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FACTORS INFLUENCING THE HYPERMAGNESAEMIA OF CHRONIC HAEMODIALYSIS

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Summary

In 18 patients treated by maintenance haemodialysis, different factors responsible for their observed hypermagnesaemia were studied. Efforts to reduce the hypermagnesaemia in these patients were not rectified by reducing dialysate magnesium content from 0.5 to 0.0mmol/L. The magnesium intake due to the use of magnesium-containing phosphate binders was calculated to be between 2.15 and 64.5mmol/day, and a strong positive correlation was observed between plasma magnesium and drug magnesium intake ($r=0.85$; $p<0.001$). A return to normal of the plasma magnesium could be achieved one month after stopping these drugs.

Introduction

Hypermagnesaemia, a frequent observation in chronic haemodialysed patients, can induce gastrointestinal, cardiovascular and neurological disorders [1]. Hypermagnesaemia has been thought desirable in uraemic patients due to its described suppressive action on parathyroid hormone secretion [2], which has recently been questioned [3]. It has, however, remained routine practice in most of the dialysis units to use a dialysate containing magnesium 0.5 or 0.75mmol/L. The present study determines the relative importance of the factors affecting the plasma magnesium concentration and tries to manipulate this concentration by modifying dialysate magnesium.

Patients and methods

Eighteen patients (11 men and 7 women) aged 60.7±11.5 years and dialysed for 557±83 minutes weekly were studied. The mean duration of maintenance haemodialysis was 23.6±4.3 months (range 1 to 62). Patients were divided into two groups according to dialysate magnesium. The first group consisted of

eight patients dialysed against 0.5mmol/L of magnesium. The second group consisted of 10 patients dialysed with magnesium-free dialysate. During the course of this study, all patients received phosphate binders as a mixture of 375mg of aluminium hydroxide and 125mg of magnesium hydroxide per tablet.

To determine the loss of magnesium during dialysis, the total amount of dialysate used during one haemodialysis session was collected. Dialysate samples were concentrated by evaporation. The dialysates containing 0.5mmol/L of magnesium were concentrated five times, those containing no magnesium were concentrated 25 times. The plasma and dialysate magnesium concentrations were determined by the spectrophotometric method of Man and Yoe [4].

The results were evaluated statistically with the Student's 't' test and the correlation tests. Results are given as mean ± standard deviation.

Results

Plasma magnesium

Plasma magnesium was first determined in a control group of 50 normal subjects of both sexes, mean value 1.00±0.03mmol/L.

There was no significant difference of pre-dialysis magnesium between patients dialysed against dialysate containing 0.5mmol/L (1.43±0.43mmol/L) and those dialysed against magnesium-free dialysate (1.55±0.57mmol/L; $p>0.5$). The difference between pre- and post-dialysis plasma magnesium was lower in the magnesium-containing dialysate group (0.31±0.09mmol/L; $p<0.02$) than in the group dialysed against magnesium-free dialysate (0.51±0.1mmol/L; $p<0.005$). This difference was significant in both groups. Nevertheless, dialysis allowed only partial and transitory correction of hypermagnesaemia since the pre-dialysis magnesium values remained high in both groups.

Dialysis magnesium

Prior to dialysis, the concentrations of magnesium-containing dialysate were controlled by direct determination. Magnesium-free dialysate was controlled by the evaporation technique. The values obtained were 0.5mmol/L and less than 0.03mmol/L respectively.

Magnesium loss during dialysis

The mean magnesium loss during dialysis, measured by collection of total spent dialysate, was slightly lower with magnesium-containing dialysate (2.43±0.49 mmol/L/hr) than with magnesium-free dialysate (3.46±0.35mmol/L/hr; $p<0.2$). Mean daily dialysis magnesium loss was 2.89mmol with 0.5mmol/L dialysate and 4.43mmol with magnesium-free dialysate. A positive linear correlation between pre-dialysis plasma magnesium and the amount of magnesium lost during dialysis existed only in patients treated with magnesium-free dialysate ($r=0.79$; $p<0.005$).

Urinary magnesium

Five of the 18 patients were anuric. Eight patients had a daily urine output of less than 1,000ml; their mean urinary magnesium excretion was 0.77±0.22mmol/d. In five patients the urine volume was more than 1,000ml/day and the mean magnesium excretion was 1.74±0.27mmol/d. The mean urinary magnesium loss of those 13 patients was 1.15mmol/d, and the maximal urinary loss during a 24-hour period was 2.15mmol. Among the patients who had a diuresis, there was no correlation between the daily urinary magnesium excretion and the plasma magnesium ($r=0.28$; $p>0.5$).

Dietary magnesium

The magnesium content of the 'dialysis diet' (low in salt, potassium, and protein) given in our hospital was calculated. All meals were collected during one week and the mean daily intake of magnesium was determined to be 10mmol. Since patients were taught by dieticians to maintain similar dietary intake at home, we assumed that their magnesium intake was similar to that contained in the hospital diet.

Magnesium-containing phosphate binders

In the 18 patients, magnesium intake due to the use of magnesium-containing phosphate binders varied from 2.1 to 64.5mmol per day. Variation in the magnesium-containing phosphate binders resulted from attempts to maintain plasma phosphate <1.6mmol/L. Magnesium drug intake was 20.7±12.2mmol in the magnesium-containing dialysate group and 24.8±19.6mmol in the magnesium-free dialysate group ($p>0.5$). Among the patients, there was a strong positive linear correlation between drug magnesium and pre-dialysis magnesium concentrations ($r=0.85$; $p<0.001$). This correlation was not higher when only the group with magnesium-free dialysate was considered ($r=0.86$; $p<0.001$). Nine patients then received non-magnesium-containing phosphate binders and pre-dialysis magnesium decreased from 1.55±0.87mmol/L to 1.05±0.15mmol/L; $p<0.05$) after only one month.

Discussion

This study shows that decreasing the magnesium content in the dialysate from 0.5 to 0.0mmol/L has no influence on plasma values. These results contradict previously published observations, where variations in magnesium dialysate concentrations were accompanied by variations in magnesaemia [2,5].

In our study, the 18 patients exhibiting hypermagnesaemia all took phosphate binders containing magnesium hydroxide and aluminium hydroxide. At their prescribed levels, these drugs represent a daily magnesium intake of up to 64.5 mmol. Magnesium loss during dialysis with magnesium-free dialysate provided only minimal, temporary reductions in plasma magnesium.

When uraemic patients are dialysed with low magnesium or magnesium-free dialysate and treated with non-magnesium-containing phosphate binders, the amount of magnesium extracted during dialysis allows a return to normal of the plasma magnesium [5,6]. Our study shows, however, that in patients with chronic renal failure, whose daily magnesium intake is strongly increased by phosphate binders, the use of magnesium-free dialysate does not allow the correction of hypermagnesaemia. Indeed, a strong positive linear correlation between drug magnesium and plasma magnesium is evidenced. We conclude, therefore, that hypermagnesaemia in our patients results from an imbalance in the patients' magnesium intake and removal and that this hypermagnesaemia cannot be treated successfully by dialysing the patient with magnesium-free dialysate.

It has been claimed that the use of high dialysate magnesium has a suppressive action on parathyroid hormone secretion and therefore allows a better control of renal osteodystrophy [2]. However, provided that normalization of plasma phosphate and calcium has been attained, an increase in dialysate magnesium from 0.75 to 1.25mmol per litre did not induce a significant decrease of plasma parathyroid hormone [3]. Even though a low plasma magnesium slightly increases plasma parathyroid hormone, it has dubious clinical significance with regard to calcium and phosphate homeostasis and renal osteodystrophy. We therefore feel that the use of high dialysate magnesium to control parathyroid hormone secretion should no longer be recommended.

Furthermore, correction of hypermagnesaemia has allowed improvement of uraemic polyneuropathy [7], pruritus [5,8] and osteomalacia [9]. Therefore, normalization of plasma magnesium should be attained. The fear that the long-term use of magnesium-free dialysate could lead to magnesium depletion is not justified. Catto et al [10], despite using magnesium-free dialysate for five years and limiting the dietary magnesium intake, have shown that bone magnesium content, a sensitive parameter of cellular magnesium depletion, remained high.

Our results indicate that the use of magnesium-free dialysate to maintain normal magnesium concentrations in chronic haemodialysis patients is not applicable when the patients are prescribed magnesium-containing phosphate binders. Therefore, administration of magnesium-containing phosphate binders to minimize aluminium intake in dialysis patients should be controlled carefully in order to avoid hypermagnesaemia.

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