Nutritional status in type 2 diabetic patients requiring haemodialysis

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Abstract

Background. Type 2 diabetic patients with end-stage renal disease are often overweight (BMI > 24) at the start of dialysis therapy. However, there are very few reports in the literature concerning the nutritional status of these patients after prolonged haemodialysis treatment. Therefore, we compared nutritional parameters in type 2 diabetic patients and age-matched non-diabetic patients after at least 18 months of renal replacement therapy with haemodialysis.

Methods. In a cross-sectional study, we measured BMI, serum albumin, total protein, serum cholesterol and interdialytic weight gain (IWG), and performed a subjective global assessment (SGA) in 14 patients with type 2 diabetes and 16 non-diabetic patients (aged ≥ 50 years, haemodialysis therapy ≥ 18 months). Protein intake was estimated using the protein catabolic rate (PCR) and Kt/V was calculated to compare the dose of dialysis.

Results. BMI was significantly higher in patients with type 2 diabetes (30 ± 7 vs 24 ± 3, P < 0.01). In contrast, the concentration of serum albumin was significantly lower (3180 ± 499 mg/dl vs 3576 ± 431 mg/dl, P < 0.05), but six of the diabetic patients had signs of chronic inflammation. All other nutritional parameters did not differ between the two groups. In addition, there were no significant differences in the intake of protein (PCR 0.93 ± 0.19 vs 0.92 ± 0.22) and the dose of dialysis (Kt/V 1.13 ± 0.19 vs 1.2 ± 0.2).

Conclusion. After ≥ 18 months of haemodialysis therapy, the majority of type 2 diabetic patients (9/14) were still overweight (BMI > 24). The nutritional status of diabetic patients was similar to that of age-matched non-diabetic patients on prolonged haemodialysis, but serum albumin levels were significantly lower in diabetics. The lower albumin levels in the diabetic patients may be explained by a state of subclinical chronic inflammation.

Key words: dietary protein intake; haemodialysis; nutrition; type 2 diabetes

Introduction

The importance of nutrition to the health of chronic haemodialysis patients has been recognized in recent years [1]. Malnutrition is found in ~30% of haemodialysis patients, and is associated with increased mortality and morbidity [2,3]. The nutritional parameters assessed in the majority of studies [4,5] include serum albumin, pre-albumin, cholesterol, transferrin, normalized protein catabolic rate (nPCR) and interdialysis weight gain. The concentration of serum albumin is related to the mortality rate of these patients [4]. In addition to malnutrition, chronic inflammation and urinary protein loss may also contribute to low albumin levels.

Many patients with type 2 diabetes and end-stage renal disease (ESRD) are overweight at the start of chronic dialysis therapy. Despite obesity, many of these patients suffer from malnutrition during renal replacement therapy. However, there are only limited data in the literature concerning the differences between the nutritional status of haemodialysis patients with and without diabetes after prolonged haemodialysis [6,7].

The aim of the present study was to compare the nutritional status of elderly chronic haemodialysis patients with and without type 2 diabetes. In addition, we evaluated the potential influence of inflammation and residual proteinuria on the serum albumin levels of diabetic and non-diabetic patients.

Patients and methods

In a cross-sectional study, we compared the nutritional status of elderly haemodialysis patients (aged 50–75 years at the start of dialysis) after prolonged (≥ 18 months) haemodialysis. From 1991 to 1995, a total of 76 patients, aged 50–75 years, started dialysis in our centre. Thirty-six of them had type 2 diabetes (mean age ± SD = 58 ± 8 years, female to male ratio 16:20, BMI 25 ± 4) and 40 had no diabetes (age = 57 ± 6 years, female to male ratio 18:22, BMI 24 ± 4).

Twenty diabetic and 13 non-diabetic subjects died and two diabetic and eight non-diabetic individuals received renal transplants. Patients with liver cirrhosis (n = 2) and malignancy (n = 1) were excluded from the study. Thus, 30 patients on chronic haemodialysis (≥ 18 months) were evaluated; 14
with type 2 diabetes (mean age $\pm$ SD $= 61 \pm 10$ years, female to male ratio 6:8) and 16 without diabetes (age $= 60 \pm 10$ years, female to male ratio 7:9). The mean duration of haemodialysis was 29 $\pm$15 months among diabetic patients and 31 $\pm$13 months among non-diabetic individuals. All patients were dialysed three times a week for 4–5 h. This schedule was maintained during the entire period of observation (diabetic patients $13.5 \pm 1.3$ vs $12.5 \pm 1.1$ h/week for the non-diabetic patients). Cuprophan dialysers with a membrane surface of 1.2–1.5 m$^2$ were used for the majority of patients, two diabetic and three non-diabetic subjects were haemodialysed with polysulfone filters. Metabolic control of the diabetic patients was achieved by insulin substitution in eight cases, by sulphonyl urea therapy in two cases and by diet in four individuals. The primary renal diseases of the non-diabetic patients were chronic glomerulonephritis ($n = 10$), chronic interstitial nephritis ($n = 4$) and arterionephrosclerosis ($n = 2$). The diagnosis of glomerulonephritis was confirmed by renal biopsy in eight cases; in all other patients renal disease was clinically diagnosed. Diagnosis of diabetic nephropathy was based on the demonstration of persistent proteinuria (>0.5 g protein/24 h-urine) and normal urine sediment in the presence of chronic diabetes.

We measured body weight (dry weight and weight at the end of haemodialysis), serum cholesterol, pre-dialysis creatinine and blood urea nitrogen (BUN), total protein, serum albumin (Hitachi 750 autoanalyzer) and inter-dialytic weight gain [5]. In patients with significant residual diuresis ($>100$ ml urine/day) we also measured urinary protein excretion (by the Biuret method). No patient had oedema at the time of investigation. Additionally, a single investigator performed a subjective global assessment (SGA) of the nutritional status of all patients [6]. The protein intake was estimated by nPCR at the end of the study according to the formula of Gotch and Sargent [8], and the adequacy of dialysis was assessed by calculating the single-pool-$Kt/V$ according to the formula of Daugirdas [9,10]. We compared the mean values of all parameters and the prevalence of pathological nutritional parameters between both patient groups. Moreover, we examined the correlation between BMI and serum albumin as the most potent predictor for mortality. Malnutrition was defined as the presence of serum protein $<60$ g/l, serum albumin $<3500$ mg/dl, total cholesterol $<150$ mg/dl, interdialytic weight gain $<2$ kg and PCR $<0.9$ g/kg/day [5,6,11]. For statistical analysis we used an unpaired Student's $t$-test to compare means between two groups and the $\chi^2$ test to compare prevalences between groups. Pearson's correlation coefficients were computed to test relationships between variables. All statistical tests were two-tailed. A $P$-value $<0.05$ was considered statistically significant.

Results

The BMI was significantly higher in patients with type 2 diabetes than in non-diabetic individuals ($30 \pm 7$ vs $24 \pm 3$, $P<0.01$). Nine of the diabetic patients (64%) were overweight (BMI $>24$), as opposed to only seven of the non-diabetic subjects (44%). In contrast, the mean concentration of serum albumin was significantly lower in the diabetic group ($3180 \pm 499$ mg/dl vs $3576 \pm 431$ mg/dl, $P<0.05$). The mean data of the other measurements were approximately the same; only weight gain was significantly higher among diabetic subjects. All parameters ($mean \pm SE$) of the two patient groups are summarized in Table 1. The prevalence of pathological nutritional parameters are shown in Table 2. The prevalence of pathological nutritional parameters tended to be higher in diabetic patients, however, the differences were not statistically significant. There was no significant correlation ($r=0.381$) between BMI and the serum albumin concentration (Figure 1) for the diabetic patients. The residual diuresis was similar in both groups, only three (21%) diabetic patients and five (31%) non-diabetic individuals had urine excretion $\geq 100$ ml/day; the mean urinary loss of protein in all diabetic and non-diabetic patients was not significantly different ($126 \pm 32$ mg/day vs $102 \pm 88$ mg/day).

### Discussion

Protein–calorie malnutrition in dialysis patients is associated with higher mortality and morbidity [11,12]. Malnutrition is common (30–40%) in patients on maintenance haemodialysis [2] and can be caused by low nutrient intake, concomitant illnesses and inadequacy of dialysis treatment [1]. Serum albumin level was the strongest predictor of mortality in all studies [2,4], and correlated best with clinical nutritional assessment [6].

### Table 1. Body mass index (BMI), nutritional parameters, protein catabolic rate (PCR) and $Kt/V$ (mean $\pm$ SD) of the patients with and without type 2 diabetes after $\leq 18$ months haemodialysis therapy

<table>
<thead>
<tr>
<th></th>
<th>Diabetic patients ($n=14$)</th>
<th>Non-diabetic patients ($n=16$)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BMI (kg/m$^2$)</strong></td>
<td>$30 \pm 7***$</td>
<td>$24 \pm 3***$</td>
</tr>
<tr>
<td>S-total protein (g/l)</td>
<td>$67 \pm 7*$</td>
<td>$66 \pm 5*$</td>
</tr>
<tr>
<td>S-albumin (mg/dl)</td>
<td>$3180 \pm 499**$</td>
<td>$3576 \pm 431**$</td>
</tr>
<tr>
<td>S-total cholesterol (mg/dl)</td>
<td>$182 \pm 52*$</td>
<td>$193 \pm 31*$</td>
</tr>
<tr>
<td>Interdialytic weight gain (kg)</td>
<td>$4.1 \pm 0.8*$</td>
<td>$3.4 \pm 0.8*$</td>
</tr>
<tr>
<td>Protein catabolic rate (g/kg/day)</td>
<td>$0.93 \pm 0.19*$</td>
<td>$0.92 \pm 0.22*$</td>
</tr>
<tr>
<td>$Kt/V$ single pool</td>
<td>$1.13 \pm 0.19*$</td>
<td>$1.20 \pm 0.21*$</td>
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<tr>
<td></td>
<td>*n.s.</td>
<td><strong>P&lt;0.05</strong>, ***P&lt;0.01.</td>
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<tr>
<th></th>
<th>Diabetic patients</th>
<th>Non-diabetic patients</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BMI ($&lt;21$ kg/m$^2$)</strong></td>
<td>1 (7)*</td>
<td>1 (6)*</td>
</tr>
<tr>
<td>S-total protein $&lt;60$ g/l</td>
<td>1 (7)*</td>
<td>1 (6)*</td>
</tr>
<tr>
<td>S-albumin $&lt;3500$ mg/dl</td>
<td>9 (64)*</td>
<td>6 (37)*</td>
</tr>
<tr>
<td>S-total cholesterol $&lt;150$ mg/dl</td>
<td>5 (35)*</td>
<td>3 (19)*</td>
</tr>
<tr>
<td>Interdialytic weight gain $&lt;2$ kg</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>PCR $&lt;0.9$ g/kg/day</td>
<td>6 (43)*</td>
<td>6 (37)*</td>
</tr>
<tr>
<td>Subjective global assessment</td>
<td>subjective well nourished</td>
<td>8 (59)*</td>
</tr>
<tr>
<td></td>
<td>subjective moderate nourished</td>
<td>4 (29)*</td>
</tr>
<tr>
<td></td>
<td>subjective malnourished</td>
<td>2 (14)*</td>
</tr>
</tbody>
</table>

*n.s.*
Fig. 1. Correlation between BMI and serum albumin concentration in the type 2 diabetic patients after ≤18 months on haemodialysis therapy; $r$-value = 0.381 (n.s.).

However, this correlation was not confirmed by other authors [13]. Malnourished patients have a serum albumin level < 3.5 g/dl, while patients with an albumin concentration < 3.0 g/dl show a higher incidence of death [3]. Other nutritional parameters such as serum total protein, pre-albumin, transferrin and cholesterol did not have the same specificity. Interdialytic weight gain has also been described as a nutritional marker, a weight gain < 2 kg/day is associated with a lower nPCR [5].

In our study, only the mean serum albumin levels were significantly lower among type 2 diabetics compared with non-diabetic individuals (Table 1). The majority of diabetic patients were still overweight with haemodialysis therapy (64% vs 44% of the non-diabetic subjects). The lower albumin levels could not be explained by malnutrition in these patients; the prevalence of all other pathological markers for malnutrition showed a tendency to be higher in the diabetic patient group, but the differences were not statistically significant with the exception of interdialytic weight gain which was higher among diabetics (Table 2). Moreover, a significant loss of albumin in urine could be excluded as a reason for lower albumin levels in our diabetic subjects. Total protein concentrations were approximately the same in both patient groups.

It has been reported in the literature that a higher dose of dialysis can improve serum albumin levels [14]. However, there was no significant difference in Kt/V between both groups in our study. The lower serum albumin levels in our haemodialysis diabetic patients can be partially explained by a higher incidence of infectious diseases. Six of the diabetic individuals (43%) had chronic diabetic ulcer or gangrene with local inflammation during the 3 months prior to the study; five of them had a serum albumin level < 3.5 g/dl.

Many of the diabetic patients ($n = 9/14, 64\%$) were still overweight after ≥18 months of haemodialysis therapy. The prevalence of overweight patients was greater in the group of surviving diabetic patients on haemodialysis than in those who died. At the start of dialysis therapy the mean BMI of the non-survivors was 22 ± 3 in contrast to 29 ± 8 of the survivors ($P > 0.01$).

In our surviving patients, we found no correlation between total body weight, BMI and serum albumin, the latter being the strongest predictor for mortality in haemodialysis patients. For diabetic subjects, this phenomenon is illustrated in Figure 1 ($r$-value = 0.381, n.s.). The mean serum albumin concentration among diabetic patients who were severely overweight (BMI ≥ 30, $n = 7$) was approximately the same as that in diabetic individuals with a lower body weight (3184 ± 151 mg/dl vs 3240 ± 320 mg/dl) ($n = 7$). The protein intake estimated by nPCR was similar among patients with and without diabetes. In addition, Kt/V as a parameter for the quality of haemodialysis [15] did not differ among the two patient groups.

In summary, the prevalence of malnutrition was not significantly higher in type 2-diabetic patients than in age-matched non-diabetic patients after ≥18 months of haemodialysis therapy. The lower serum albumin levels of patients with type 2 diabetes may be partly explained by more frequent intercurrent illnesses. The influence of residual urinary loss of protein on serum albumin concentrations was negligible in our patients.

References
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