Is it possible to control hyperphosphataemia with diet, without inducing protein malnutrition?

Margarita Rufino, Eduardo de Bonis, Marisa Martín, Sagrario Rebollo, Basilio Martín, Rosa Miquel, Marián Cobo, Domingo Hernández, Armando Torres and Victor Lorenzo

Nephrology Service, Hospital Universitario Canarias and 1Nephrology Section, Hospital Tamaragua, Santa Cruz de Tenerife, Spain

Abstract Dietary intervention, phosphate (P) removal during dialysis and, especially, phosphate binders are current methods for the management of hyperphosphataemia. Ideally, the amount of P absorbed from the diet should equal the amount of P removed during dialysis, and this must occur in the context of an adequate protein intake. We evaluated the relationship between P intake and protein intake in 60 stable chronic uraemic patients (mean age 55 ± 15 years, 25% diabetics, 68% males) on standard 4 h haemodialysis. The dietary counselling was relatively free for protein and calories. Nutrient intake was recorded during a 5 day period, and average daily ingestion of P and proteins was calculated using a computerized diet analysis system. A highly significant correlation was observed between protein and P intake. The mean daily ingestion of P and proteins was 998 ± 316 mg and 64 ± 19 g (1 ± 0.4 g/kg/day), respectively. For an optimal protein diet of 1–1.2 g/kg/day, the P intake was 778–1444 mg. The amount of P removed by haemodialysis, extrapolated to an average week, is 250–300 mg/day. Since ~40% of P ingested is absorbed from the gut by uraemic patients treated with intestinal P binders, 750 mg of P intake should be the critical value above which a positive balance of P may occur. This value corresponds to a protein intake of 45–50 g per day (>0.8 g/kg body weight/day for a 60 kg patient). In patients undergoing standard chronic haemodialysis, a neutral P balance is difficult to achieve, despite phosphate binder therapy, when protein intake is >50 g. Additional protein restriction, in order to obtain a neutral balance, may impose the risk of protein malnutrition.

Key words: chronic haemodialysis; dietary phosphorus; hyperphosphataemia; malnutrition; protein intake

Introduction

Control of hyperphosphataemia is crucial to prevent the development of secondary hyperparathyroidism and renal osteodystrophy. Dietary intervention, phosphate removal during dialysis and, especially, phosphate binders are current methods for the management of hyperphosphatemia [1–3].

In the majority of dialysis patients, phosphorus (P) intake largely exceeds the amount of P removed during haemodialysis. Thus, the use of bowel P binders is almost universal in this population. In spite of this, some patients suffer uncontrolled hyperphosphataemia. The reduction of P intake is considered an additional measure for the prevention of P retention. However, P intake is closely related to protein intake [4], and an excessive reduction of P in the diet may jeopardize an adequate protein nutrition.

The purpose of this study was to assess the relationship between phosphorus and protein intake in chronic haemodialysis patients on an unrestricted protein diet. From this relationship, we derived the maximum reduction of P intake not associated with undesirable protein restriction.

Subjects and methods

In a cross-sectional study, we evaluated 60 chronic haemodialysis patients (25% diabetics), 41 male and 19 female, aged 55 ± 15 years (range 22–80 years) on haemodialysis treatment for 80 ± 42 months (range 3–240 months). All patients were in a steady clinical condition and free from recent medical complications.

All patients were on thrice weekly, 4 h standard bicarbonate haemodialysis. Most patients received phosphate binders to avoid hyperphosphataemia, together with vitamin supplements. Calcium carbonate was the primary P binder, and aluminum hydroxide was added in moderate amounts when serum P remained >5.5 mg/dl. No patients received anabolic steroids or protein supplements. The diet was relatively free, with potassium, sodium and fluid restriction according to the patient’s needs.
**Assessment of nutrient intake**

The dietary intake was recorded during a 5 day period, which included two dialysis days and the weekend. From the food intake records, the average daily ingestion of nutrients was calculated using a computerized diet analysis system obtained from the current standard tables of the dietetic section of our hospital.

**Statistics**

All the data are expressed as mean ± SD. Regression analysis was employed for statistical evaluation using the RSigma® software (Horus Hardware, Madrid). Significant differences were defined by $P<0.05$.

**Results**

The mean daily ingestion of nutrients is shown in Table 1. The average daily protein intake equalled the recommended 1 g/kg body weight. However, the mean daily calorie intake was ~25% lower than the recommended 35 kcal/kg/day. Dietary intake of calcium was deficient compared with the recommendations for uraemic patients, who need >1 g per day. P intake was relatively high (982 ± 336 mg/day) for the current capacity of P removal by dialysis.

Figure 1 shows a highly significant correlation between dietary P intake and protein intake. The linear regression and 95% confidence interval demonstrate that a standard protein diet of 60 g (1 g/kg/day for a 60 kg patient) provides an obligatory P intake of 880–980 mg.

Table 2 shows the dietary P content at different levels of protein intake. The last column shows the estimated percentage of P absorbed from the diet in patients on P binder therapy. For the calculations, we used the average reported percentage absorption (30–40%) [5–7].

**Discussion**

In order to prevent P retention in stable chronic haemodialysis patients, adequate phosphorus removal by dialysis, restriction of phosphorus intake and the use of intestinal phosphate binders should be considered.

The reported amount of P removed by dialysis is quite variable. The dialysate calcium concentration, the type of buffer (acetate or bicarbonate), the type of membrane or the increase in convective transport, as in haemodiafiltration, have failed to demonstrate a significant effect on net P removal. Comparative studies indicate that the average daily P removal by a standard 4 h haemodialysis is 250–300 mg [2,3], and the major determinant of net mass removal of P is the predialysis serum P level.

In order to maintain P balance, the amount of P absorbed from the gut should equal the amount removed by dialysis. As P and protein intake are related, dietary phosphorus restriction should always be viewed in the context of an adequate protein intake of ≥1 g/kg/day. Because of the catabolic stresses associated with the dialysis procedure, a lower protein intake poses the risk of malnutrition and increase in mortality [8–10]. The present study clearly demonstrates a highly significant and direct correlation between phosphorus and protein intake in chronic

**Table 1.** Mean daily ingestion of calories, proteins, calcium and phosphorus

<table>
<thead>
<tr>
<th>Calories (kcal/kg/day)</th>
<th>26 ± 9</th>
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<tbody>
<tr>
<td>% Proteins</td>
<td>16 ± 4</td>
</tr>
<tr>
<td>% Carbohydrates</td>
<td>48 ± 9</td>
</tr>
<tr>
<td>% Lipids</td>
<td>38 ± 8</td>
</tr>
<tr>
<td>Proteins (g/day)</td>
<td>64 ± 19</td>
</tr>
<tr>
<td>Calcium (mg/day)</td>
<td>738 ± 293</td>
</tr>
<tr>
<td>Phosphorus (mg/day)</td>
<td>982 ± 336</td>
</tr>
</tbody>
</table>

**Table 2.** Dietary P content (mean ± SD), at different levels of protein intake, in 60 stable chronic haemodialysis patients

<table>
<thead>
<tr>
<th>Protein intake (g/kg/day)</th>
<th>No. of patients</th>
<th>Diet phosphorus content (mg/day)</th>
<th>Range</th>
<th>Estimated percentage of P absorbed in patients on P binder therapy (30–40%) [5,7]</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;1.2</td>
<td>15</td>
<td>1353 ± 272</td>
<td>873–1784</td>
<td>406–541</td>
</tr>
<tr>
<td>1–1.2</td>
<td>10</td>
<td>1052 ± 219</td>
<td>778–1444</td>
<td>315–421</td>
</tr>
<tr>
<td>0.8–1</td>
<td>15</td>
<td>936 ± 217</td>
<td>480–1352</td>
<td>281–374</td>
</tr>
<tr>
<td>0.6–0.8</td>
<td>13</td>
<td>831 ± 142</td>
<td>574–1056</td>
<td>249–332</td>
</tr>
<tr>
<td>&lt;0.6</td>
<td>7</td>
<td>599 ± 105</td>
<td>475–760</td>
<td>180–240</td>
</tr>
</tbody>
</table>
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