polycystic kidney disease	2	2	
Unknown	5	5	
Dietary protein intake *g/kg/day*	0.33 ± 0.09	0.89 ± 0.21	<0.0001
Dietary energy intake *kcal/kg/day*	31.5 ± 6.8	28.4 ± 6.4	NS
P-urea *mmol/L*	14.8 ± 5.8	33.1 ± 11.2	<0.0001
P-creatinine *μmol/L*	717.3 ± 103.2	768.0 ± 159.1	NS
Glomerular filtration rate *mL/mn*[a]	6.3 ± 1.6	—	—
Creatinine clearance *mL/min*[b]	8.7 ± 2.1	8.2 ± 2.4	NS
Proteinuria *g/day*	1.2 ± 1.1	2.4 ± 1.4	0.02
Calcium *mmol/L*	2.33 ± 0.16	2.20 ± 0.24	NS
Phosphorus *mmol/L*	1.45 ± 0.28	1.80 ± 0.61	NS
Bicarbonates *mmol/L*	22.0 ± 3.4	22.0 ± 1.9	NS

SVLPD is supplemented very low protein diet.
[a] GFR was measured by ^{51}Cr-EDTA clearance
[b] Estimated by Cockroft and Gault formula

to 46 g/L; prealbumin, 0.20 to 0.40 g/L; and transferrin, 2 to 3 g/L.

Assessment of body composition

The outcome of body composition was assessed via the serial use of DEXA. The first investigation was performed the week before start of dialysis, then at 6 and 12 months on a midweek day, 15 to 21 hours after completion of a dialysis session [27]. To determine body composition, a whole-body scan (software 8.19 a:3) was performed using a fan beam model QDR-4500 A-DEXA densitometer (Hologic, Inc., Waltham, MA, USA). The scan time was 3 minutes and the radiation dose approximately 2 μSv per scan. The precision error of DEXA is quite low, 425 g for both fat and fat-free mass, allowing longitudinal studies of body composition in individual subjects. The coefficients of variation for DEXA measurements have been reported elsewhere and are 0.8% for bone mineral content, 0.7% for total lean body mass, 1.1% for total fat mass, and 0.8% for long-term reproducibility of percentage of body fat (% fat) [28]. The effect of hydration on percentage of fat is negligible, changing less than 0.6% when the lean mass hydration varied between 78.2% and 68.2% [28].

Statistics

Data are expressed as mean ± SD. Analysis of variance for repeated measurements and paired *t* test were used for evaluation of continuous variables with normal distributions at different time points. For nonnormally distributed variables, the equivalent nonparametric tests were used as needed (Kruskal-Wallis, Mann-Whitney, and Wilcoxon tests). Correlations were studied using Spearman test. $P < 0.05$ was considered significant. All statistical analyses were performed using Statview 5.0 software (Abacus Concept, Berkeley, CA, USA).

Table 2. Comparison of nutritional parameters at baseline between the two groups of patients

	SVLPD	Control	*P* value
Weight *kg*	64.7 ± 11.1	64.3 ± 10.8	NS
Body mass index *kg/m*^{2}	22.6 ± 3.0	23.7 ± 3.4	NS
Lean mass *kg*	44.9 ± 7.8	44.3 ± 7.0	NS
Fat mass *kg*	17.8 ± 6.4	18.1 ± 7.7	NS
Percentage of fat mass %	27.2 ± 8.0	27.7 ± 8.0	NS
Bone mass *kg*	2.1 ± 0.5	1.9 ± 0.4	NS
Albumin *g/L*	37.1 ± 5.8	40.8 ± 5.7	NS
Prealbumin *g/L*	0.39 ± 0.09	0.37 ± 0.1	NS
Transferrin *g/L*	1.91 ± 0.4	1.9 ± 0.40	NS

SVLPD is supplemented very low protein diet.

RESULTS

Clinical characteristics of the patients

The baseline characteristics of the two groups of patients, at the start of the study [i.e., at the start of hemodialysis therapy (T0)], are reported in Table 1 and Table 2. It is noticeable that, unlike many patients with end-stage renal disease (ESRD), the patients of the two groups had no major comorbid illnesses. Before the start of hemodialysis, dietary protein intake and plasma urea were significantly different between the two groups, but calorie intake was not. One week before T0, GFR, evaluated by the urinary clearance of ^{51}creatinine-ethylenediaminetetraacetic acid (^{51}Cr-EDTA) [25] only in the SVLPD group, was 6.2 ± 1.7 mL/min. The estimation of GFR using the Gault and Cockcroft formula [29] was not different between the two groups at T0 (SVLPD, 8.7 ± 2.4 mL/

Table 3. Dialysis parameters

	SVLPD	Control
Dialysis membrane %		
High flux	31	27
Middle flux	16	7
Low flux	53	66
Urea reduction ratio %	69 ± 5.4	67 ± 7.1
Dialysis duration *hours/week*	11.4 ± 1.1	11.4 ± 1.1
Hemoglobin *g/L*	115 ± 12	111 ± 15
Patients with epoietin %	73	66

SVLPD is supplemented very low protein diet. All data were obtained at 12 months.

min; control, 8.2 ± 2.4 mL/min; $P = 0.53$). The duration of SVLPD before dialysis was 42.4 ± 31.2 months (10 to 124 months). During the study, all patients remained free of significant acute illness.

Adequacy of dialysis

No cuprophane membrane was used and membranes were not reused. There was no difference in dialysis prescription between the two groups of patients. Membrane types, mean weekly dialysis time (11.4 ± 1.1 hours), and mean urea reduction ratio (68% ± 6.3%) were similar in the two groups (Table 3).

Dietary intake

The evolution of protein and calorie intakes obtained by dietary inquiry is depicted in Figure 1. At the start of dialysis, dietary protein intake was significantly different between the two groups of patients: 0.33 ± 0.10 g/kg/day in the SVLPD group versus 0.90 ± 0.21 g/kg/day in the control group ($P < 0.0001$). After 3 months of dialysis treatment, dietary protein intake increased significantly, near to recommended values in both groups, and then stabilized till the end of the study. Throughout the 12-month period of dialysis, no significant differences in protein intake were observed between SVLPD patients and those who had received predialysis conventional advice. Protein intakes at the end of the study were 1.29 ± 0.34 g/kg/day in the SVLPD group and 1.16 ± 0.29 g/kg/day in the control group.

At the start of dialysis, energy intake was slightly but not significantly higher in the SVLPD group compared to the control group (31.5 ± 6.8 kcal/kg/day versus 28.5 ± 6.5 kcal/kg/day). The difference became statistically different at 12 months: SVLPD, 31.8 ± 6.8 kcal/kg/day versus control, 26.0 ± 5.2 kcal/kg/day; $P = 0.04$.

Serum phosphorus concentrations were not significantly different ($P = 0.06$) in this small series of patients, but we have previously reported in greater series that SVLPD improves calcium and phosphorus disorders [24, 25].

Nutritional assessment

At the initiation of dialysis, body weight and BMI were similar in the two groups of patients. They progressively

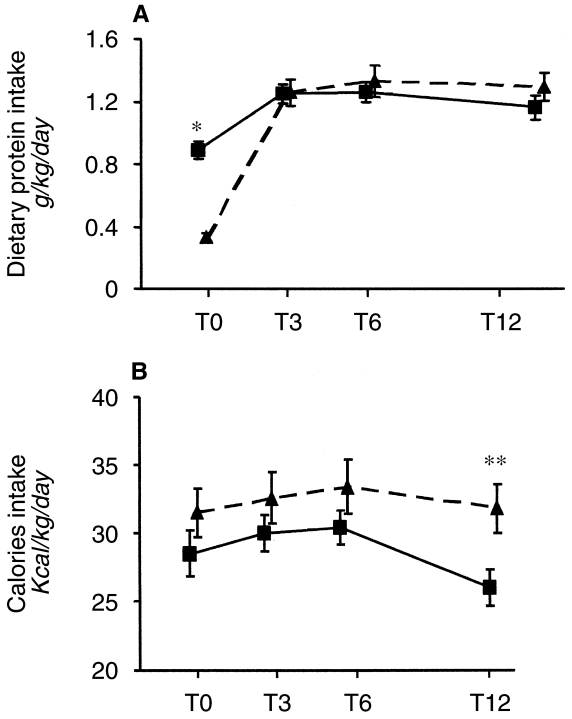

Fig. 1. Dietary intake. Mean daily total energy and protein intakes were assessed by means of 3-day food record every 3 months. (*A*) Protein intake increased significantly in both control patients (■) and supplemented very low protein diet (SVLPD) patients (▲) from 3 months of dialysis treatment and then stabilized until the end of the study. (*B*) Energy intake was close to 30 kcal/kg per day in both groups during the follow-up. Results are expressed as mean ± SEM. $*P < 0.0001$; $**P = 0.04$ control vs. SVLPD.

increased during the year in the two groups by 2.54 ± 2.86 kg and 0.90 ± 1.05 kg/m^2 ($P < 0.01$) in the SVLPD group and by 2.89 ± 4.46 kg and 1.04 ± 1.56 kg/m^2 ($P < 0.05$) in the control group. Biochemical nutritional indices were within the normal range in the two groups. In 20% of patients, proteinuria was higher than 3 g/day, without any correlation between albuminuria and serum albumin levels. Urinary data were not available after the initiation of hemodialysis. On dialysis treatment, in both groups, plasma albumin increased significantly by 17.3 ± 20.1% in the SVLPD group (from 37.1 ± 5.7 g/L to 41.6 ± 4.8 g/L; $P < 0.01$) and 11.7 ± 16.7% in control patients (from 40.8 ± 5.7 g/L to 44.8 ± 6.4 g/L; $P < 0.05$) from T0 to T6 months, and then stabilized. Mean plasma albumin was not statistically different between the two groups. In the same time, serum prealbumin increased by 0.054 ± 0.095 g/L ($P = 0.004$) in the two groups while serum transferrin levels remained unchanged.

Between T0 and T12 months, serum creatinine levels increased in both groups, but at different rates by a mean of 27.8% ± 25.6% ($P = 0.001$) in the SVLPD group and of 14.8% ± 28.6% (NS) in the control group. In the SVLPD group, creatinine values increased regularly during the first 6 months and then stabilized. In the control

Table 4. Evolution of biologic data

	Supplemented very low protein diet			
	T0	T3	T6	T12
Protein *g/L*	61 ± 6.5	71 ± 5.7[b]	73 ± 5.2[c]	74 ± 5.1[c]
Albumin *g/L*	37.1 ± 5.7	40.7 ± 4.8[a]	42.6 ± 5[b]	41.6 ± 4.8[b]
Prealbumin *g/L*	0.39 ± 0.09	0.44 ± 0.09	0.46 ± 0.07[c]	0.44 ± 0.10
Transferrin *g/L*	1.9 ± 0.4	1.9 ± 0.4	2.1 ± 0.4[a]	2 ± 0.37
Urea *mmol/L*	14.8 ± 5.8	27 ± 6[c]	25 ± 9[c]	26.7 ± 5.3[c]
Creatinine *μmol/L*	717 ± 103	811 ± 214[a]	912 ± 160[b]	900 ± 148[b]
Bicarbonate *mmol/L*	22 ± 3.4	23 ± 4	22.5 ± 3	23 ± 2.2
Hemoglobin *g/L*	10.2 ± 1.1	11.4 ± 1.3[a]	10.9 ± 0.9	11.4 ± 1.2[a]
	Control			
	T0	T3	T6	T12
Protein *g/L*	67.4 ± 5.9	72.4 ± 4.7[a]	74.8 ± 6.7[b]	73 ± 6.6[b]
Albumin *g/L*	40.8 ± 5.7	42.6 ± 3.5	45.2 ± 7.2[a]	44.8 ± 6.4[b]
Prealbumin *g/L*	0.37 ± 0.11	0.41 ± 0.06[a]	0.44 ± 0.09[b]	0.43 ± 0.09[b]
Transferrin *g/L*	1.9 ± 0.4	2.1 ± 0.4	2.0 ± 0.4[a]	1.9 ± 0.37
Urea *mmol/L*	33.1 ± 11.2	28 ± 3	25 ± 5	27.0 ± 6.8
Creatinine *μmol/L*	768 ± 159	836 ± 140	815 ± 117	852 ± 157
Bicarbonate *mmol/L*	22 ± 1.9	25 ± 3.3[a]	25 ± 3	24 ± 3.8
Hemoglobin *g/L*	102 ± 16	104 ± 13	112 ± 16	111 ± 15

[a]$P < 0.05$; [b]$P < 0.01$; [c]$P < 0.001$ vs. T0 (paired *t* test)

Table 5. Evolution of body composition during the first year of hemodialysis

	Initial value *kg*	Variation % (0–6 months)	Variation % (0–12 months)
Body weight			
SVLPD	64.7 ± 11.1	3.7 ± 4.3[b]	4.2 ± 4.8[c]
Control	64.3 ± 10.8	2.2 ± 4.7	4.7 ± 7.5[a]
Fat mass			
SVLPD	17.8 ± 6.4	10.6 ± 18.2[a]	12.6 ± 18.7[a]
Control	18.1 ± 7.7	11.2 ± 9.8[c]	16.6 ± 16.1[c]
Lean body mass			
SVLPD	44.9 ± 7.8	1.8 ± 3.9	1.2 ± 4.4
Control	44.3 ± 7.0	−1.4 ± 4.3	0.3 ± 5.8
Bone mass			
SVLPD	2.1 ± 0.5	0.1 ± 3.2	1.4 ± 8.3
Control	1.9 ± 0.4	1.8 ± 3.3	2.1 ± 3.7

SVLPD is supplemented very low protein diet.
[a]$P < 0.05$; [b]$P < 0.01$; [c]$P < 0.005$

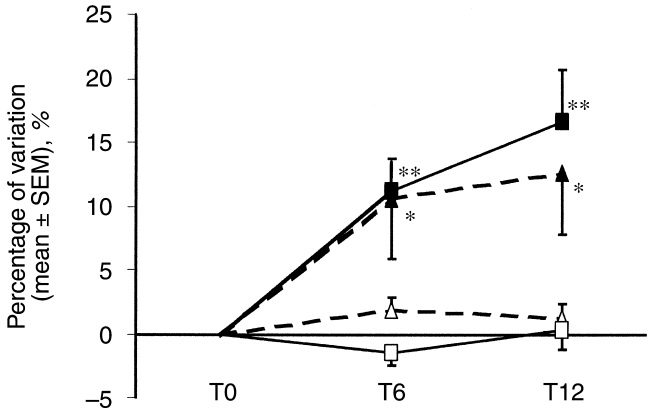

Fig. 2. Evolution of body composition (fat mass and lean body mass). A significant increase occurred in fat mass over the first year of hemodialysis in the two groups of patients (*$P < 0.05$; **$P < 0.005$). No change was observed in lean mass during the same period. Symbols are: (■), control fat mass; (□), control lean mass; (△), SVLPD lean mass; and (▲), SVLPD fat mass.

group, creatinine values increased and stabilized at the third month.

At the end of the year of hemodialysis, hemoglobin levels were higher than 11.0 g/dL in the two groups (Table 4).

DEXA analysis

Lean body mass. At T0, there were no differences in lean mass between the two groups of patients and this was the same at T12 months. Lean body mass remained stable overall in the two groups of patients during the first year of hemodialysis. Results are reported in Table 5 and Figure 2.

Fat mass. Fat mass increased significantly in the two groups of patients [mean difference for the overall population, 2.36 ± 2.94 kg ($P = 0.001$)]. The gain in fat mass between T0 and T12 months was 14.6% ± 17.2% (Table 5 and Fig. 2).

Bone mass. Total bone mass was significantly lower in females than males in all groups. No significant changes occurred during the study year in each group (Table 5).

DISCUSSION

In this prospective study, we have monitored the nutritional status of 15 patients previously on SVLPD and 15 uremic patients who had only received conventional predialysis dietary counseling during the first year of their dialysis treatment. In both groups, adaptation to a higher protein intake was obtained within 3 months, nutritional biochemical markers increased progressively and were stable after 6 months. Body weight and BMI increased in patients of both groups, but body composi-

tion evolved in a somewhat different manner according to gender and predialysis dietary prescription.

At the initiation of dialysis treatment, renal function was similar in the two groups of patients, the lower serum creatinine levels observed in the SVLPD group being due to the restriction of proteins from animal origin, which is accompanied by a lower intake of exogenous creatine [25]. These values of GFR are lower than the values recommended by the DOQI recommendations [30] to begin dialysis, which have been challenged recently [31], but close to those reported in different series [32, 33], including a previous study by our group in which the isotopic GFR of 165 SVLPD patients was 5.8 ± 1.5 mL/min/1.73 m^2 at the initiation of dialysis [22]. In the two groups, daily energy intake was close to 30 kcal/kg/day before dialysis in accordance with previously reported results [22], and higher than usually observed in patients with similar renal function [e.g., 22.9 ± 1.3 kcal/kg/day in patients with GFR <10 mL/min studied during the follow-up period of the pilot study of the Modification of Diet in Real Disease (MDRD) Study] [34]. Satisfactory compliance with predialysis dietary counseling was evidenced by the estimated protein intake that was very close from the recommended objectives in the two groups.

Concerns have been raised about the ability of incident hemodialysis patients to increase their protein intake early after the initiation of dialysis [23]. In a study concerning 52 hemodialysis patients, Pollock et al [23] reported that, regardless of their predialysis dietary regimen, patients failed to increase their protein intake within 3 months after the initiation of dialysis. Increase in protein intake became significant only 6 to 9 months after the beginning of dialysis. Pollock et al concluded "that adaptation from a low to high protein diet after the initiation of dialysis is almost uniformly unsuccessful in the short term" [23]. However, in the present study, perhaps because of a regular dietary survey before dialysis, at least for patients on SVLPD, patients of both groups adapted very quickly to their new dietary regimen. At 3 months, energy intake was slightly above 30 kcal/kg/day and protein intake above 1.2 g/kg/day in the two groups. Dietary assessment was not performed before the third month, but it is likely that the adaptation to dietary prescription occurred very early, regardless of the predialysis protein intake. It can be concluded that predialysis SVLPD does not represent, by any means, an obstacle to a quick adaptation of dialyzed patients to their new regimen.

Numerous studies about the evolution of nutritional status of prevalent dialyzed patients have been reported with an initial cross-sectional assessment performed after various dialysis vintage [2, 8–14]. In the present study, serum levels of the different nutritional biochemical markers increased during the first 6 months in the two groups of patients, regardless of their predialysis diet, and stabilized thereafter at the upper limit of the normal range. Close results have been reported in most series dealing with the nutritional outcome of incident dialysis patients with an increase in serum albumin during the first 6 to 12 months after initiation of dialysis (abstract; Pupim et al, *J Am Soc Nephrol* 12:362A, 2001) [35–38]. Parker et al [36] have found that the increase of albumin was earlier and greater in patients who were dialyzed with biocompatible instead of cuprophane membranes. It is likely that these results were related to the diminution of the inflammatory response during dialysis. In our study, all patients were dialyzed on biocompatible membranes, but we have not evaluated their inflammatory status. The combination of several mechanisms may explain this frequent increase in serum albumin observed during the first months on dialysis: increased protein intake, a relative hemoconcentration observed in the first weeks in patients who were volume overloaded at the beginning of their dialysis treatment, and a decline in proteinuria observed after the initiation of dialysis [37]. Inflammation also plays a key role in nutritional status changes in hemodialysis patients [39]. Improvement of general status and of appetite, increased vigor, and functional capacity are commonly observed in newly dialyzed patients. Weight gain is frequently observed, even if it was not the case in all the above-mentioned series. The increase of BMI was statistically significant neither in Jager et al [38] nor in Ishimura et al [40] series.

Assessment of dry body weight is difficult particularly during the first months of dialysis because rapid changes in hydration status occur at this time. To assess more precisely body composition and its outcome in patients, we have used DEXA, which is an easy to perform and very accurate method to determine body composition in healthy subjects [41], with a high reproductibility rate [42, 43]. However, as this technique is not able to differentiate intracellular and extracellular water [42, 43], the volume status must be considered when lean body mass is estimated by DEXA. In hemodialysis patients, who present large variations in fluid status, measurements of body composition should be made when patients are close to their dry weight to avoid discrepancies in hydration status likely to interfere with lean body mass assessment [27, 44]. In our study, all measurements were performed roughly at the same time after a dialysis session (15 to 21 hours after dialysis) in order to have comparable fluid status at the time of assessment. DEXA has been previously used in prevalent hemodialyzed patients in cross-sectional studies [45–47] or serially to follow changes in body composition but, to our knowledge, only Ishimura et al [40] have used DEXA to assess the changes in body composition during the first year of hemodialysis treatment. Despite no significant changes in energy intake, fat mass increased in patients of both groups, suggesting a better substrate and energy utilization once on

dialysis. The increase was not correlated to initial nutritional status and was different according to gender and predialysis diet. Fat mass increased also in the study of Ishimura et al [40], but no significant differences were observed between men and women. Pupim et al have also found by bioelectrical impedance a progressive increase in fat mass during the first year of dialysis treatment (abstract; Pupim et al, *J Am Soc Nephrol* 12:362A, 2001).

In the present study, lean body mass remained stable during the first year of hemodialysis. Ishimura et al [40], who have observed a decrease in lean body mass, have suggested that this decrease might reflect progressive fluid removal to achieve optimal dry weight. It is likely that, in our patients whose body weight increased steadily until the end of the study, the possible fluid removal was concealed by a regular increase in protein synthesis. Ikizler et al [48] showed recently that a dialysis session is a catabolic event and leads to a net loss of protein stores. However, longitudinal survey of the nutritional effects of dialysis treatment showed that hemodialysis per se improves body protein metabolism, which may be due to the clearance of uremic toxins counterbalancing the catabolic effects of hemodialysis. Using a leucine kinetic study before and 8 to 10 weeks after initiation of dialysis treatment in incident patients maintained on an unchanged diet, Lim, Yarasheski, and Flanigan [49] observed after initiation of dialysis treatment, restoration of protein flux to normal, and an increase in protein synthesis.

The positive effect of the initiation of dialysis on nutritional status of patients with CRF was recently confirmed in two studies. Mehrotra et al [50] showed a progressive increase of serum albumin levels in 97 patients during the first 6 months following the initiation of hemodialysis. This increase was associated with an increase of protein intake but the relationship between serum albumin and nitrogen appearance was not significant. Pupim et al [51] found similar results in 50 patients during the first year of hemodialysis with an improvement of biologic parameters and a gain of fat mass without increase of lean body mass. Their patients showed a small decrease in total body weight and lean mass but it was not significant. A similar evolution of nutritional status after the initiation of hemodialysis was also found in our study in control patients and in patients previously on SVLPD who increased their dietary energy and protein intake.

CONCLUSION

The prescription of SVLPD prior to dialysis does not preclude an early adaptation of patients to their new dietary regimen, as also observed in their counterparts who had only received general predialysis counseling. In both groups of patients, who were adequately dialyzed, clinical and biochemical nutritional indices improved during the first year of dialysis treatment. DEXA analysis showed that fat mass increased in all groups of patients and lean body mass remained stable. These findings confirm the absence of deleterious effects of predialysis SVLPD on the outcome of patients once they are on dialysis treatment.

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