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CONTROL OF HYPERPHOSPHATAEMIA BY ORAL MAGNESIUM CARBONATE ON ZERO MAGNESIUM DIALYSATE WITHOUT ALUMINIUM BINDERS

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Summary

In October 1983 all patients dialysing in the renal unit were changed from a regime of aluminium hydroxide ($Al(OH)_3$) as a phosphate binder and dialysate magnesium of 0.85mmol/L to a regime of zero magnesium dialysate with magnesium carbonate ($MgCO_3$) as phosphate binder with elimination of $Al(OH)_3$ from treatment. After 18 months on this regime we have found a significant fall in pre-dialysis aluminium. Pre-dialysis phosphate has not changed significantly but remains above the normal range. We have found no evidence of an increased incidence of secondary hyperparathyroidism. Pre-dialysis magnesium has also shown a significant fall. Our data suggest that aluminium containing phosphate binders are unnecessary for the control of hyperphosphataemia. $MgCO_3$ may be an alternative and as yet less toxic compound.

Introduction

Phosphate retention ensues when 75 per cent of renal function has been lost, leading to secondary hyperparathyroidism and extraskeletal calcification. To control the symptoms and signs of hyperphosphataemia the pre-dialysis plasma level should be maintained below 2mmol/L [1]. Diets chosen for their low nitrogen low phosphate content still require phosphate binders such as $Al(OH)_3$, but aluminium retention causes osteomalacia, myopathy, dementia and anaemia.

The first objective was to eliminate $Al(OH)_3$ from our dialysis regime and the second was to use magnesium salts as an alternative binder without producing the complications of hypermagnesaemia.

We had previously shown that pre-dialysis serum magnesium is directly proportional to dialysate magnesium [2]. This encouraged us to omit $Al(OH)_3$ from therapy, omit magnesium from the dialysate and add magnesium carbonate $MgCO_3$ to treatment, avoiding large doses of vitamin D where possible because of its effects on serum magnesium [4].

Patients and methods

In October 1983 all patients on chronic hospital haemodialysis were changed from $Al(OH)_3$ phosphate binders and dialysate magnesium concentration of 0.85mmol/L to a regime of zero magnesium dialysate. Dialysate calcium concentration was maintained at 1.65mmol/L. Patients were dialysed for eight to 16 hours weekly. $MgCO_3$ was given at doses of 1.56g to 4.5g daily. Eleven of 25 patients received 0.25μg to 1μg of 1-Alphahydroxycholecalciferol (1 ALPHA) daily. The patient who underwent parathyroidectomy received up to 4μg of 1-ALPHA daily at one stage.

Pre-dialysis calcium, alkaline phosphatase, magnesium and aluminium were measured periodically. Aluminium measurements were by graphite furnace atomic absorption spectroscopy.

Results

The results on 25 patients dialysing for between four and 18 months (mean 11 months) are reported. The data are summarized in Tables I and II.

TABLE I. Mean pre-dialysis concentrations ± SD

Month	$Al(OH)_3$ 9/83	$MgCo_3$ + zero magnesium dialysate. 12/83	6/84	1/85	4/85	p value
Phosphate*	1.78 ±0.4	1.95 ±0.65	1.54 ±0.73	2.17 ±0.55	1.94 ±0.7	NS
Magnesium*	1.52 ±0.35	1.01 ±0.44	1.33 ±0.4	1.16 ±0.32	1.17 ±0.35	<0.01
Calcium**	2.4 ±0.23	2.31 ±0.28	2.34 ±0.21	2.35 ±0.28	2.35 ±0.12	NS
Aluminium*	3.01 ±0.24	–	–	–	0.55 ±0.23	**** <0.01
Potassium*	5.9 ±1.2	5.8 ±1.2	5.9 ±1.0	5.9 ±0.8	5.8 ±1.2	NS
Alkaline phosphatase***	116 ±97	115 ±120	120 ±80	120 ±78	123 ±80	NS

* mmol/L
** μmol/L
*** Normal range <85
NS Not statistically significant
**** Statistically significant (p<0.01)

TABLE II. Six patients with raised alkaline phosphatase levels

	Age	Sex	Alkaline phosphatase	Calcium	Phosphate	Magnesium	Treatment
1.	46	M	131	2.11	2.74	1.24	Parathyroidectomy
2.	55	M	232	2.32	1.41	0.85	(1-ALPHA-OHD$_3$)
3.	23	M	465–182	1.94	2.28	1.15	(1-ALPHA-OHD$_3$)
4.	29	M	235	2.25	1.53	1.14	(1-ALPHA-OHD$_3$)
5.	29	M	85–140	2.38	1.96	0.75	(1-ALPHA-OHD$_3$)
6.	22	M	85–224	2.45	1.8	0.75	(1-ALPHA-OHD$_3$)

Phosphate and hyperparathyroidism

The mean pre-dialysis phosphate in the unit throughout the period of the study has been 1.97±0.14 (SD) mmol/L, not significantly different from that before the change in the regime (1.9±0.14mmol/L). Six patients had raised alkaline phosphatase values (Table II). Two of these patients (patients 1 and 2) had raised alkaline phosphatase with elevated parathyroid hormone (PTH) before the study; one has undergone parathyroidectomy with resolution of biochemical abnormality; the other has had reasonable phosphate control (mean 1.8mmol/L) and normocalcaemia. Patient 3 has had a return to normal alkaline phosphatase since starting 1-ALPHA therapy. The fourth patient presented in end-stage renal failure and has started on 1-ALPHA. The other two patients developed high alkaline phosphatase after nine months on the regime. They were both asymptomatic with reasonable phosphate control (mean 1.96±0.28 and 1.8± 0.42mmol/L). Both have raised PTH and have started 1-ALPHA.

Magnesium

The mean pre-dialysis magnesium runs at 1.16±0.6mmol/L ($p<0.01$). We thought that the low magnesium might be due to non-compliance and be reflected by a higher phosphate value. However, there was no correlation between magnesium and phosphate values ($r=0.051$).

Aluminium

Mean pre-dialysis aluminium has shown a significant fall from 3.01±1.24μmol/L to 0.55±0.23μmol/L ($p<0.01$).

There has been no significant change in pre-dialysis calcium, alkaline phosphatase or potassium.

Discussion

Berlyne et al in 1970 [5] reported hyperaluminaemia in patients with renal failure ingesting aluminium resins. Magnesium salts also bind potassium strongly,

rendering it unabsorbable, but the use of magnesium containing phosphate binders without adjustment of dialysate magnesium has been reported to cause severe bone disease [6].

After 18 months using magnesium-free dialysate and $MgCO_3$ as a phosphate binder, serum phosphate has been reasonably, if not excellently, controlled. We have not encountered an increased incidence of hyperparathyroidism as judged by alkaline phosphatase in the face of lower plasma aluminium. Serum magnesium has been significantly lower on the new regime. Serum aluminium has also shown a significant fall. This is an interim report and we have some reservations about the possible long-term effects. Patients in chronic renal failure have high serum magnesium, but tissue measurements have given variable results, high, low, and normal. We have previously shown an increase in PTH in the majority of patients dialysed against a lowered dialysate magnesium [2] as also has been noted by Nilson [7].

We intend to perform bone biopsies at two years to assess magnesium status and correlate this with bone histology and PTH. Kanis et al [8] found no evidence that concomitant ingestion of 1-ALPHA increased magnesium absorption and we have found no significant difference in magnesium concentrations between those on 1-ALPHA and those not taking this supplement.

Our evidence suggests that we have not increased total body magnesium load. If this is borne out by more definite measurements of body magnesium (bone and muscle biopsy, white blood cell magnesium content) then we may be in a position to improve phosphate control by increasing doses of $MgCO_3$.

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